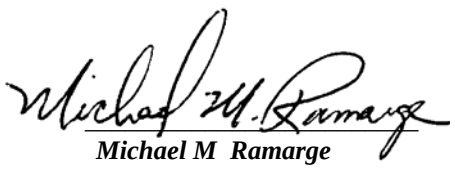
CLU Arrester

Certified Test Report

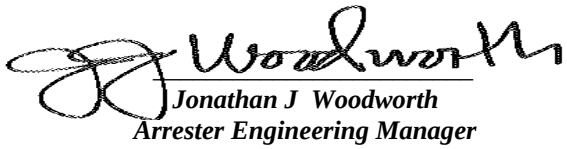
IEEE Standard C62.11™-1999

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.



Michael M Ramarge
Chief Engineer



Jonathan J Woodworth
Arrester Engineering Manager

INTRODUCTION

This test report certifies that the VariSTAR arresters CLU were successfully tested to IEEE C62.11-1999 "Metal-Oxide surge arresters for a.c. circuits (>1kV)".

TEST PROGRAM

OBJECT

To demonstrate that the VariSTAR CLU Arrester 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…….	Per IEEE C62.11 Section 8.1.1
B.	Discharge-Voltage Characteristics	
	a) Discharge-voltage Current Characteristics..…..	Per IEEE C62.11 Section 8.3.1
	b) Discharge-voltage Time Characteristics……	Per IEEE C62.11 Section 8.3.2
C.	Accelerated Aging Procedure…….	Per IEEE C62.11 Section 8.5
D.	High Current, Short Duration ……...	Per IEEE C62.11 Section 8.10.1
E.	Low Current, Long Duration ……	Per IEEE C62.11 Section 8.10.2
F.	Operating Duty Cycle Test ……..…….	Per IEEE C62.11 Section 8.11
G.	Power Frequency Voltage vs. Time …….	Per IEEE C62.11 Section 8.12.2
H.	Failure Mode Test for Liquid-immersed Arresters	
	a) Test for fail-open mode……..	Per IEEE C62.11 Section 8.16.2.2
	b) Test for fail-short mode……..	Per IEEE C62.11 Section 8.16.2.3

RESULTS

The VariSTAR CLU arresters met all performance requirements of **IEEE C62.11™**-1999.

TEST A:
INSULATION WITHSTAND

Test Report Number: 13-7351-20-05-039
Certifying Laboratory: Thomas A. Edison Technical Center

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

Procedure: The test samples were mounted in mineral oil, meeting ASTM D3487-88 (1993), at room temperature. The samples were subject to positive and negative 1.2 X50 μs voltage impulses which were larger than the minimums in Table 4, IEEE C62.11™-1999. These samples were also subject to 60 Hz withstand voltages higher than the minimums in Table 4, IEEE C62.11™-1999.

Results: None of the samples flashed over during any of the above tests in accordance with requirements.

TEST B:
DISCHARGE-VOLTAGE CHARACTERISTICS

Test Report Number: 13-7351-20-05-035
Certifying Laboratory: Thomas A. Edison Technical Center

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

Discharge-Voltage Current Characteristics
Procedure: The sample arresters were impulsed using an 8 X 20 μs wave shape at 1.5, 3, 5, 10, 20, and 40kA crest. The discharge voltage crest was measured.

Discharge-Voltage Time Characteristics
Procedure: A classifying current of 5kA crest was used to determine the equivalent front-of-wave protective level. The arresters were impulsed using front times of 8 μs, 2 μs, and 1 μs. The maximum discharge voltage and the time to voltage crest were measured. The voltage/time measurements were plotted on linear voltage versus log time paper and the maximum voltage at 0.5 μs was determined and recorded.

Result:

Duty Cycle Voltage Rating (kV)	COV (kV)	Front-of-Wave Protective Level (kV, crest)	Maximum Discharge Voltage (kV, peak) 8/20 μs Current Wave						Switching Surge (kV, peak) 30/60 μs Current Wave	
			1.5 kA	3 kA	5kA	10kA	20kA	40kA	500A	1.5 kA
3	2.55	10.5	8.6	9.2	9.9	10.8	12.4	14.4	7.5	8.1
6	5.10	20.9	17.1	18.5	19.8	21.6	24.7	28.7	15.0	16.2
9	7.65	31.5	25.8	27.8	29.8	32.6	37.2	43.2	22.6	24.3
10	8.40	33.4	27.4	29.5	31.6	34.5	39.4	45.9	24.0	25.8
12	10.2	42.0	34.4	37.0	39.7	43.4	49.5	57.6	30.1	32.4
15	12.7	50.8	41.6	44.8	48.0	52.5	59.9	69.6	36.4	39.2
18	15.3	63.1	51.6	55.6	59.6	65.1	74.4	86.5	45.2	48.7
21	17.0	66.9	54.7	59.0	63.2	69.1	78.9	91.7	48.0	51.6
24	19.5	77.3	63.3	68.2	73.1	79.9	91.2	106	55.5	59.7
27	22.0	89.8	73.5	79.2	84.9	92.8	106	123	64.4	69.4
30	24.4	97.8	80.0	86.2	92.4	101	115	134	70.1	75.5
33	27.0	111	90.9	98.0	105	115	131	152	79.7	85.8
36	29.0	117	96.1	104	111	121	139	161	84.2	90.7

TEST C:
ACCELERATED AGING PROCEDURE

Test Report Number: 13-7351-20-04-072
Certifying Laboratory: Thomas A. Edison Technical Center

Object: To verify K_C (MCOV Ratio) and K_R (Duty Cycle Ratio) of the arresters.

Procedure: MOV valve elements were placed in mineral insulating oil, meeting ASTM D3487-88 (1993), and energized at MCOV for a period of 7000 hours. The watts loss was measured at the MCOV and duty cycle voltage levels within two to five hours after the start of the test. The watts loss was re-measured at 7000 hours at MCOV and duty cycle voltage levels.

Results: Power ratios for both measurements were equal to or less than 1 for the 7000 hr test procedure in standard transformer oil (mineral oil based).

TEST D:
HIGH CURRENT, SHORT DURATION

Test Report Number: 5A4-13-1
Certifying Laboratory: Cooper Power Systems, Olean, NY

Object: To demonstrate the ability of the arrester to meet the high current, short duration test requirements.

Procedure: The samples were tested in mineral oil meeting ASTM D3487-88 (1993) with a temperature 75 $\pm$ 5°C. The samples were subject to two 4/10 μs impulse current waves having 40kA crest amplitude. The samples were allowed to cool between impulses. Within five minutes of the second discharge each arrester was energized at the thermal recovery voltage for 30 minutes minimum.

Results: The samples achieved thermal stability and were not physically damaged.

TEST E:
LOW CURRENT, LONG DURATION

Test Report Number: 5A4-12-1
Certifying Laboratory: Thomas A. Edison Technical Center

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

Procedure: The samples were tested in mineral oil meeting ASTM D3487-88 (1993) with a temperature 20 $\pm$ 5°C. The samples were subject to twenty 2000 μs rectangular current waves having 75kA crest amplitude. The first eighteen impulses were applied in three groups of six operations and cool between groups of operations. Prior to the nineteenth impulse the arrester temperature was equilibrated at 120°C. Within five minutes of the twentieth impulse the arrester was energized at the thermal recovery voltage for 30 minutes minimum.

Results: The samples met test requirements with less than 10% change in residual voltage, achieving thermal stability, and no physical damage.

TEST F:
OPERATING DUTY CYCLE TEST

Test Report Number:	13-7351-20-05-034
Certifying Laboratory:	Thomas A. Edison Technical Center

Object: To demonstrate the ability of the arrester to meet the duty cycle test requirements.

Procedure: The samples were tested in mineral oil meeting ASTM D3487-88 (1993). The samples were each energized at K_R times the duty cycle voltage (K_R= 1), for the duration of the time needed to allow 20 impulses. Each sample was impulsed with a 5kA crest surge of 8X 20 μs wave shape. The impulse occurred at approximately 60^o before the crest on the power frequency wave with 50-60 seconds between impulses. After the twentieth impulse the samples were heated to 120 $\pm$ 5 ^oC. Once at temperature, the samples were impulsed at 5kA. Samples remained energized at the thermal recovery voltage for 30 minutes minimum.

Results: The samples met test requirements with less than 10% change in residual voltage, achieving thermal stability, and no physical damage.

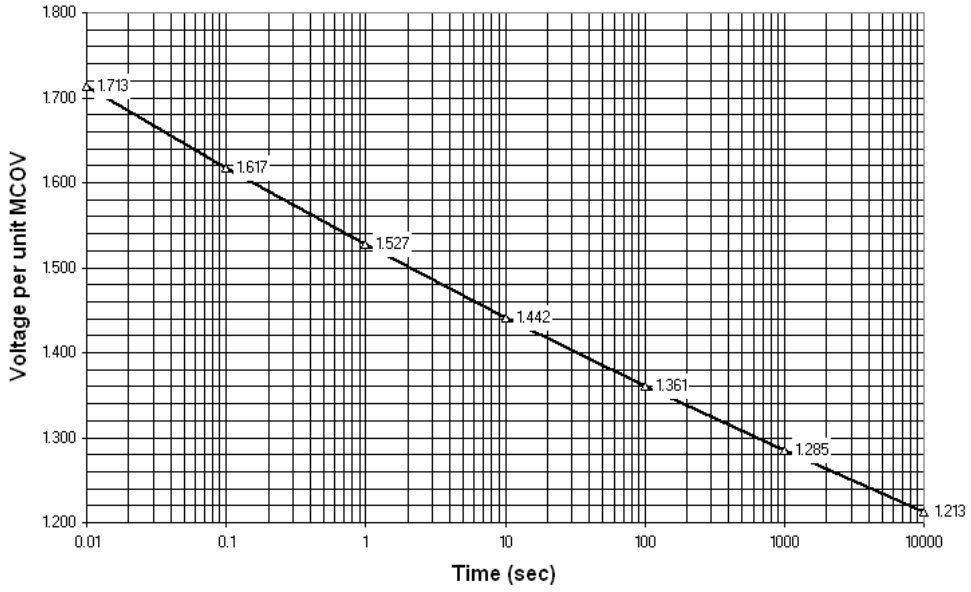
TEST G:
POWER FREQUENCY VOLTAGE VS. TIME

Test Report Number: 13-7351-20-05-033
Certifying Laboratory: Thomas A. Edison Technical Center

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

Procedure: The sample was placed in mineral oil meeting ASTM D8347-88 (1993) and heated to the temperature 120°±5°C. The sample was then subject to each over voltage at each specified time range. The recovery voltage was applied to the sample for thirty minutes.

Results:



TEST H:
FAILURE MODE TEST FOR LIQUID-IMMERSED ARRESTERS

TEST FOR FAIL-OPEN MODE:

Test Report Number: 13-7351-19-05-012
Certifying Laboratory: Thomas A. Edison Technical Center

Object: To verify the fail-open current rating above which the arrester is claimed to evolve into an open circuit upon failure.

Procedure: The samples tested were three of both the highest and lowest ratings available. The samples were mounted in mineral oil meeting ASTM 8347-88 (1993). Samples were pre-killed using an over voltage applied less than 5 minutes.

Results: The arresters failed open above 1250 Amps.

TEST FOR FAIL-SHORT MODE:

Test Report Number: 13-7351-19-05-009
Certifying Laboratory: Thomas A. Edison Technical Center

Object: To verify the fail-open current rating below which the arrester is claimed to evolve into a short circuit upon failure.

Procedure: The samples tested were three of both the highest and lowest ratings available. The samples were mounted in mineral oil meeting ASTM 8347-88 (1993). Samples were pre-killed using an over voltage applied less than 5 minutes.

Results: The arresters failed short up to 5kA.