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

CERTIFIED TEST REPORT ADDENDUM
USING THIRD PARTY DISKS

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 addendum test report certifies that the UltraSIL™ Polymer-Housed VariSTAR™ Type UHS Heavy Duty Distribution Class SurgeArresters were successfully tested to IEEE Std C62.11™-2020 standard "IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits" using a third party sourced MOV disk. This supplements the main certified test report.

OBJECTIVE

To demonstrate that the UltraSIL Polymer-Housed VariSTAR Type UHS Distribution Class Surge Arresters meet all disk type test performance requirements using a third party sourced MOV disk.

PROCEDURE

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

DESIGN TESTS

	Test Description	Per IEEE Std C62.11™-2020 section
A.	Discharge Voltage Current Characteristics	8.2
B.	Accelerated Aging Procedure	8.5
C.	Single impulse Energy Rating Test (Q_{rs})	8.12
D.	Heat Dissipation Behavior Verification of Test Samples	7.2.2
E.	Operating Duty Test for distribution arrester (Q_{th})	8.13
F.	Temporary Overvoltage (TOV) Test	8.14

RESULTS

UltraSIL Polymer-Housed VariSTAR Type UHS Distribution Class Surge Arresters met all performance requirements.

TEST A
DISCHARGE VOLTAGE CURRENT CHARACTERISTICS

Normalized lightning impulse discharge voltages

OBJECTIVE
To determine the maximum discharge voltage characteristics of the VariSTAR Type UHS Heavy Duty Distribution Class Surge Arresters at 1.5, 3, 5, 10, 20 and 40 kA crest in accordance with IEEE Std C62.11™-2020 standard.

PROCEDURE
- Sample arresters were impulsed using an 8 x 20 µs wave shape at 1.5, 3, 5, 10, 20 and 40 kA crest.
- The discharge voltage crest was measured.

RESULTS
Table 1 shows the maximum 8 x 20 discharge voltages for the VariSTAR Type UHS Heavy Duty Distribution Class Surge Arresters.

Normalized FOW discharge voltage

OBJECTIVE
To obtain the front-of-wave and switching impulse protective levels of the VariSTAR UHS Heavy Duty Distribution Class in accordance with IEEE Std C62.11™-2020 standard.

PROCEDURE
Determination of FOW discharge voltage:
- A current of 10 kA was used to determine the front-of-wave protective level
- Three samples were impulsed using front time of 1 µs
- The samples were impulsed using front time of 8 µs (Test B)
- A metal block was impulsed using front time of 1 µs
- For each sample, the voltage trace of the metal block was subtracted from the voltage trace measured on the sample
- The normalized FOW discharge voltage for each sample was determined by dividing the maximum voltage of the sample with 1 µs front time (excluding inductive voltage) by the 8 µs front time voltage
- The highest of the three normalized results is reported.

RESULTS
Table 1 shows the normalized front-of-wave impulse protective levels for the VariSTAR UHS Heavy Duty Distribution Class.

Table 1

UHS		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 B
ACCELERATED AGING

OBJECTIVE
To verify the that the metal-oxide disks of the VariSTAR Type UHS Heavy Duty Distribution Class remain stable and do not increase in power dissipation at MCOV during their expected lifetime in accordancewith IEEE Std C62.11™2020 standard.

PROCEDURE
- Samples were placed in an oven at 115°C and energized at MCOV for 1,000 hours.
- The watts loss was measured at the MCOV voltage level within two to five hours after the start of the test.
- The watts loss was remeasured at 1,000 hours at MCOV and duty cycle voltage levels.

RESULTS
The final watts loss did not exceed the initial watts loss therefore meets all performance requirements.

TEST C
SINGLE IMPULSE CHARGE TRANSFER TEST

OBJECTIVE

To demonstrate that the VariSTAR Type UHS Heavy Duty Distribution Class Surge Arrester series meets the single impulse charge transfer rating capability (Q_{rs}). The capability expressed in Coulombs represents the maximum charge transfer of a single current impulse that the arrester can withstand multiple times without causing physical or electrical damage for distribution arresters in accordance with IEEE Std C62.11™-2020 standard.

PROCEDURE

- Ten VariSTAR samples of the 36 mm nominal diameter with the greatest nominal length used in the arrester design with the highest discharge voltage at the classifying current that is used in the design.
- Each sample was impulsed with the lightning impulse classifying current and the reference voltage was measured at the reference current.
- Each sample was subjected to ten groups of two current impulses were subject to twenty lightning impulses 8/20 with an amplitude resulting in a current density of 0.5kA/cm2, divided into ten groups of two operations, with approximately 60 seconds between impulses.
- The charge content of the impulses were 1.1 times the single impulse charge transfer rating claimed for the test as defined in IEEE Std C62.11™-2020 standard.
- The samples were permitted to cool after each group of two impulses.

RESULTS

VariSTAR UHS Heavy Duty Distribution Class Surge Arresters met the Single Impulse charge transfer rating of 0.5 C as claimed with ten samples passing the requirements of 20 impulses, <5% change in discharge voltage andreference voltage, and no physical damage.

TEST D
HEAT DISSIPATION BEHAVIOR VERIFICATION OF TEST SAMPLE

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 22.0°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 19.8°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 hour.

TEST E
Operating Duty Test for Distribution Arresters

OBJECTIVE
To demonstrate that the VariSTAR Type UHS Heavy Duty Distribution Class Surge Arrester series meets the multiple discharge switching surge energy capability withstand (Q_{th} - thermal charge transfer rating) claimed for heavy duty distribution arresters in accordance with IEEE Std C62.11™-2020 standard.

PROCEDURE
- Three prorated equivalent thermal sections were used for this test.
- Each sample was impulsed with the lightning impulse classifying current.
- The samples were then subjected to one 100 kA 4/10 µs impulses.
- The prorated sections were placed into an oven until they stabilized at 60 °C.
- Upon removal from the oven, the samples were subject to two 8/20 lightning impulses so that the accumulated charge is greater than the thermal charge transfer rating claimed. The impulses were applied 50 to 60 seconds apart.
- Within 100 ms after the second discharge, the sample was energized at duty cycle rated voltage for 10 sec, followed by the power frequency recovery voltage was applied and the watts loss was monitored for a minimum of 30 minutes to verify thermal recovery.

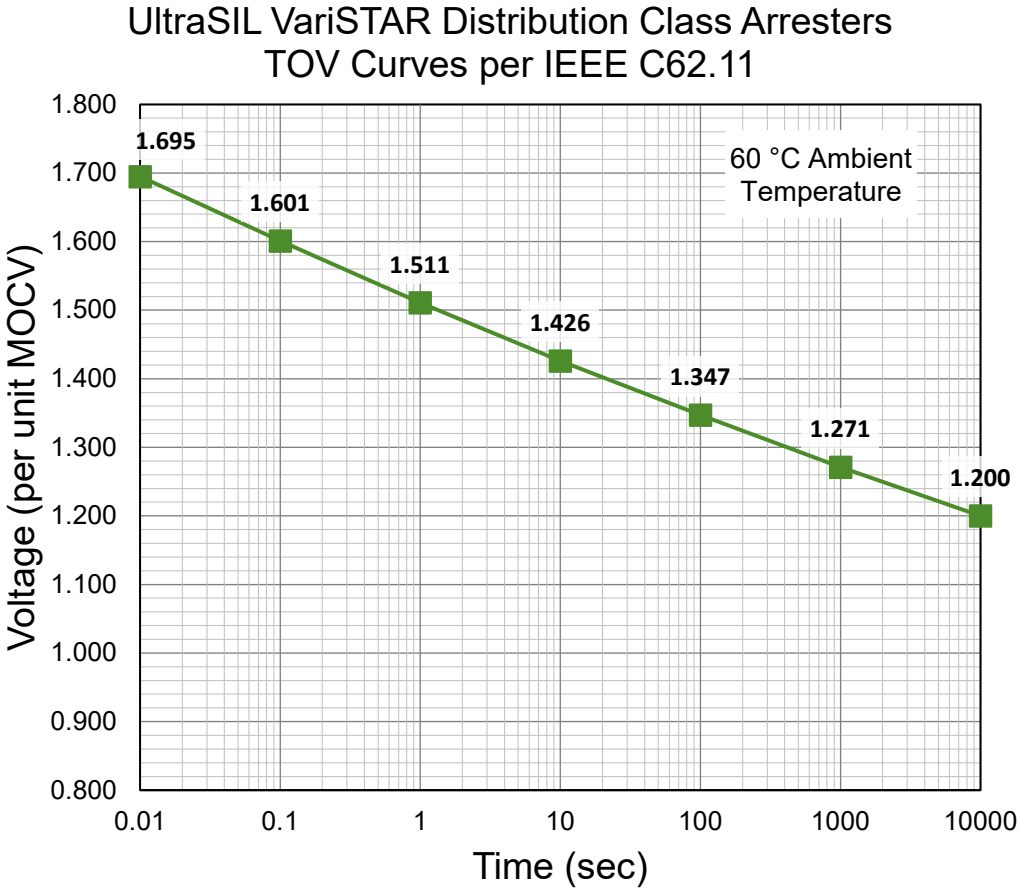
RESULTS
VariSTAR Type UHS Heavy Duty Distribution Class Surge Arrester series met the twoshot thermal charge transfer rating (Q_{th}) of 1.1 C and demonstrated thermal recovery, no sign of physical damage, and the lightning impulse discharge voltage at the classifying current changed by less than 5 %.

TEST F
TEMPORARY OVERVOLTAGE (TOV)

OBJECTIVE
To verify what levels of power frequency temporary overvoltage the VariSTAR Type UHS Heavy Duty Distribution Class survive in accordance with IEEE Std C62.11™-2020 standard.

PROCEDURE
- Prorated equivalent thermal sections were used for this test.
- Each sample was impulsed with a 10kA crest, 8 x 20 µs wave and the discharge voltage measured.
- Samples were preheated to 60°C.
- Each sample was removed from the oven and immediately energized at the overvoltage.
- The overvoltage was removed before sample failure.
- Within 1 second, each sample was energized at the thermal recovery voltage per IEEE Std C62.11™- 2020 standard for 30 minutes. Sample current and power loss were monitored for thermal runaway.
- Each sample was impulsed with a 10kA crest, 8 x 20 µs wave and the discharge voltage measured. The discharge voltage was compared to the discharge voltage taken prior to the Temporary Overvoltage testing to make sure that it did not vary by more than 5%.
- The samples were inspected after testing to assure that no physical damage occurred.
- Temporary overvoltage test points were plotted.
- The above test procedures were repeated with "prior duty" energy applied to the arrester before the TOV is applied.
- The "prior duty" energy applied to the arrester before the TOV was the energy generated in two 8/20 lightning impulse surges greater than the two shot thermal charge transfer rating (Q_{th}) of 1.1 C.

RESULTS



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