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Storm Trapper® H.E.
Low Voltage Distribution Arresters

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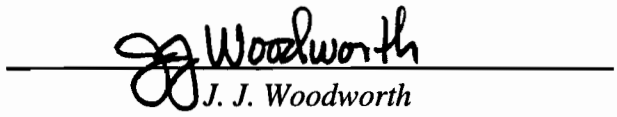
Low Voltage Distribution Arresters

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.



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INTRODUCTION

This test report certifies that the Storm Trapper® H.E. arresters were successfully tested to IEEE Standard C62.11-1993 *"IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits"*.

TEST PROGRAM

OBJECT

To demonstrate that the Storm Trapper H.E. Arresters meet all performance requirements.

PROCEDURE

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

DESIGN TESTS

A.	Insulation Withstand	Per IEEE C62.11-1993, Para. 8.1.1
B.	Discharge Voltage Current Characteristics	Per IEEE C62.11-1993, Para. 8.3.1
C.	Discharge Voltage Time Characteristics	Per IEEE C62.11-1993, Para. 8.3.2.1
D.	Accelerated Aging Procedure	Per IEEE C62.11-1993, Para. 8.5
E.	High-Current, Short-Duration	Per IEEE C62.11-1993, Para. 8.6.1
F.	Low-Current, Long-Duration	Per IEEE C62.11-1993, Para. 8.6.2.2
G.	Duty Cycle	Per IEEE C62.11-1993, Para. 8.7
H.	Internal Ionization and RIV	Per IEEE C62.11-1993, Para. 8.8
I.	Contamination Test	Per IEEE C62.11-1993, Para. 8.12
J.	Temporary Overvoltage (TOV)	Per IEEE C62.11-1993, Para. 8.15
K.	Seal Integrity	Per IEEE C62.11-1993, Para. 8.17
L.	Fault Current Withstand of Metal Enclosed Version	Per CPS Testing

RESULTS

The Storm Trapper H.E. arresters met all performance requirements.

TEST A
INSULATION WITHSTAND

OBJECT

To verify that assembled insulating members of the arrester withstand impulse and power frequency voltage tests in accordance with IEEE C62.11-1993, para. 8.1.1.

PROCEDURE

- New clean arrester housings of each rating were subjected to positive and negative 1.2 x 50 µs voltage impulses which were larger than the minimums in C62.11-1993, Table 2a.
- These arresters were also subjected to both wet and dry 60 Hertz withstand voltages higher than the minimums in C62.11-1993, Table 2a.
- The voltage was applied to the lead wire of a functional arrester while external grounding was attached to the housing.

RESULTS

None of the samples flashed over during any of the above tests in accordance with the insulation withstand requirements of IEEE C62.11-1993, Para. 8.1.1.

TEST B
DISCHARGE VOLTAGE CURRENT CHARACTERISTICS

OBJECT

To determine maximum discharge voltage characteristics of the arrester at 1.5, 3, 5, 10, 20 and 40 kA crest in accordance with IEEE C62.11-1993, para. 8.3.1.

PROCEDURE

- 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

Chart 1 shows the maximum discharge voltages for the arresters.

TEST C
DISCHARGE VOLTAGE TIME CHARACTERISTICS

OBJECT

To obtain the front-of-wave protective level of the arrester based on an impulse that results in a discharge voltage cresting in 0.5 μs in accordance with IEEE C62.11-1993, Para. 8.3.2.

PROCEDURE

- A classifying current of 5 kA 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.

RESULTS

Chart 1 shows front-of-wave protective levels for the arresters.

TEST D
ACCELERATED AGING PROCEDURE

OBJECT

To verify K_C and K_R ratios of the arresters in accordance with IEEE C62.11-1993, Para. 8.5.

K_C = MCOV Ratio
K_R = Duty Cycle Ratio

These ratios were determined to calculate the test values of MCOV and duty cycle voltages used during testing.

PROCEDURE

- MOV valve elements were placed in an oven at 115 °C and energized at MCOV for 1,000 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 remeasured at 1,000 hours at MCOV and duty cycle voltage levels.

- $K_C = \frac{\text{Watts Loss @ 1,000 Hrs @ MCOV}}{\text{Watts Loss @ 2-5 Hrs @ MCOV}}$

- $K_R = \frac{\text{Watts Loss @ 1,000 Hrs @ Rated Voltage}}{\text{Watts Loss @ 2-5 Hrs @ Rated Voltage}}$

- If K_C and $K_R \leq 1$, then K_C and K_R are equal to 1.

RESULTS

- K_C and $K_R < 1$ for the arresters.

TEST E
HIGH-CURRENT, SHORT-DURATION

OBJECT

To demonstrate that arresters meet the high-current, short-duration requirements in accordance with IEEE C62.11-1993, Para. 8.6.1.

PROCEDURE

- Three 480 volt Storm Trapper H.E. surge arresters were used for this test.
- Each arrester was impulsed with a 40 kA crest current wave with a wave shape of 4 x 10 µs.
- The arresters were allowed to cool to ambient temperature.
- Each arrester was impulsed a second time.
- Immediately following the second impulse, the arresters were energized at the thermal recovery voltage per C62.11, paragraph 7.2.2 (MCOV x K_W x K_C) for 30 minutes to verify thermal recovery.
- The arresters were inspected after testing to make sure that there was not any physical damage.

RESULTS

The arresters met the high-current, short-duration requirements of two impulses, thermal recovery, and no physical damage.

TEST F
LOW-CURRENT, LONG-DURATION

OBJECT

To demonstrate that arresters meet the low-current, long-duration requirements in accordance with IEEE C62.11-1993, Para. 8.6.2.2.

PROCEDURE

- Three 480 volt Storm Trapper H.E. surge arresters were used for this test.
- Each sample was impulsed with a 5 kA crest, 8x20 µs wave and the discharge voltage measured.
- Each arrester was impulsed using a 75 amp by 2,000 µs square wave six times, once every 50 to 60 seconds. The arresters were allowed to cool to room temperature. This procedure was repeated two more times.
- Immediately after the 18th shot, the arresters were placed into an oven until they stabilized at 60°C.
- The arresters were removed from the oven and impulsed two more times.
- Immediately after the 20th shot, the arresters were energized at the thermal recovery voltage per C62.11, paragraph 7.2.2 (MCOV x K_W x K_C) for 30 minutes minimum to verify thermal recovery.
- Each arrester was impulsed with a 5 kA crest 8x20 µs wave and the discharge voltage measured. The discharge voltage was compared to the discharge voltage taken prior to the low-current, long-duration testing to make sure that it did not vary by more than ±10%.
- The arresters were inspected after testing to assure that no physical damage occurred.

RESULTS

The arresters met the low-current, long-duration requirements of 20 impulses, thermal recovery, <10% change in discharge voltage, and no physical damage.

TEST G
DUTY CYCLE

OBJECT

To demonstrate arresters meet the duty cycle requirements in accordance with IEEE C62.11-1993, Para. 8.7.

PROCEDURE

- Three 480 volt Storm Trapper H.E. surge arresters were used for this test.
- Each arrester was impulsed with a 5 kA crest, 8x20 µs wave and the discharge voltage measured.
- Each arrester was energized at K_R times the duty cycle voltage (K_R = 1), for the duration of time needed to allow 20 impulses.
- Each arrester was impulsed with a 5 kA crest surge of 8x20 µs wave shape.
- The impulse occurred at approximately 60° before the crest on the power frequency wave.
- Each arrester was impulsed once every 50 to 60 seconds for 20 consecutive impulses.
- After the 20th impulse, the arresters were de-energized and placed into an oven until they stabilized at 60°C.
- Each arrester was removed from the oven and immediately energized at (MCOV x K_W x K_C) and impulsed twice more at a 5 kA crest within one minute.
- Arresters remained energized at the thermal recovery voltage for 30 minutes minimum to verify thermal recovery.
- Each arrester was impulsed with a 5 kA crest 8x20 µs wave and the discharge voltage measured. The discharge voltage was compared to the discharge voltage taken prior to duty cycle to make sure that it did not vary by more than ±10%.
- The arresters were inspected after testing to assure that no physical damage occurred.

RESULTS

The arresters met the duty cycle test requirements of 22 impulses, thermal recovery, <10% change in discharge voltage, and no physical damage.

TEST H
INTERNAL IONIZATION AND RIV

OBJECT

To verify that arresters do not generate unacceptable levels of internal ionization current or RIV noise in accordance with IEEE C62.11-1993, Para. 8.8.

PROCEDURE

- A 1.05 x MCOV power frequency voltage was applied across the line and ground terminals of arresters with different voltage ratings.
- RIV and ionization voltage measurements were taken at 1.0M Hertz.

RESULTS

All of the arresters had measured RIV and ionization voltages much lower than 10µV which was in accordance with IEEE C62.11-1993, Para. 8.8.

NOTE

All production arresters are 100% tested for RIV noise using an RIV tester (RIV ≤ 10 µV).

TEST I
CONTAMINATION TEST

OBJECT

To demonstrate the ability of the arresters to withstand the electrical stresses caused by contamination on the housing, in accordance with IEEE C62.11-1993, Para. 8.12.

PROCEDURE

- Arresters were energized for a minimum of one hour at MCOV.
- The watts loss at MCOV was measured at the end of the hour.
- The arresters were de-energized. Within 13 minutes, a 400-500 ΩcM slurry was applied to the housing heavily enough to form drops on the skirts.
- The arresters were energized at the MCOV voltage.
- The watts loss was measured after 15 minutes.
- The arresters were de-energized again and another slurry application was performed.
- The arresters were energized at MCOV for 30 minute intervals and the watts loss was monitored to verify decreasing levels towards the original measurement.
- Once the arresters were cleaned and dried, they were inspected for internal damage using partial discharge measurements at MCOV.

RESULTS

The arrester samples passed the test by having stabilized lower watts loss over time, by not flashing over and by not having any internal physical damage in accordance with IEEE C62.11-1993, Para. 8.12.

TEST J
TEMPORARY OVERVOLTAGE (TOV)

OBJECT

To verify what levels of 60 cycle temporary overvoltage the arresters survive in accordance with IEEE C62.11-1993, Para. 8.15.

PROCEDURE

- Each arrester was impulsed with a 5 kA crest, 8x20 μs wave and the discharge voltage measured.
- Arresters were preheated to 60 °C.
- Each arrester was removed from the oven and immediately energized at the overvoltage.
- The overvoltage was removed after the guaranteed duration.
- Within 1 mS, each arrester was energized at the thermal recovery voltage per C62.11, paragraph 7.2.2 (MCOV x K_w x K_c) for 30 minutes. Arrester current and temperature were monitored for thermal runaway.
- Each arrester was impulsed with a 5 kA crest 8x20 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 ±10%.
- The arresters were inspected after testing to assure that no physical damage occurred.
- Temporary overvoltage test points were plotted.

RESULTS

Graph 1 and Chart 2 show the performance results.

TEST K
SEAL INTEGRITY

OBJECT

To verify that the seal design of the Storm Trapper H.E. arrester is robust in accordance with C62.11-1993, Para. 8.17.

PROCEDURE

- Three arresters were subjected to all of the following tests.
- The RIV and watts loss was measured at the duty cycle rating.
- An AWG No. 1 solid wire was installed on the top and bottom terminals and torqued to 20 ft lbs.
- The arresters were temperature conditioned by heating them to 70°C for 14 days.
- Once the arresters returned to ambient temperature, they were heated to 60°C for one hour.
- The arresters were then placed in a 4°C cold water bath for two hours.
- The 60° to 4°C cycle was repeated 10 times.
- Within 24 hours of the last cycle, the RIV and watts loss were measured at the duty cycle voltage to verify that the RIV did not increase more than 20 μV and the watts loss did not increase more than 50% than the initial value.
- The arresters were internally inspected to verify that there was no moisture present.

RESULTS

The arresters met the test requirements in accordance with IEEE C62.11-1993, Para. 8.17.

TEST L
FAULT CURRENT WITHSTAND OF METAL ENCLOSED VERSION

OBJECT

To determine the fault current withstand of the metal enclosed (E-Series) Storm Trapper H.E.

PROCEDURE

- Five 480 volt arresters were electrically pre-failed by thermally overloading the MOV disks using excessive power frequency voltage.
- 22,000 amperes RMS of test current was applied to each arrester for 10 cycles (60 Hertz).
- Each arrester was visually inspected after the test.

RESULTS

All of the arresters stayed in one piece without any signs of form distortion.

CHART 1 — **Storm Trapper H.E. Arrester Discharge Voltages**

Duty Cycle Voltage Rating (kV)	MCOV (kV)	Equivalent Front-of-Wave (kV)*	Maximum Discharge Voltage (kV crest) 8/20 µs Current Wave					
			1.5 kA	3 kA	5 kA	10 kA	20 kA	40 kA
175	175	1.7	1.4	1.5	1.6	1.8	2.0	2.4
240	240	1.8	1.5	1.6	1.7	1.9	2.2	2.6
480	400	2.0	1.7	1.8	1.9	2.1	2.4	2.9
650	540	2.6	2.1	2.3	2.4	2.6	3.0	3.6

* Based on a 5 kA current impulse that results in a discharge voltage cresting in 0.5 µs.

GRAPH 1 — **TOV Recovery Curve of Storm Trapper H.E. Arresters**

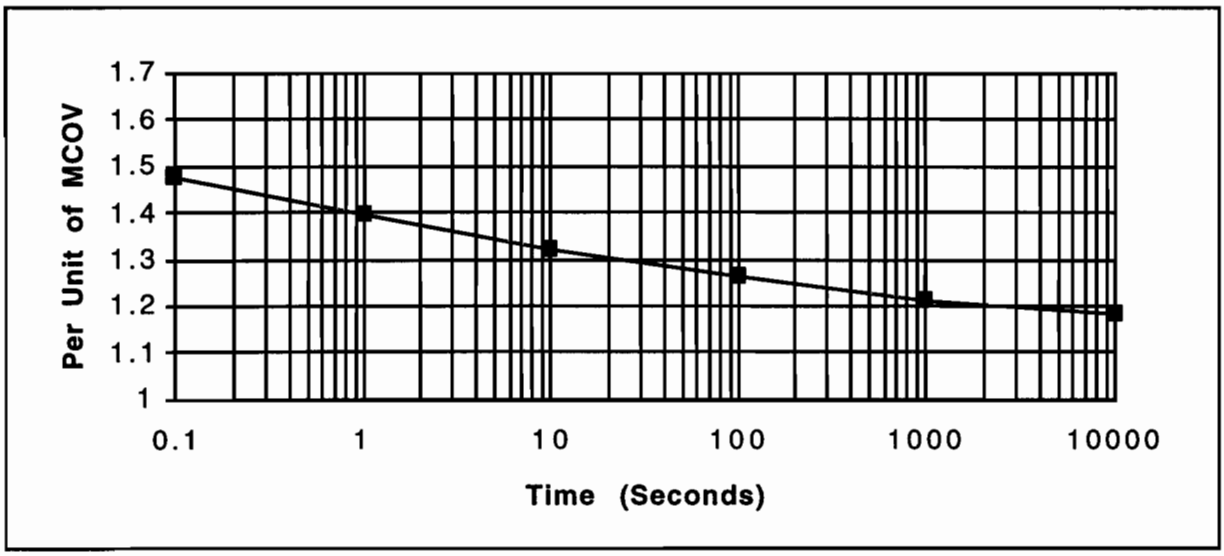

CHART 2 — **TOV Recovery Capability of the Storm Trapper H.E.**

Time, Seconds	Per Unit of MCOV
.1	1.475
1	1.395
10	1.320
100	1.260
1000	1.213
10000	1.185

Storm Trapper® is a registered trademark of Cooper Industries, Inc.

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