CONTROLLER OSCILLATORY SWC TEST REPORT

Client: G&W Electric Co., 3500 W. 127th Street, Blue Island IL, 60406

Test Date: July 23, 2010                     Project: 20114-27 (C)

Nameplate Data:

Three Phase Recloser Controller:
Manufacturer: SEL
Model: 0651RR12BAAB831123XX
Serial No.: 2010183448

Three Pole Switch:
Manufacturer: G&W
Catalog No.: VIP388-ER-12-1-ST
Impulse level (BIL): 125 kV\textit{peak} Line-to-Ground; 125 kV\textit{peak} Line-to-Line
Rated voltage: 27 kV\textit{rms}
Rated current: 800 A\textit{rms} continuous/12.5 kA interrupting
Serial No.: 2010 0701 0018

Test Standard: IEEE C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"

Test Witnesses: Blair Kerr, G&W Blue Island, IL; Alex Bradley, SEL, Pullman, WA

Atmospheric Conditions:
- Temperature: 20.1 °C
- Relative humidity: 47%
- Barometric pressure: 753.1 mmHg

Test Voltage: 2.5 kV\textit{peak}

Test Procedure: Test surges were applied to the control cable in common mode using a capacitive clamp and transverse mode through 1.5 mH coils. Test surges were applied to ac power input in common mode and transverse mode using an external coupling filter. The AC power supplied to the controller was 120 Volts, 60 Hz.

Test Results: A controller panel mounted GFCI receptacle failed during the EMI tests and was disabled. No other problems were observed.

The controller and recloser operated normally following the Oscillatory SWC Test performed in accordance with the test procedures as per the above document. The controller complied with requirements of "IEEE C37.60-2003, Clause 6.13.1."

Tested by: Robert G. Pollock
Senior Project Specialist

Approved by: A.J. Vandermaar, P.Eng.
Manager, High Voltage Laboratory

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Project No.: 20114-27 (C)
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 2.50 kV
   Feed through voltage 0.8 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 82 ns (60 to 90 ns – 10% to 90%)
   Peak voltage level (no load) 2.55 kV (2.25 to 2.5 kV when set to 2.5 kV)
   Output impedance 199.0 Ω (160 to 240 Ω)
   Waveform envelope decay 4.5 μs (4 to 6 μs to 50%)
   Oscillation frequency 0.926 MHz (0.9 to 1.1 MHz)
   Repetition rate 8 bursts per period (6-10 bursts per 16.7 mS)
   Test duration 2.18 s (2 to 2.2 s)

4. Test Pass X Test Fail ________

Figure 1

Figure 2

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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

1. Measuring system feedthrough test
   Generator Output voltage 2.5 kV
   Feed through voltage 4.0 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 82 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 208.4 Ω (160 to 240 Ω)
   Waveform envelope decay 5.53 μs (4 to 6 μs to 50%)
   Oscillation frequency 0.934 MHz (0.9 to 1.1 MHz)
   Repetition rate 8 bursts per period (6-10 bursts per 16.7 mS)
   Test duration 2.12 s (2 to 2.2 s)

4. Test Pass X Test Fail

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Figure 1

Figure 2

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CONTROLLER FAST TRANSIENT SWC TEST REPORT

Client: G&W Electric Co., 3500 W. 127th Street, Blue Island IL, 60406

Test Date: July 23, 2010  Project: 20114-27 (F)

Nameplate Data:
Three Phase Recloser Controller:
Manufacturer: SEL
Model: 0651RR12BAA83123XX
Serial No.: 2010183448

Three Pole Switch:
Manufacturer: G&W
Catalog No.: VIP388-ER-12-1-ST
Impulse level (BIL): 125 kV<sub>peak</sub> Line-to-Ground; 125 kV<sub>peak</sub> Line-to-Line
Rated voltage: 27 kV<sub>rms</sub>
Rated current: 800 A<sub>rms</sub> continuous/12.5 kA interrupting
Serial No.: 2010 0701 0013

Test Witnesses: Blair Kerr, G&W Blue Island, IL; Alex Bradley, SEL, Pullman, WA

Test Standard: IEEE Std C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"

Atmospheric Conditions:
- Temperature 20.1 °C
- Relative humidity 47%
- Barometric pressure 753.1 mmHg

Test Voltage: 4.0 kV<sub>peak</sub>

Test Procedure: Test surge was applied to the control cable in common mode using a capacitive clamp and transverse mode through 1.5 mH coils. Test surge was applied to ac power input in common mode and transverse mode using an external coupling filter. The AC power supplied to the controller was 120 Volts, 60 Hz.

Test Results: A controller panel mounted GFCI receptacle failed during the EMI tests and was disabled. No other problems were observed.

The controller and recloser operated normally following the Oscillatory SWC Test performed in accordance with the test procedures as per the above document. The controller complied with requirements of "IEEE C37.60-2003, Clause 6.13.1".

Tested by: Robert G. Pollock
Senior Project Specialist

Approved by: A.J. Vandermaar, P.Eng.
Manager, High Voltage Laboratory

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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  0.8  V (pass if ≤ 1%)  

2. Open circuit voltage waveform test
   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification
   
   Rise time  4.05  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  46.7  Ω (40 to 60 Ω)
   Impulse duration  60  ns (35 to 65 ns to 50% value)
   Repetition rate  2.50  kHz (2 to 3 kHz)
   Burst duration  14.9  ms (12 to 18 ms)
   Burst period  300  ms (240 to 360 ms)
   Test duration  60.1  s (≥ 60 s)

4. Test Pass  X  Test Fail  

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Figure 1

Figure 2

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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

1. Measuring system feedthrough test
   Generator Output voltage _______ 4 _______ kV
   Feedthrough voltage ________ 0.3 _______ V (pass if ≤ 1%)

2. Open circuit voltage waveform test
   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification
   Rise time _______ 4.45 _______ 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 _______ 42.0 _______ Ω (40 to 60 Ω)
   Impulse duration _______ 59 _______ ns (35 to 65 ns to 50% value)
   Repetition rate _______ 2.50 _______ kHz (2 to 3 kHz)
   Burst duration _______ 14.8 _______ ms (12 to 18 ms)
   Burst period _______ 300 _______ ms (240 to 360 ms)
   Test duration _______ 60.0 _______ s (≥ 60 s)

4. Test Pass _______ X _______ Test Fail _______
# Recloser Controller Simulated Surge Arrester Operation Test Report

**Client:** G&W Electric Co., 3500 W. 127th Street, Blue Island IL, 60406  
**Test Date:** July 20-21, 2010  
**Project:** 20114-27 (A)

## Nameplate Data:
- **Three Phase Recloser Controller:**
  - Manufacturer: SEL  
  - Model: 0651RR12BAA831123XX  
  - Serial No.: 201018344B

- **Three Pole Switch:**
  - Manufacturer: G&W  
  - Catalog No.: VIP388-ER-12-1-ST  
  - Impulse level (BIL): 125 kV\text{peak} Line-to-Ground; 125 kV\text{peak} Line-to-Line  
  - Rated voltage: 27 kV\text{rms}  
  - Rated current: 800 A\text{rms} continuous/12.5 kA interrupting  
  - Serial No.: 2010 0701 0018

## Test Witnesses:
Blair Kerr, G&W Blue Island, IL; Alex Bradley, SEL, Pullman, WA

## Test Standard:

## Atmospheric Conditions:
<table>
<thead>
<tr>
<th></th>
<th>July 20/10</th>
<th>July 21/10</th>
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<tbody>
<tr>
<td>Temperature</td>
<td>21.1 °C</td>
<td>22.2 °C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>55 %</td>
<td>57 %</td>
</tr>
<tr>
<td>Barometric pressure</td>
<td>755.9 mmHg</td>
<td>755.0 mmHg</td>
</tr>
</tbody>
</table>

## Nominal Test Voltage and Current:
100 kV (125 kV \times 0.8), 7 kA\text{peak}

## Test Configurations Tested (in accordance with the above standard):
- **A** – 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushings with the switch open.
- **B** – 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushings with the switch closed.
- **C** – 15 surges of positive polarity and 15 surges of negative polarity were applied to the load bushings with the switch closed.
- **D** – 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the recloser closed.
- **E** – 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the recloser open.

## Test Results:
The controller and switch complied with the requirements of IEEE Std C37.60-2003, Clause 6.13.2, configurations A to E.

## Remarks:
None

Tested by:  
R.C. Pollock,  
Senior Projects Specialist

Reviewed by:  
A.J. Vandermaar, P.Eng.  
Manager, High Voltage Laboratory

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