To: Darrin Leroy
Environmental Potentials

SURGE TESTS ON STRIKESORB SURGE PROTECTORS

Kinectrics Report: 12327-RC-0001-R00

December 20, 2005

Jody Levine
Senior Engineer
Transmission and Distribution Department

1.0 INTRODUCTION

At the request of the Environmental Potentials, samples of EP-2000 480 delta, EP-2000 277/480 wye, EP-2500 480 delta and EP-2500 277/480 wye surge protectors were subjected to surge waves per IEEE C62.45-2002 “IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits”. Surges were applied according to the requirements for location category C-High in Table 1 of section 4.7. Some devices were pre- and posted- tested with 6 kV / 3 kA combination waves to verify let-through-voltage per NEMA LS-1992 “Low Voltage surge Protective Devices.”

The tests were carried out at the Kinectrics (formerly Ontario Hydro Technologies) High Voltage Laboratory. Waveforms were recorded for each surge application. After testing each device was visually inspected for damage.

The high-current surge tests were conducted on October 26, 2005. The 6 kV / 3 kA combination waves were applied on October 25 and December 9. Kinectrics test personnel were George Gouliaras, Jody Levine and Don Goldthorpe, and present from Environmental Potentials were Brian Cherrington and Darrin LeRoy.

2.0 TEST DESCRIPTION AND RESULTS

Recommended Practice C62.45 states that devices in the “C High” category be subjected to a current wave with a peak value of 10 kA and front/tail times of 8/20 µs. The impedance of the source is not defined and it is understood that the peak current is driven through the device.

For the category “C High” level it is also recommended that a voltage wave of voltage wave with a peak of 10 kV and a front/tail time of 1.2/50 µs be applied. This wave is defined with the supply driving an open circuit, and again, no supply impedance is specified. For MOV based devices, the 10 kV 8/20 current wave imposes a greater voltage on the device than voltage wave supplied from a high-impedance generator defined as 10 kV on an open circuit, and the 10 kV voltage wave is not relevant.

2.1 Tests on Delta-Connected Units

The EP-2000 Delta and EP-2500 Delta surge protectors are three phase units with the protective MOV circuits arranged between each phase. The fuses normally installed in each mode were not present for testing and had been replaced with shorting bars. External lead lengths were 7-8 inches, per the manufacturer’s recommendation. The 10 kA surge was applied to the phases with the longest internal connection leads to simulate the worst case let-through-voltage condition for the 10 kA, 8/20 µs current wave. The let-through voltage was recorded during the surge. The devices were inspected for visible damage following the applied surge. The waveforms are plotted in Figures 1 and 2.

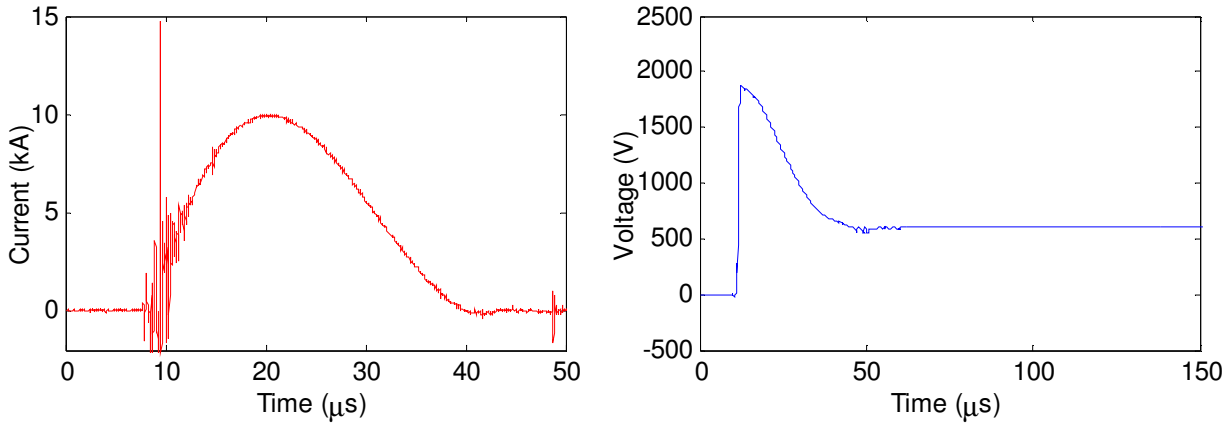


Figure 1: EP-2000 Delta: Applied Current :9.95 kA, 9.6 / 23 µs, Let Through Voltage 1880 V

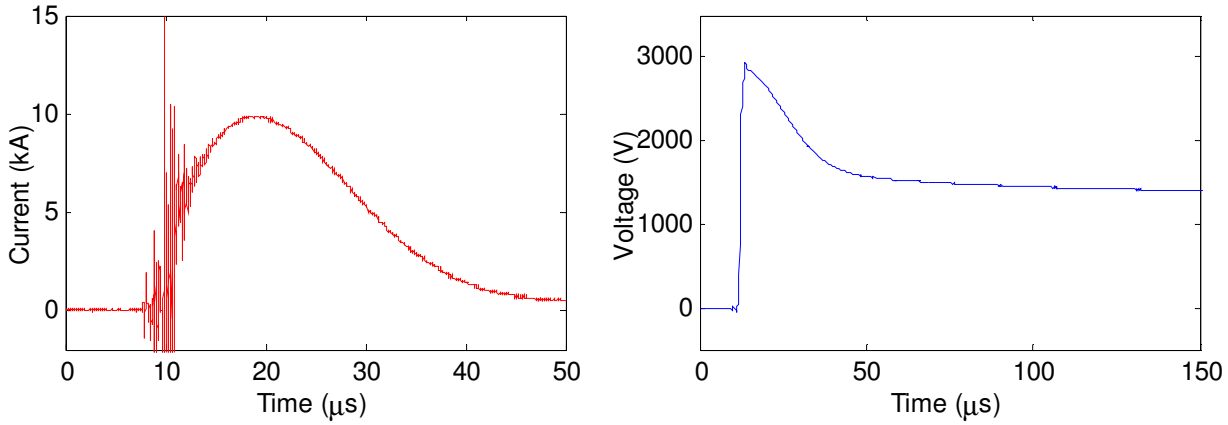


Figure 2: EP-2500 Delta Test, Applied Current :9.85 kA, 7.6 / 22.1 μs, Let Through Voltage 2943 V

Neither device showed any evidence of disruptive discharge during the test, nor displayed any evidence of damage in the visual inspection.

2.1 Tests on Wye-Connected Units

The EP-2000 480 Wye and EP-2500 480 Wye are three phase units with the protective MOV circuits arranged with protective modes from each phase to neutral. The fuses normally present in each mode were not installed, and had been replaced with shorting bars. Each phase-to-neutral mode was tested on each device.

In addition to the 10 kA maximum surge and visual inspection, these units were subjected to 6 kV 1.2/50 open-circuit-voltage and 3 kA 8/20 short-circuit current combination surges before and after testing to demonstrate stability in let-through voltage (LTV) per NEMA LS1-1992. The maximum allowable let-through voltage deviation is 10 %. The connection leads were cut as short as possible short to minimize the effect of connection geometry on the let-through-voltage results. These let-through voltage values based on the standard combination wave are intended to be comparative, and may not represent the actual let-through-voltage in a field installation. The results are summarized in Table 1.

Table 1: Surge Test Summary for Wye Connected Devices

Model	Phase	Pre Max. Surge Comb. Wave LTV (V)			Max. Surge Peak (kA)	Post Max. Surge Comb. Wave LTV (V)			LTV Change %
		Shot1	Shot2	Avg.		Shot1	Shot2	Avg	
EP-2000 480 Wye	A	1100	1100	1100	10.5	1120	1120	1120	1.8
	B	1100	1100	1100	10.9	1120	1120	1120	1.8
	C	1150	1155	1153	10.6	1120	1120	1120	-2.9
EP-2500 480 Wye	A	1120	1130	1125	10.6	1135	1130	1133	0.7
	B	1025	1025	1025	11.1	1090	1090	1090	6.3
	C	1090	1090	1090	11.4	1090	1090	1090	0.0

The EP-2000 480 Wye and EP-2500 480 Wye units survived the 10 kA surge with no disruptive discharges and no visible damage. Both units and demonstrate satisfactory pre- and post surge let-through-voltage characteristics given a 10 kA maximum surge (unpowered) per NEMA LS-1.

3.0 CONCLUSIONS

The EP-2000 Delta and EP-2500 Delta devices survived the IEEE C62.45 Category C-High 10 kA current surge with no disruptive discharge and no visible damage.

The EP-2000 Wye and EP-2500 Wye devices survived the IEEE C62.45 Category C-High 10 kA current surge with no disruptive discharge and no visible damage. These devices demonstrated less than 10 % let-through-voltage deviation for a 6 kV / 3 kA combination wave per NEMA LS1

Prepared by:

_____

Jody Levine, P. Eng.
Senior Engineer
High Voltage Laboratory, Transmission and Distribution Department

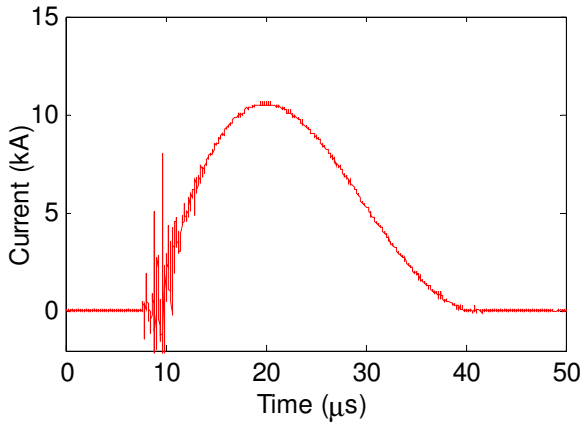
Approved by:

_____

Dr. John Kuffel, P. Eng.
Manager
Transmission and Distribution Department

APPENDIX

SURGE WAVEFORMS FOR WYE-CONNECTED DEVICES



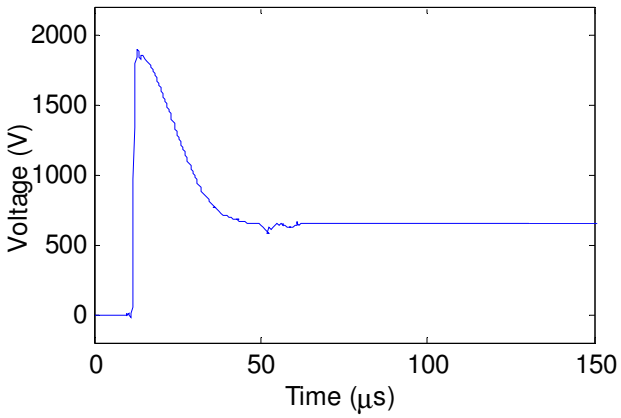
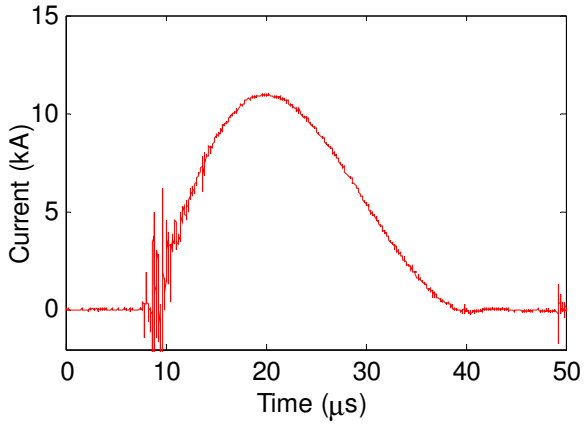


Figure A-1: EP-2000 Wye Test, Phase A, Current :10.5 kA, 8.1 / 21 µs, LTV: 1902 V



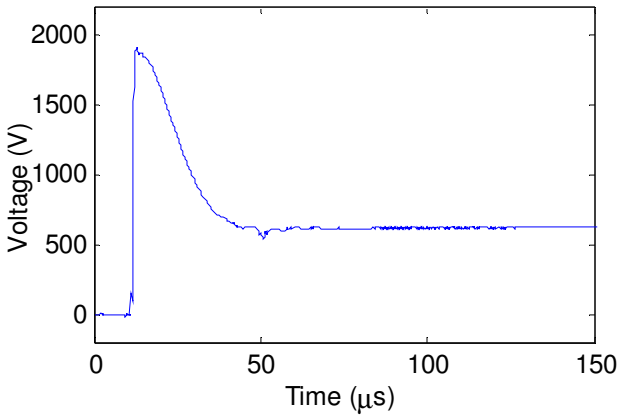
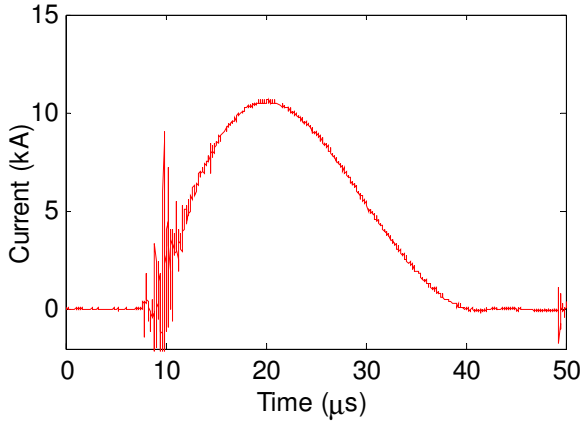


Figure A-2: EP-2000 Wye Test, Phase B, Current :10.9 kA, 8.3 / 21 µs, LTV: 1915 V



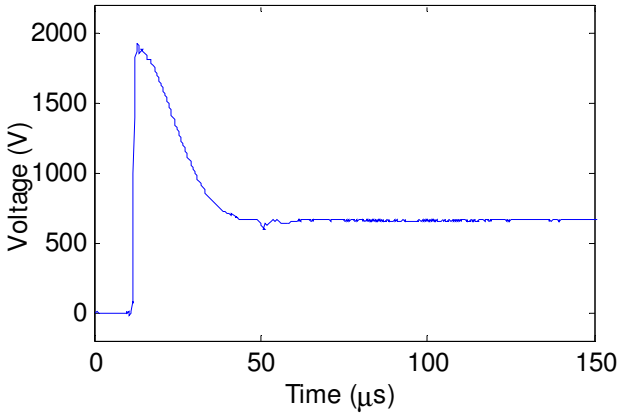


Figure A-3: EP-2000 Wye Test, Phase C, Current :10.6 kA, 8.3 / 21 µs, LTV: 1932 V

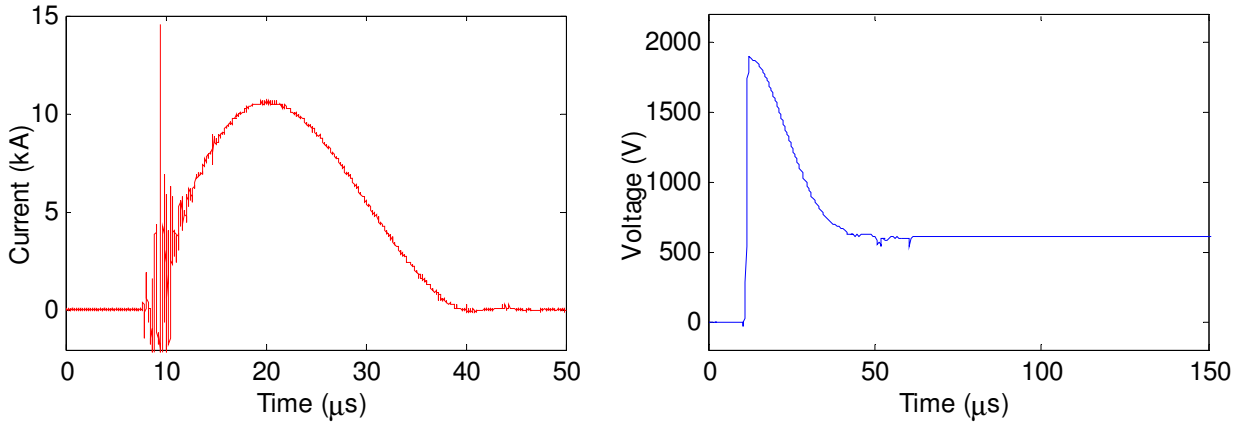


Figure A-4: EP-2500 Wye Test, Phase A, Current :10.6 kA, 9.4 / 22 µs, LTV: 1907 V

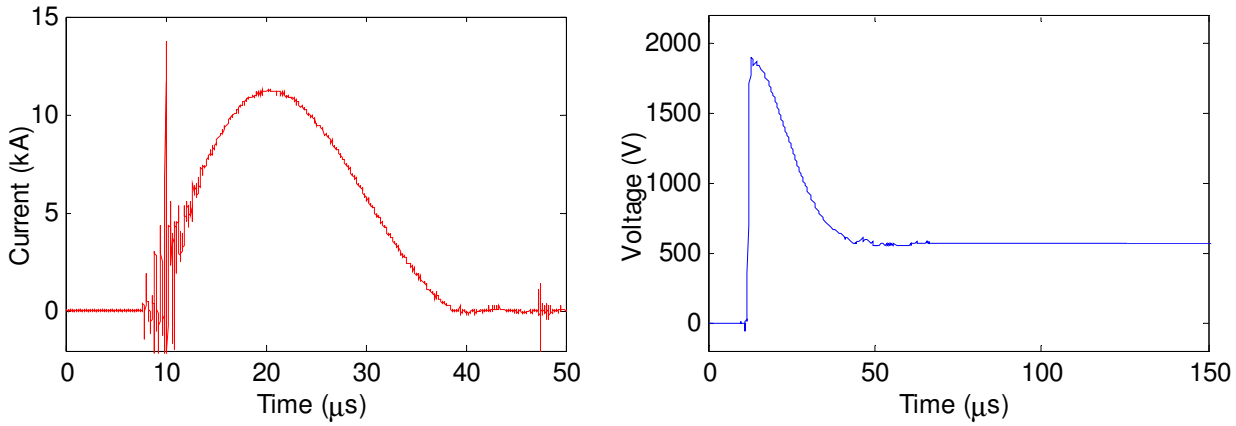


Figure A-5: EP-2500 Wye Test, Phase B, Current :11.2 kA, 9.2 / 22 µs, LTV: 1896V

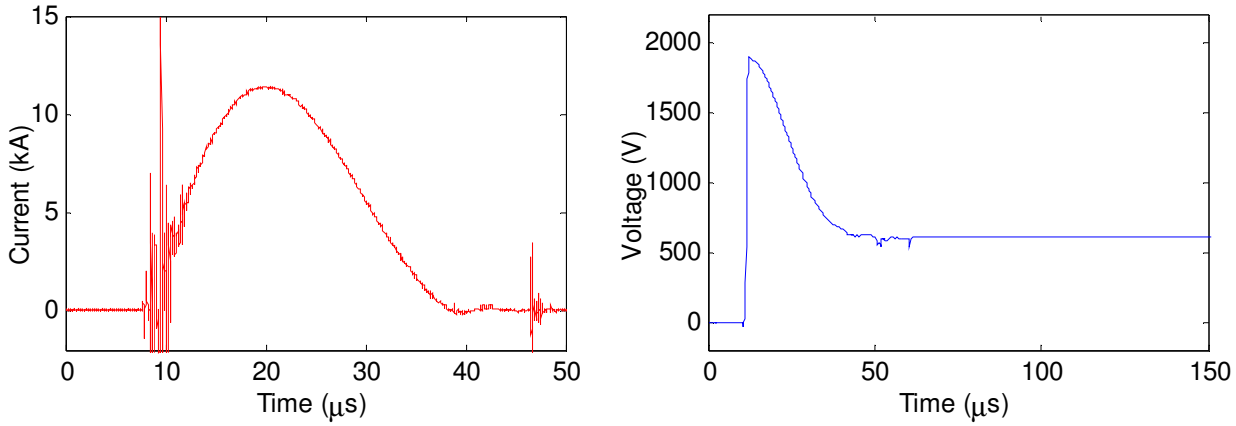


Figure A-6: EP-2500 Wye Test, Phase C, Current :11.4 kA, 9.4 / 22 µs, LTV: 1891V

Figure A-7 shows the short circuit and open circuit waveforms for the combination wave tests.

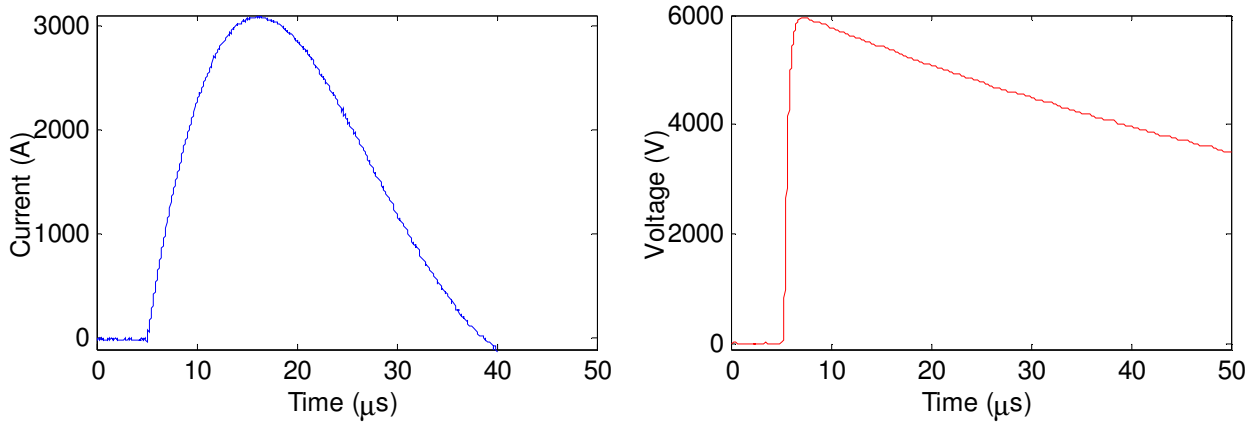


Figure A-7: Combination Wave: SC Current :3.1 kA, 8.4 / 23 μs, OC Voltage 5.95 kV, 1.1 / 52 μs

DISCLAIMER

KINECTRICS INC., FOR ITSELF, ITS SUBSIDIARY CORPORATIONS, AND ANY PERSON ACTING ON BEHALF OF THEM, DISCLAIMS ANY WARRANTY OR REPRESENTATION WHATSOEVER IN CONNECTION WITH THIS REPORT OR THE INFORMATION CONTAINED THEREIN, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND DISCLAIMS ASSUMPTION OF ANY LEGAL LIABILITY WHATSOEVER (INCLUDING ANY CONSEQUENTIAL DAMAGES) RESULTING FROM THE SELECTION, USE, OR THE RESULTS OF SUCH USE OF THIS REPORT BY ANY THIRD PARTY OTHER THAN THE PARTY FOR WHOM THIS REPORT WAS PREPARED AND TO WHOM IT IS ADDRESSED.

Distribution:

Darrin LeRoy	Environmental Potentials, Detroit, Michigan
J. Levine	KL206
J. Kuffel	KL206