Powertech
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CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST REPORT

Client:	Schweitzer Engineering Laboratories, 2350 NE Hopkins Court, Pullman, WA 99163-5603, USA		
Test Date:	16 & 17 May 2006	**Project:**	16533-27

Nameplate Data:

Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Pullman, Washington, USA
Model:	SEL-651R
Part No.:	0651R0618A8203X1XX
Serial No.:	2006088298

Recloser:

Manufacturer:	Cooper Power Systems, Milwaukee WI USA
Type:	NOVA-TS-15
Impulse level (BIL):	110 kV_{peak}
Rated voltage:	15.5 kV_{rms}
Rated current:	400 A_{rms} continuous; 8 kA interrupting
Serial No.:	000101, 000125, 000127

Test Witness: Darin McKee, Schweitzer Engineering Laboratories

Test Standard: IEEE Std C37.60-2003, Clause 6.13.2: "Simulated Surge Arrester Operation Test"

Atmospheric Conditions:

Temperature	24.1 °C
Relative humidity	38%
Barometric pressure	758.4 mmHg

Test Current: 7 kA_{peak}

Test Configurations (in accordance with the above standard):

A – surges applied to the source bushing with the recloser open
B – surges applied to the source bushing with the recloser closed
C – surges applied to the load bushing with the recloser closed
D – surges applied to a properly rated transformer with the recloser open
E – surges applied to a properly rated transformer with the recloser closed

If the device under test has a self-contained power source, conditions D and E may be omitted. This controller is designed to be powered by isolated dc batteries, so configuration D and E were omitted.

Test Results: The controller and recloser operated normally following the Simulated Surge Arrester Operation Test performed in accordance with the test procedures as per the above standard. The controller complied with the requirements of IEEE Std C37.60-2003, Clause 6.13.2.

Remarks: None

Prepared by:

May Wang, P.Eng. May 26, 2006
Senior Electrical Engineer

Approved by:

A.J. Vandermaar, P.Eng. 26 May 2006
Manager, High Voltage Laboratory

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CONTROLLER OSCILLATORY SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, 2350 NE Hopkins Court, Pullman, WA 99163-5603, USA	
Test Date:	May 16, 2006	**Project:** 16533-27

Nameplate Data:

Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Pullman, Washington, USA
Model:	SEL-651R
Part No.:	0651R0618A8203X1XX
Serial No.:	2006088298

Recloser:

Manufacturer:	Cooper Power Systems, Milwaukee WI USA
Type:	NOVA-TS-15
Impulse level (BIL):	110 kV_{peak}
Rated voltage:	15.5 kV_{rms}
Rated current:	400 A_{rms} continuous; 8 kA interrupting
Serial No.:	000101, 000125, 000127

Test Witness:	Darin McKee, Schweitzer Engineering Laboratories
Test Standard:	IEEE Std C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"
Test Voltage:	2.5 kV_{peak}
Test Procedure:	Test surge applied in common mode and transverse mode to wire pairs.
Test Results:	The controller and recloser operated normally following the Oscillatory SWC Test performed in accordance with the test procedures. The controller complied with requirements of IEEE C37.60-2003, Clause 6.13.1.
Remarks:	The controller passed the test.

Tested by:

May 30/06

Robert G. Pollock
Senior Project Specialist

Approved by:

30 May '06

A. John Vandermaar, P.Eng.
Manager, High Voltage Laboratory

APPENDIX 1

Oscillatory SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed before the Oscillatory SWC Test

1. Measuring system feedthrough test

   Generator Output voltage 2.5 kV

   Feedthrough voltage 3 V (pass ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Rise time of the first peak	72	ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load)	2.5	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	191	Ω	(160 to 240 Ω)
Waveform envelope decay	4.92	µs	(4 to 6 µs to 50%)
Oscillation frequency	0.91	MHz	(0.9 to 1.1 MHz)
Repetition rate	8	bursts per period	(6-10 bursts per 16.7 mS)
Test duration	2.1	s	(2 to 2.2 s)

4. Test Pass X Test Fail _____

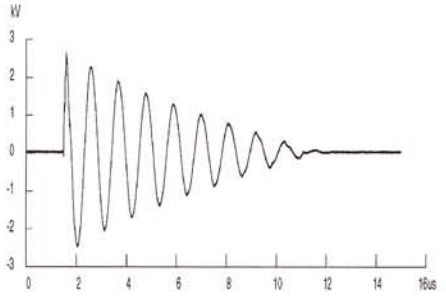

Figure 1

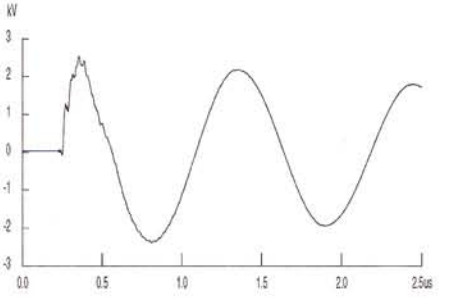

Figure 2

APPENDIX 2

Oscillatory SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed after the Oscillatory SWC Test

4. Measuring system feedthrough test

   Generator Output voltage 2.5 kV

   Feedthrough voltage 4.1 V (pass ≤ 1%)

5. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

6. Test Generator performance verification

Rise time of the first peak	86	ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load)	2.3	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	232	Ω	(160 to 240 Ω)
Waveform envelope decay	4.4	µs	(4 to 6 µs to 50%)
Oscillation frequency	0.93	MHz	(0.9 to 1.1 MHz)
Repetition rate	8	bursts per period	(6-10 bursts per 16.7 mS)
Test duration	2.17	s	(2 to 2.2 s)

5. Test Pass X Test Fail _____

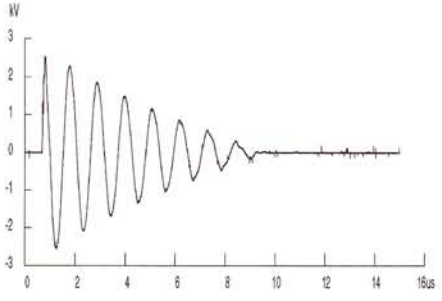

Figure 1

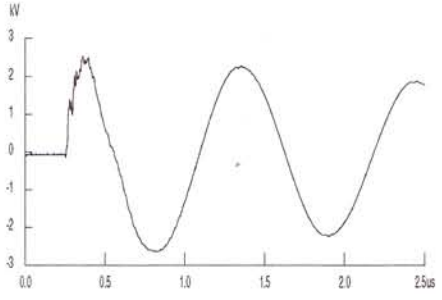

Figure 2

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CONTROLLER FAST TRANSIENT SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, 2350 NE Hopkins Court, Pullman, WA 99163-5603, USA	
Test Date:	May 15, 2006	**Project:** 16533-27

Nameplate Data:

Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Pullman, Washington, USA
Model:	SEL-651R
Part No.:	0651R0618A8203X1XX
Serial No.:	2006088298

Recloser:

Manufacturer:	Cooper Power Systems, Milwaukee WI USA
Type:	NOVA-TS-15
Impulse level (BIL):	110 kV_{peak}
Rated voltage:	15.5 kV_{rms}
Rated current:	400 A_{rms} continuous; 8 kA interrupting
Serial No.:	000101, 000125, 000127

Test Witness:	Darin McKee, Schweitzer Engineering Laboratories
Test Standard:	IEEE Std C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"
Test Voltage:	4.0 kV_{peak}
Test Procedure:	Test surge applied in common mode and transverse mode to wire pairs.
Test Results:	The controller and recloser operated normally following the Fast Transient SWC Test performed in accordance with the test procedures. The controller complied with the requirements of IEEE C37.60-2003, Clause 6.13.1.
Remarks:	The controller passed the test.

Tested by:

May 30/06

Robert G. Pollock
Senior Project Specialist

Approved by:

30 May '06

A. John Vandermaar, P.Eng.
Manager, High Voltage Laboratory

APPENDIX 1

Fast Transient SWC Waveform Validity Tests

(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed before the Fast Transient SWC Test

1. Measuring system feedthrough test

   Generator Output voltage ____4____ kV

   Feedthrough voltage ____0____ V (pass if ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Rise time	3.85	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.0	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	47.9	Ω	(40 to 60 Ω)
Impulse duration	60.2	ns	(35 to 65 ns to 50% value)
Repetition rate	2.5	kHz	(2 to 3 kHz)
Burst duration	15.0	ms	(12 to 18 ms)
Burst period	300	ms	(240 to360 ms)
Test duration	60.0	s	(≥ 60 s)

4. Test Pass ___X___ Test Fail _____

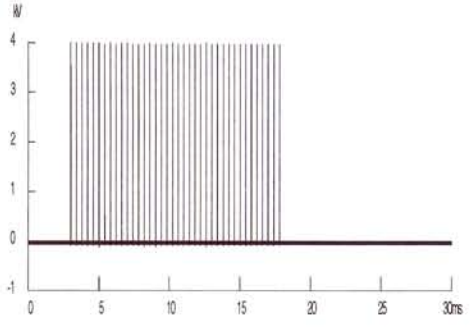

Figure 1

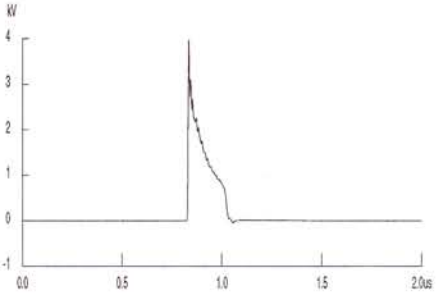

Figure 2

APPENDIX 2

Fast Transient SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed after the Fast Transient SWC Test

5. Measuring system feedthrough test

   Generator Output voltage ____4____ kV

   Feedthrough voltage ____0___ V (pass if ≤ 1%)

6. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification

Rise time	3.5	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.2	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	49.8	Ω	(40 to 60 Ω)
Impulse duration	63	ns	(35 to 65 ns to 50% value)
Repetition rate	2.5	kHz	(2 to 3 kHz)
Burst duration	15.0	ms	(12 to 18 ms)
Burst period	300	ms	(240 to360 ms)
Test duration	60.4	s	(≥ 60 s)

8. Test Pass ____X___ Test Fail _____

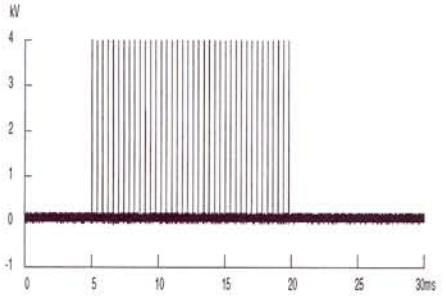

Figure 1

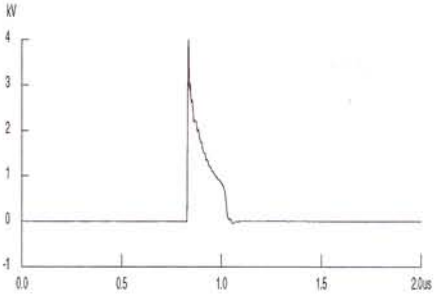

Figure 2