

***Product Assurance North Carolina***

**Qualification Testing of the  
Surge Protective Device Everprotect 4-120**

**NCTR-99-064**

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### 1. TEST BY VISUAL INSPECTION AND INSTALLATION ON APPROVAL

The Everprotect 4-120 is attached to the ground or the neutral conductor using a 1/2-20 threaded stud. The high voltage conductor is connected to the high voltage electrode using a 1/4-20 screw.

### 2. TEST OF EVERPROTECT 4-120 IDENTIFICATION

The following data are given on the name plate in a well legible way (name plate color is white with writing in black characters):

- Description of the product : Transient Voltage Surge Suppressant
- Type name of the manufacturer : Keyitec
- Suppressed Voltage Rating : 330 V
- Year of manufacture : week/year
- Trade Mark : Everprotect 4-120

### 3. TEST OF AIR DISTANCE AND CREEPAGE DISTANCE

The following table shows a comparison between the requirements on the air distance and the creepage distance between the active parts and the ground according to E DIN VDE 0675 / part 6 (table 3) and the actual values of the device.

Rated Voltage (V)	Air distance (mm)		Creepage distance for insulating material (mm)	
	Set	Actual	Set	Actual
300 to 600	5.5	20	11	20

**Table 1:** Creepage and air distance as measured on the Surge Protective Device and as stipulated by the standard.

The material used for the Everprotect 4-120 housing is 6061T6 Aluminum with the electrical insulation provided with ULTEM® 1000 of General Electric.

#### 4. TEST OF PROTECTIVE LEVEL WITH NORMAL DISCHARGE CURRENT

The tests were carried out on three new units of Everprotect 4-120.

##### 4.1 Determination of the V-I characteristics

The residual voltage at DC current in the range from 0.1 mA to 5 mA was measured on three new units. The results are shown in Table 2.

Sample	0.1 mA	0.5 mA	1 mA	5 mA
Q29	185	210	221	268
Q31	158	207	216	264
Q35	156	208	217	266

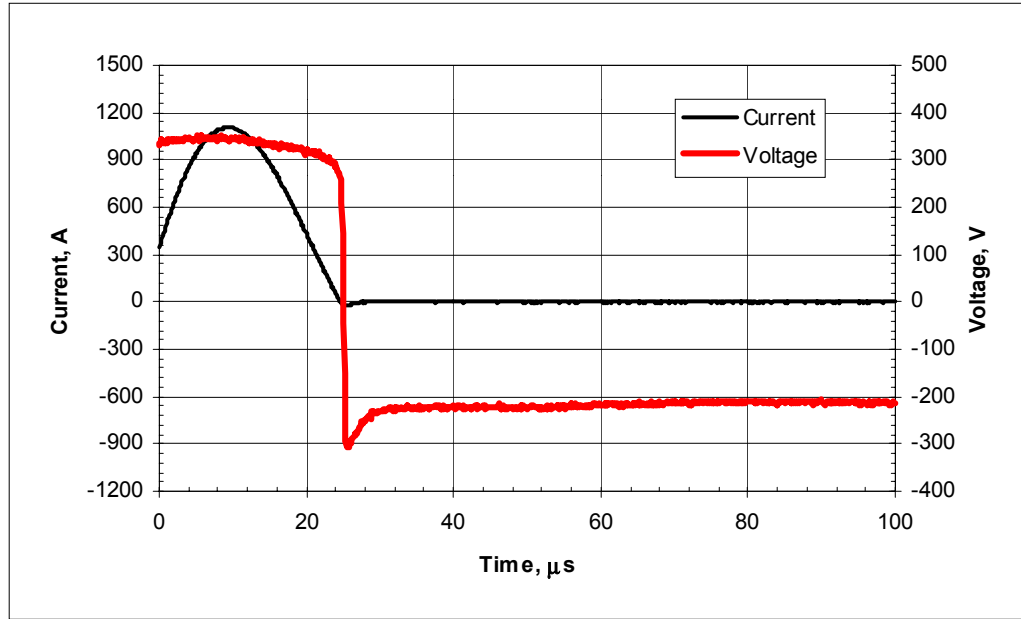
**Table 2:** DC voltage-current characteristics of the surge protective device samples.

The residual voltage test with lightning impulse current was made on the same samples with positive impulse current in the range 1 kA to 130 kA (8/20  $\mu$ s except for 100 kA and higher which are 4/10  $\mu$ s). Table 3 shows these results.

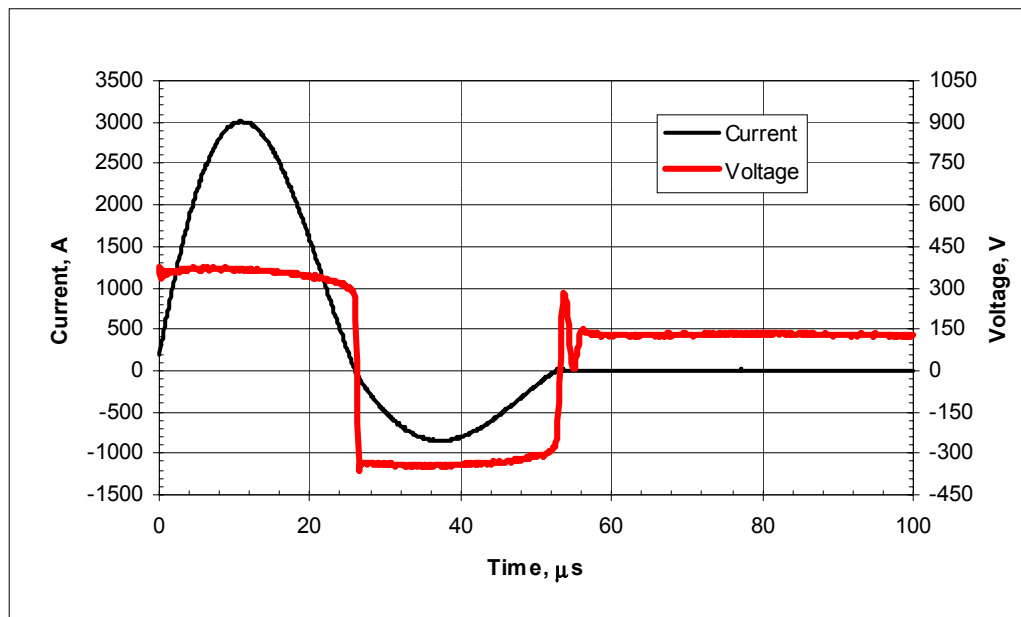
Sample	1 kA	3 kA	5 kA	10 kA	20 kA	40 kA	100 kA	130 kA
Q29	353	373	384	419	455	488	576	622
Q31	351	368	382	409	446	487	580	605
Q35	351	375	383	414	449	490	562	622

**Table 3:** Impulse voltage-current characteristics of the surge protective device samples.

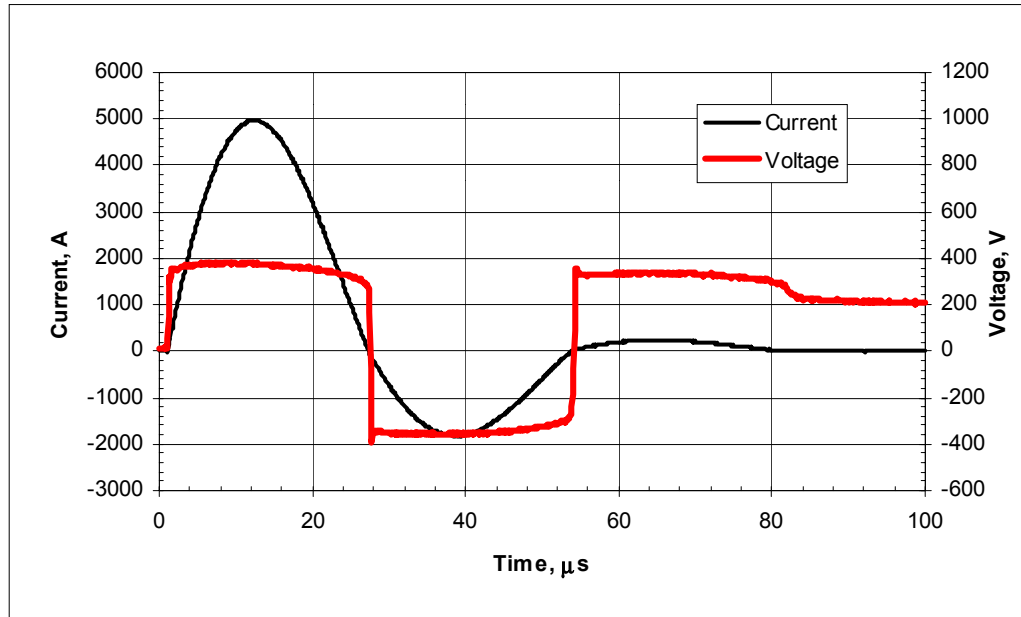
Figures 1 to 8 show the diagrams of the measurements.



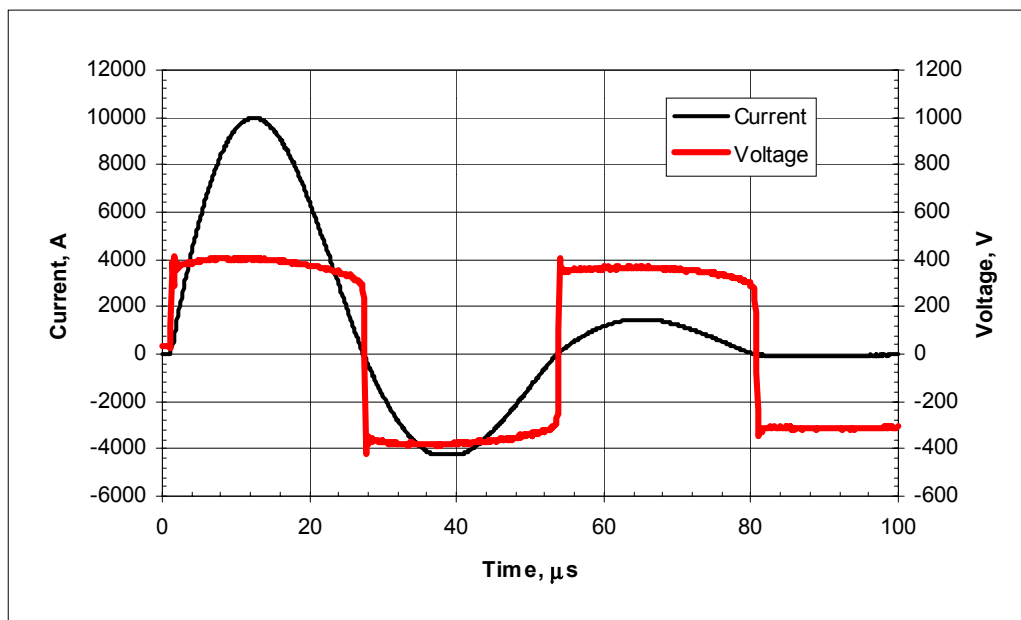
**Figure 1:** Voltage and current oscillograms ( $I = 1 \text{ kA}$ ).



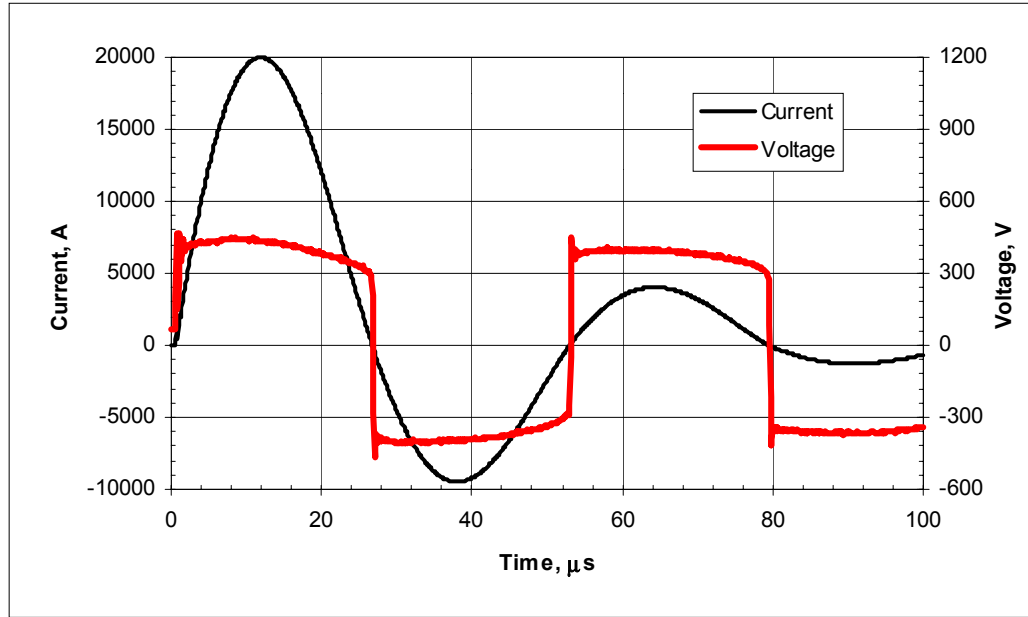
**Figure 2:** Voltage and current oscillograms ( $I = 3 \text{ kA}$ ).



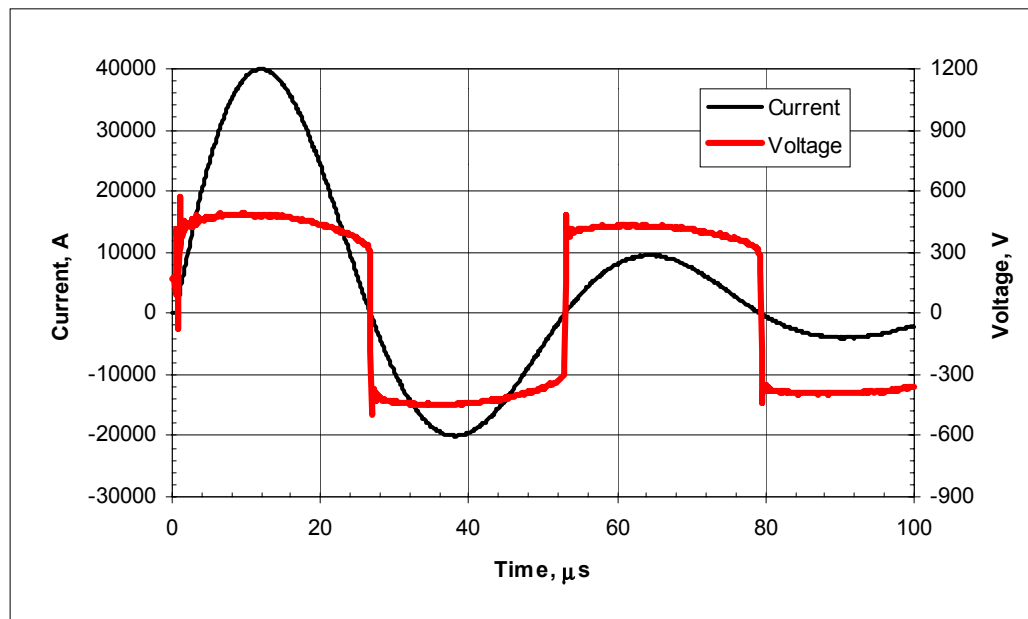
**Figure 3:** Voltage and current oscillograms ( $I = 5 \text{ kA}$ ).



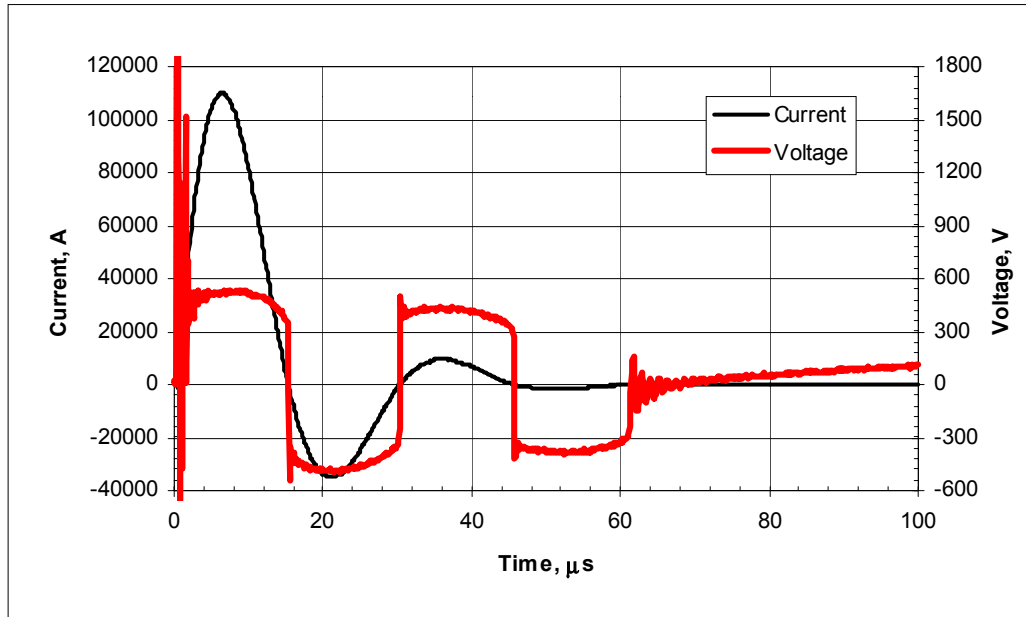
**Figure 4:** Voltage and current oscillograms ( $I = 10 \text{ kA}$ ).



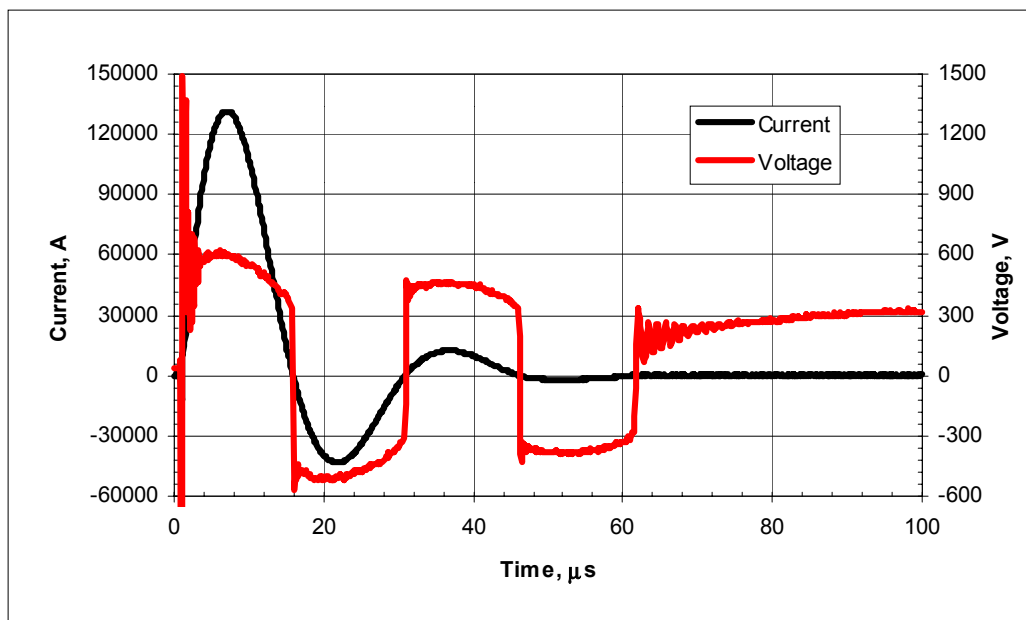
**Figure 5:** Voltage and current oscillograms ( $I = 20 \text{ kA}$ ).



**Figure 6:** Voltage and current oscillograms ( $I = 40 \text{ kA}$ ).

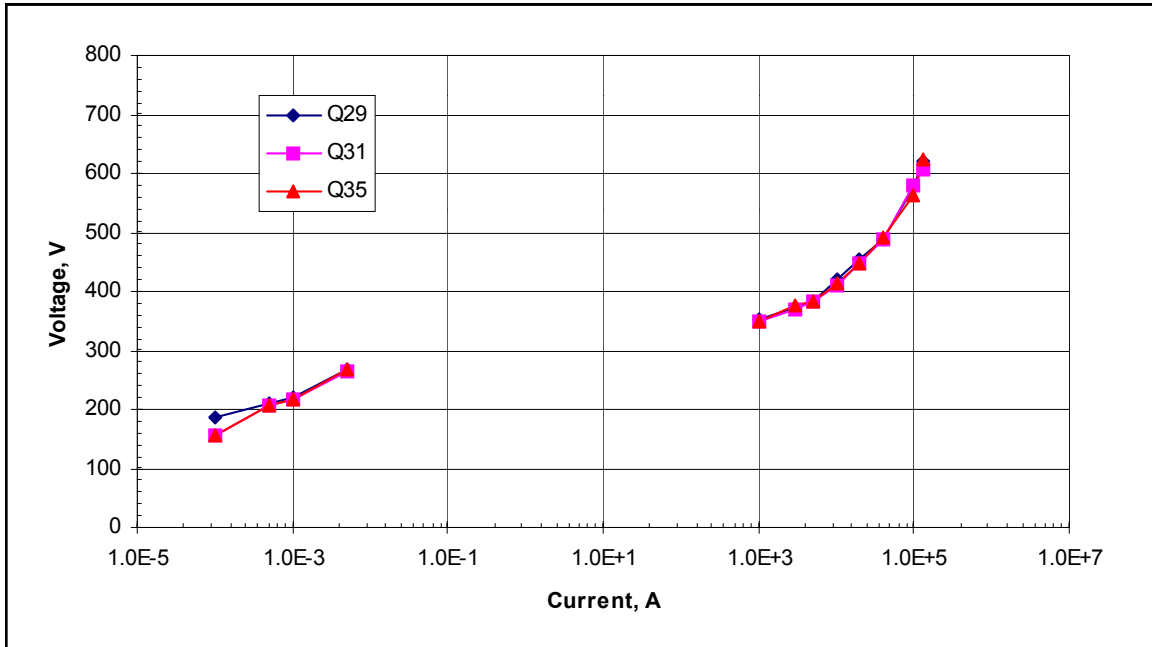


**Figure 7:** Voltage and current oscillograms ( $I = 100 \text{ kA}$ ).



**Figure 8:** Voltage and current oscillograms ( $I = 130 \text{ kA}$ ).

Figure 9 shows the voltage/ current characteristics under DC, 8/20  $\mu$ s and 4/10  $\mu$ s impulse.



**Figure 9:** Voltage / current characteristics under DC, 8/20  $\mu$ s and 4/10  $\mu$ s impulse.

#### 4.2 Test of protective level

The protective level was determined with 3 positive current impulses at 10 kA (8/20  $\mu$ s). The results are shown in Table 4.

Sample	Impulse #1	Impulse #2	Impulse #3
Q29	425	419	420
Q31	420	414	415
Q35	428	425	418

**Table 4:** Residual voltage at 10 kA, 8/20  $\mu$ s.

#### 5. TEST WITH INCREASED DISCHARGE CURRENT 40 kA, 8/20 $\mu$ s

Each of the samples used in test #4 above, was subjected to 3 lightning impulse currents with positive polarity at 4 times the nominal discharge current level (10 kA, 8/20  $\mu$ s).

Table 5 shows the residual voltage measured across the samples during this test.

Sample	Impulse #1	Impulse #2	Impulse #3
	Voltage, V		
Q29	493	490	487
Q31	487	487	491
Q35	486	491	483

**Table 5:** Residual voltage at 40 kA, 8/20  $\mu$ s.

## 6. OPERATING DUTY TEST

The test was made on three new Everprotect 4-120 units according to the procedure outlined in the IEC 99-4 standard. The initial measurements, conditioning and the measurements after the test were all made at ambient temperature.

### Test procedure:

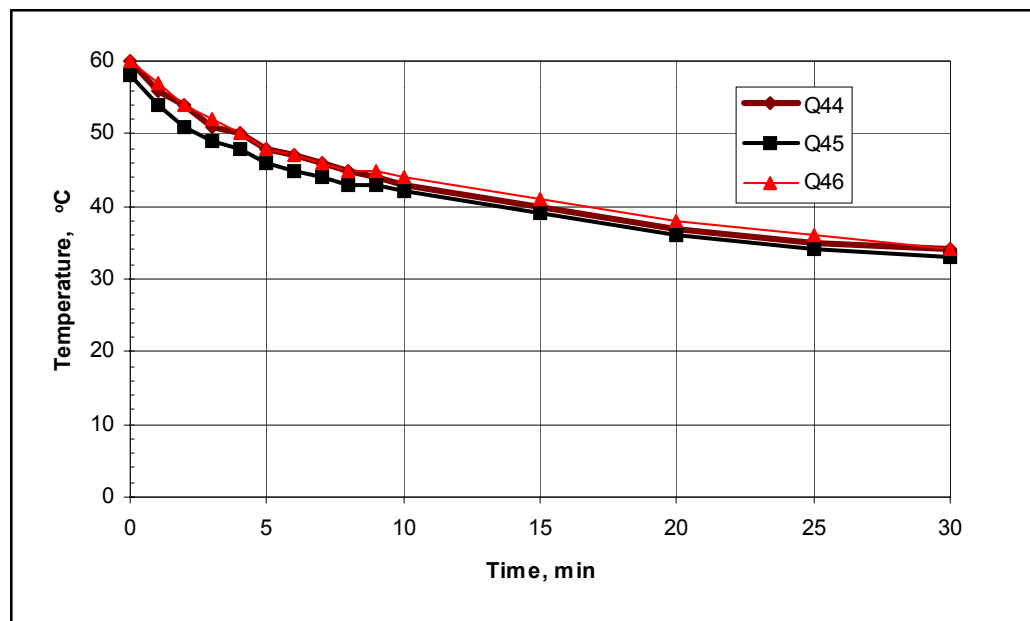
- Initial measurement of reference voltage ( $U_{ref}$ ) at the reference current ( $I_{ref} = 5$  mA) and residual voltage ( $U_{res}$ ) at the nominal current ( $I = 10$  kA, 8/20  $\mu$ s) were carried out.
- Conditioning with 20 lightning impulses of 10 kA, 8/20  $\mu$ s, 1 minute apart, with applied continuous operating voltage  $U_c$ .
- Application of a 130 kA, 4/10  $\mu$ s lightning impulse.
- Heating of sample to +65 °C.
- With the sample temperature at +60 $\pm$ 3 °C, application of a 130 kA, 4/10  $\mu$ s lightning impulse followed within 100 ms by the continuous operating voltage  $U_c$ .
- Continuous registration of the Everprotect 4-120 temperature with the applied voltage (for 30 min.) to demonstrate thermal and electrical stability.
- Final measurement of reference voltage ( $U_{ref}$ ) at the reference current ( $I_{ref} = 5$  mA) and residual voltage ( $U_{res}$ ) at the nominal current ( $I = 10$  kA, 8/20  $\mu$ s) were carried out.

Table 7 shows a summary of the operating duty test results.

	Sample Q44			Sample Q45			Sample Q46		
	Before (V)	After (V)	Change %	Before (V)	After (V)	Change %	Before (V)	After (V)	Change %
$U_{ref}$	297	288	-2.9	299	294	-1.5	278	267	-4.0
$U_{res}$	449	439	-2.2	466	443	-4.9	416	412	-0.9

**Table 7:** Change of reference voltage and nominal residual voltage due to the operating duty test.

The thermal stability was reliably reached (Figure 10). The change of the reference voltage and residual voltage were -4.9 to -0.9 (permissible 5%).



**Figure 10:** Variation of the Surge Protective Devices' temperature with time after the second 130 kA impulse.

There were no punctures, sparkovers or any other mechanical damages during the test. The disconnector did not operate in any case.

The samples passed the test.

## 7. LONG DURATION CURRENT IMPULSE TEST

The test was made on three new units at ambient temperature according to the procedure outlined in the IEC 99-4 standard. Each sample was subjected to 20 rectangular current impulses 750A/2000  $\mu$ s, 60 seconds apart.

The reference voltage ( $U_{ref}$ ) at  $I_{ref} = 5$  mA, and the rated residual voltage at 10 kA, 8/20  $\mu$ s were measured in each case before and after the test.

Table 8 shows a summary of the test results.

Sample #		Q50	Q51	Q52
Reference voltage	Before (V)	280	294	274
	After (V)	276	296	267
	Change (%)	-1.1	0.7	-2.6
Residual voltage	Before (V)	407	422	402
	After (V)	405	423	401
	Change (%)	-0.6	0.1	-0.2
Rectangular impulse current (A/ $\mu$ s) number of impulses		750/2000 20		
Rect. Impulse #1	I (A)	758	748	754
	V (V)	341	359	340
Rect. Impulse #20	I (A)	750	754	752
	V (V)	345	364	345
Energy per pulse (J)		> 550	>580	>550

**Table 8:** Summary of the long duration current impulse test results.

There were no sparkovers, punctures or other mechanical damages during the test. The disconnector did not operate in any case.

The reference voltage and the nominal residual voltage changed by a maximum of 2.6% (permissible 5%).

The samples passed the test.

## 8. ACCELERATED AGING TEST

The test was carried out on 3 fully assembled Everprotect 4-120 units according to the IEC 99-4.

- Test temperature : 115 °C
- Medium : Air
- Test duration : 1000 hours
- Test voltage : 162 V r.m.s.

The power loss in each of the three samples is monitored continuously during the test. The power loss/time characteristics shows a continuous negative slope after reaching a maximum about 2 hours into the test. The test is still underway.