Overview

PowerLines reviews and analyzes hundreds of power quality monitoring data sets each year – most from medical facilities, monitoring services, distribution panels, feeders, and banch circuits feeding medical imaging systems.

As part of this work, we encounter many instances of testing and/or operation of the facility emergency power system. While medical imaging system are not generally required to be powered from the emergency or backup power source by electrical code (unlike things like elevators, fire safety equipment, lighting, or life support equipment) – it is often desired to power such equipment deemed necessary for patient treatment, especially for trauma centers.

We've found some interesting differences in these system in terms of the transfer switch technology – resulting in various levels of disruption or disturbance during testing of the emergency power system. This application note documents some of these differences, relying on Fluke 1750 power analyzer data.

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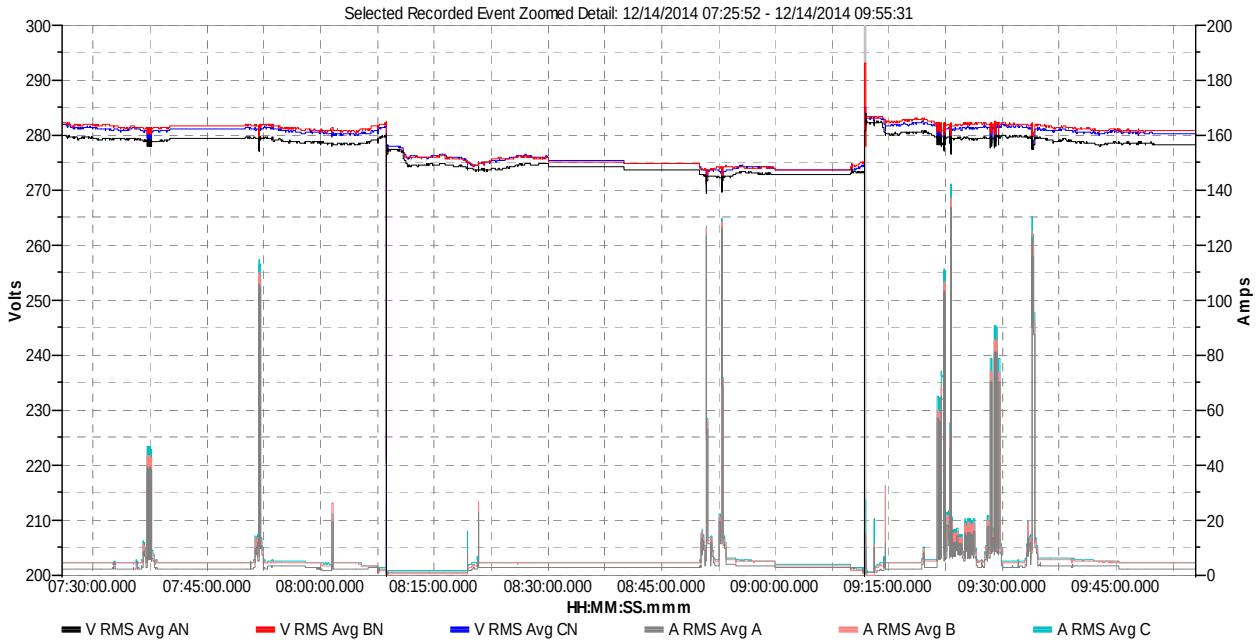
Emergency Power Testing – Example 1 (Extended Outage)

In this example, emergency power system transfer switches are clearly “break before make” devices, with a prolonged (~2 second) interruption during the transitions to/from emergency power.

Since this is a very clear voltage outage, there is no expectation of the medical imaging system riding through this event seamlessly.

High frequency transients in this particular example are unusual – might be related to an electronic transfer switch, rather than a mechanical one, or other sneak path for electrical signals during the “break” period.

#	Date/Time	Type	Duration (Days - Hrs:Min:Sec)	% of Nominal	Absolute	Triggered Phase
5	12/14/2014 08:08:41.881.562	Dip	0 - 00:00:02.176391300	1.02%	4.08 V	AN, BN, CN
6	12/14/2014 08:08:41.976.789	Interruption	0 - 00:00:02.063916100	1.02%	4.08 V	AN, BN, CN
7	12/14/2014 09:11:51.566.415	Dip	0 - 00:00:02.170273700	1.05%	4.20 V	AN, BN, CN
8	12/14/2014 09:11:51.661.547	Interruption	0 - 00:00:02.050015700	1.05%	4.20 V	AN, BN, CN



Outage Event # 5 – 8	**Two outages, with lower voltage level in between, characteristic of emergency power system testing.**

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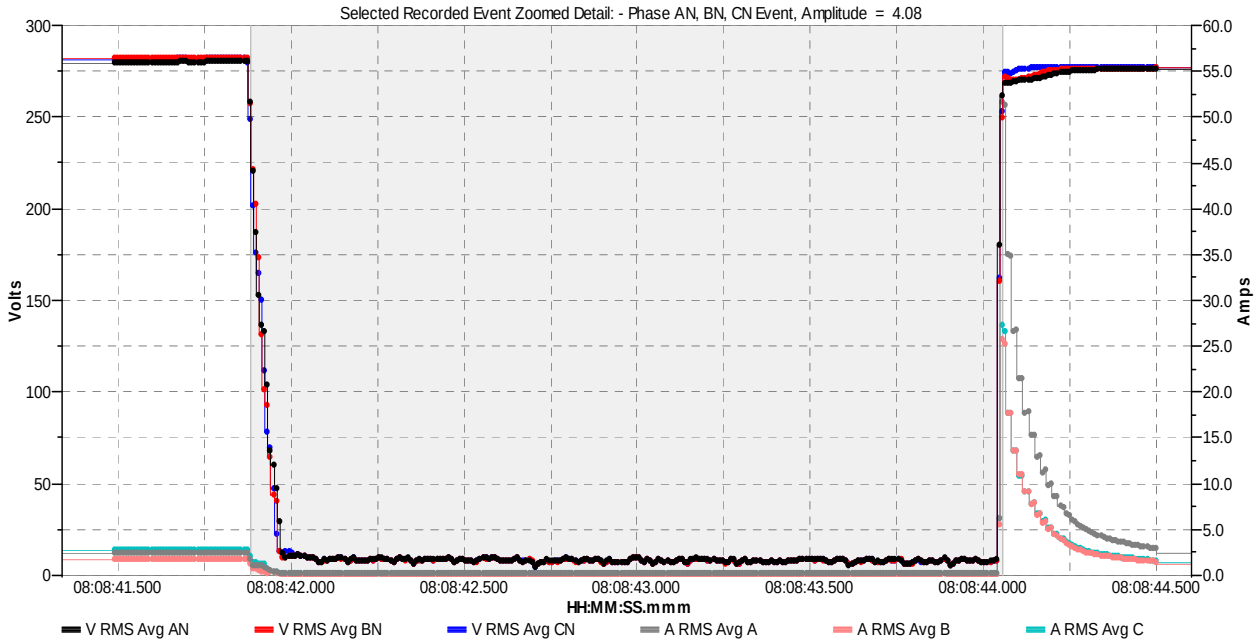
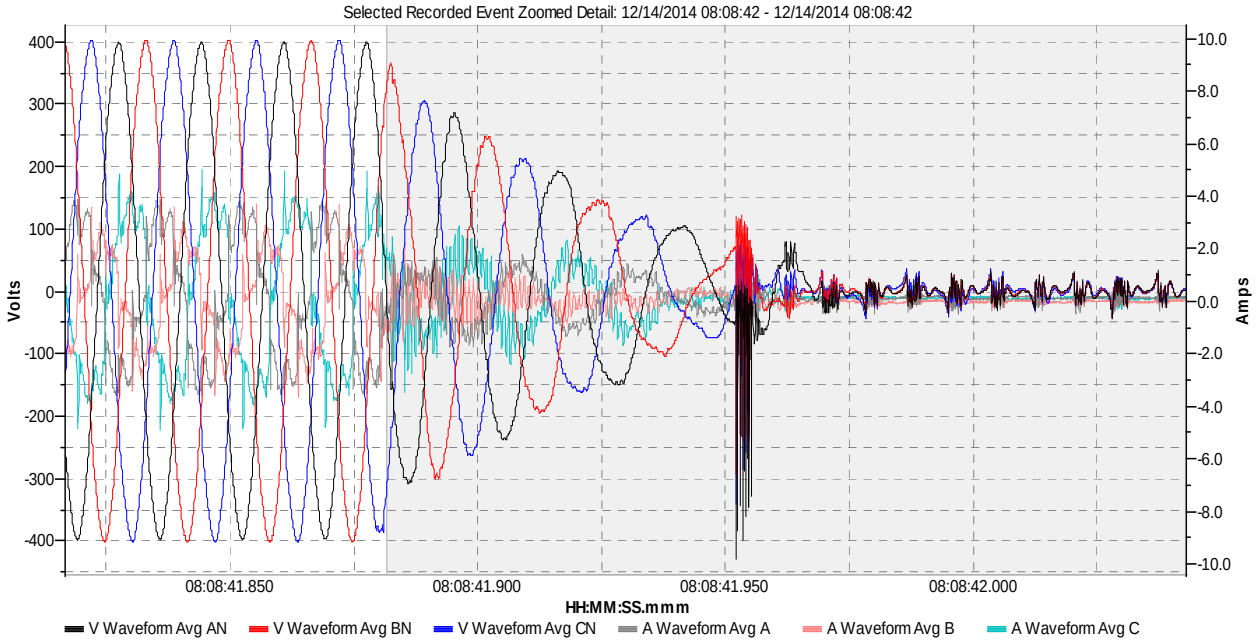
Emergency Power Testing – Example 1 (Extended Outage)



Outage Event # 5 - 6	**Voltage outage appears to be related to emergency power system testing - transfer from utility power to the backup power source.**



Outage Event # 5 - 6	**Emergency power transfer event - note high frequency transients.**

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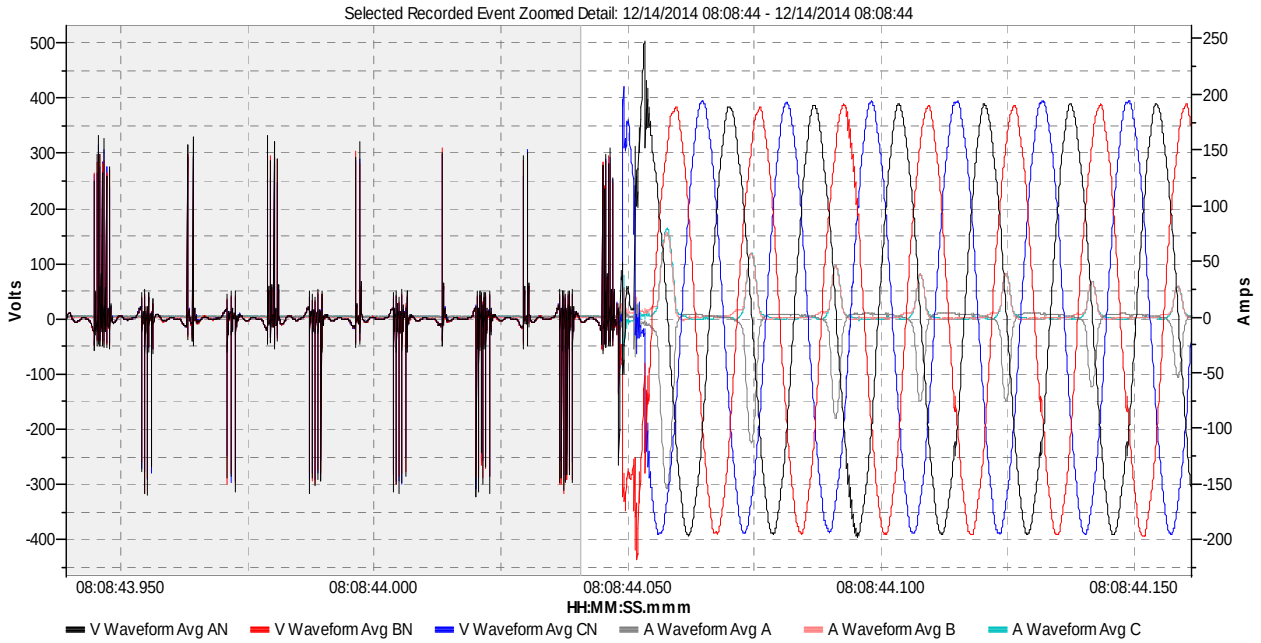
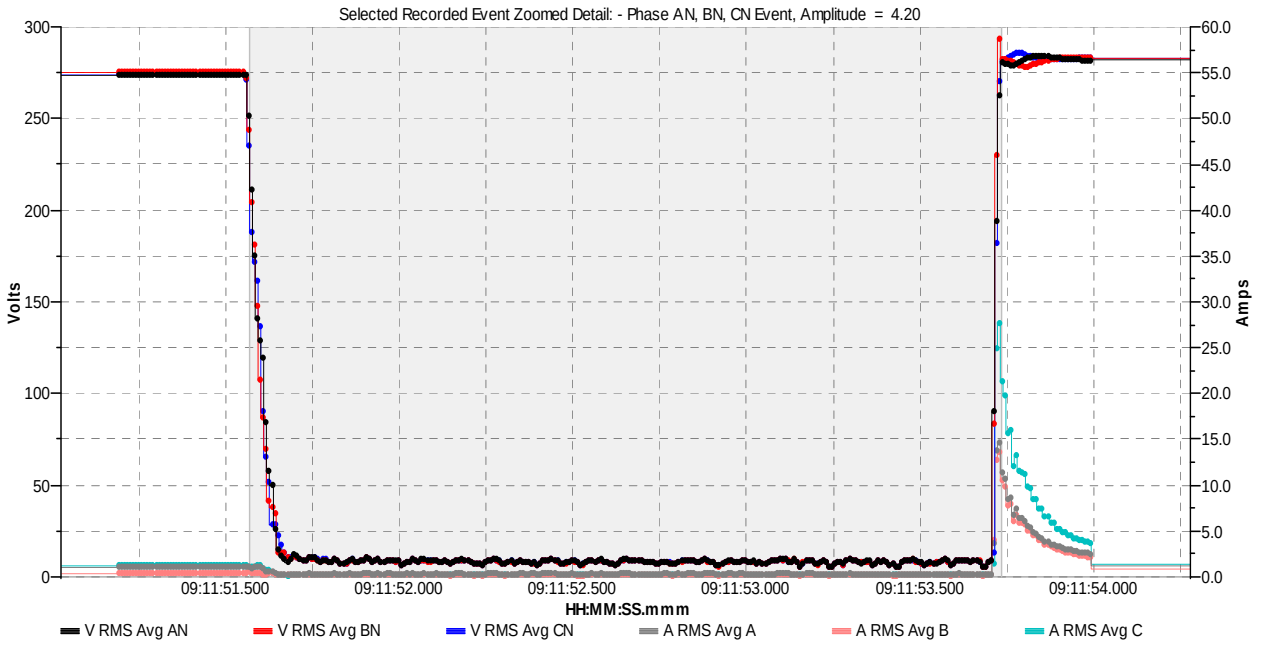
Emergency Power Testing – Example 1 (Extended Outage)



Outage Event # 5 - 6	End of emergency power transfer event - note high frequency transients.



Outage Event # 7 - 8	Voltage outage appears to be related to emergency power system testing - transfer from the backup power source to utility power.

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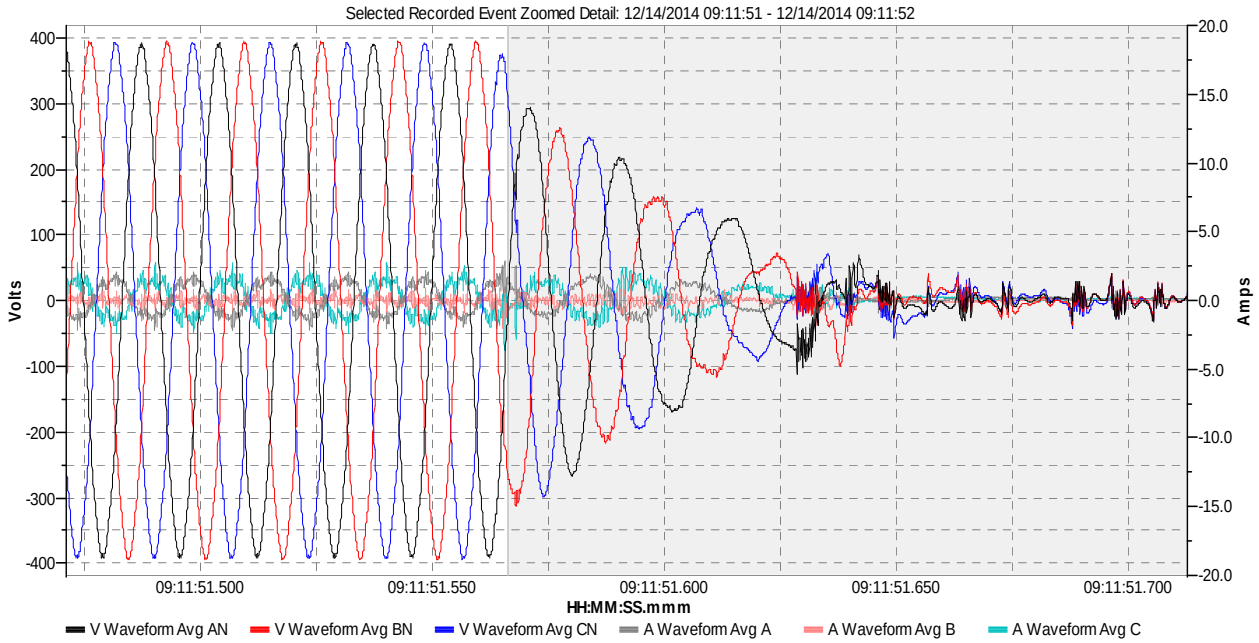
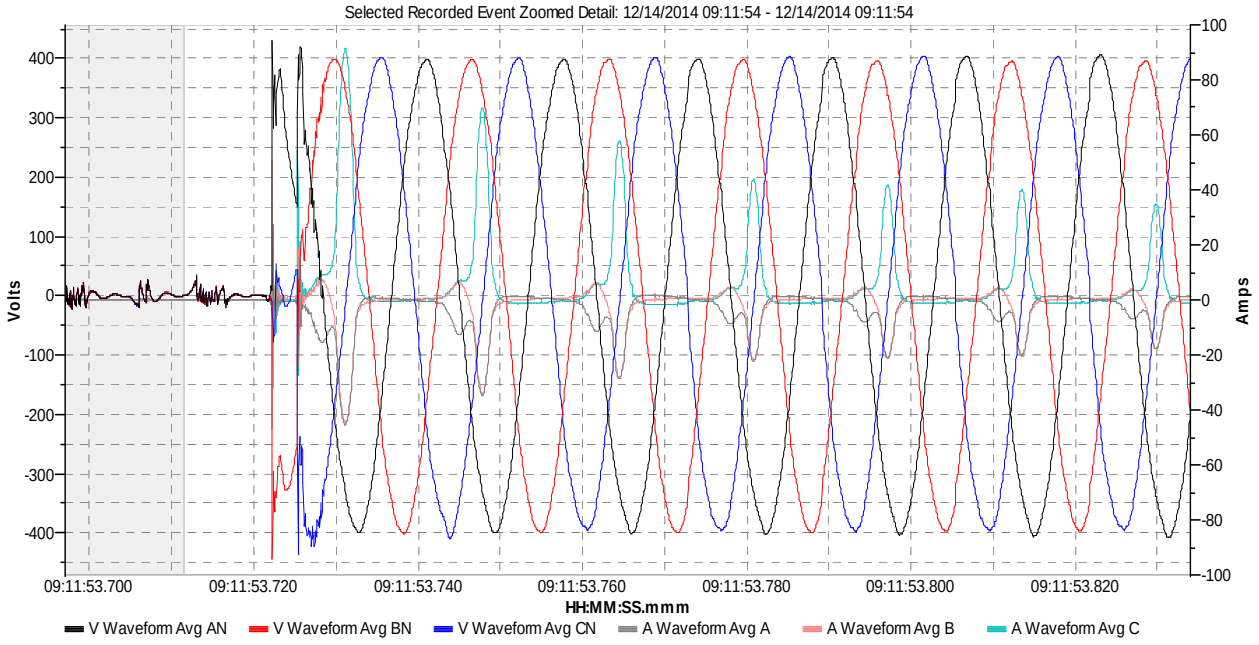
Emergency Power Testing – Example 1 (Extended Outage)



Outage Event # 7 - 8	Emergency power transfer event - note high frequency transients.



Outage Event # 7 - 8	End of emergency power transfer event - note high frequency transients.

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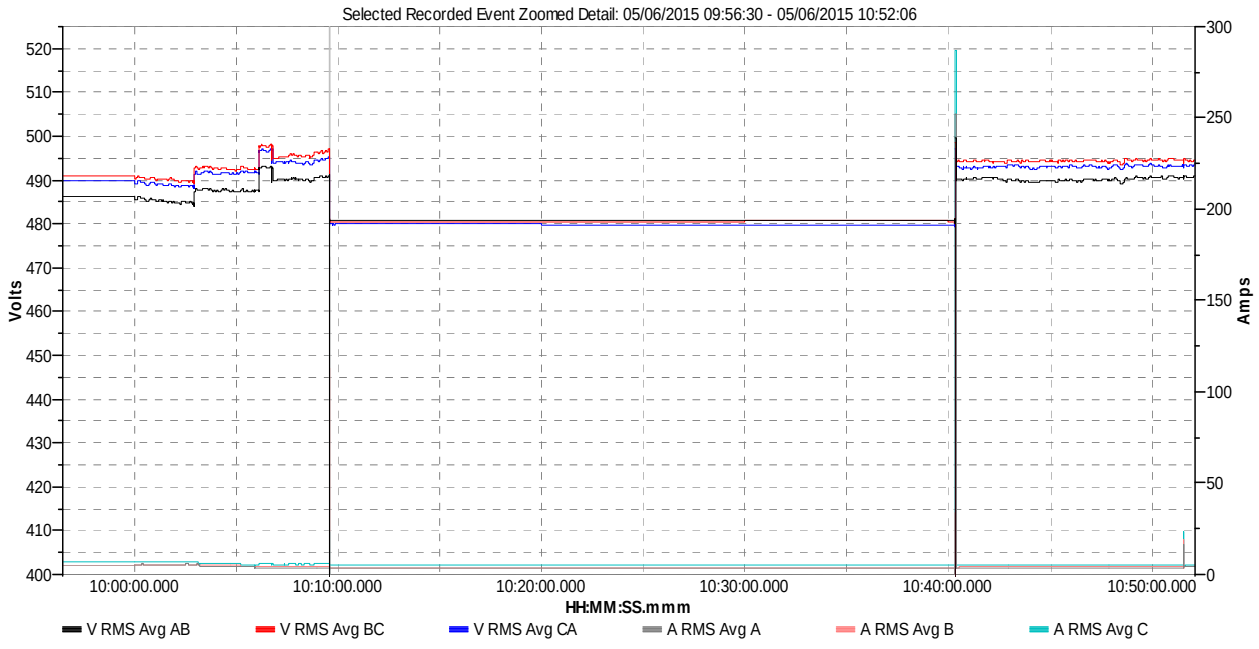
Emergency Power Testing – Example 2 (Short Outage / Sag)

In this example, emergency power system transfer switches are “break before make” devices, but the “off time” is very short (~50 msecs) – probably the time required for a single operator switch to travel between contacts.

Since this is a very short outage (really, a sag or dropout), some systems may ride through the event, and it may be barely perceptible in terms of lights or motors. However, there is a clear disturbance event here (loss of voltage, voltage transients) and disruption or damage to sensitive electronic systems is possible.

Many imaging systems incorporate isolation transformers (either integrated or add-on) to improve power quality and grounding; elevated inrush currents into an energized transformer can cause circuit breaker tripping during emergency power testing, depending upon the duration of the outage / sag events. In this example, the inrush current following the transition is much higher than that seen during a static switch-on at the same site.

#	Date/Time	Type	Duration (Days - Hrs:Min:Sec)	% of Nominal	Absolute	Triggered Phase
2	05/06/2015 10:09:34.344.588	Swell	0 - 00:00:00.008464100	106.59%	511.64 V	BC
3	05/06/2015 10:09:34.353.052	Dip	0 - 00:00:00.067877300	18.61%	89.35 V	AB, BC, CA
4	05/06/2015 10:40:20.179.898	Swell	0 - 00:00:00.008458600	105.45%	506.16 V	AB
5	05/06/2015 10:40:20.179.898	Dip	0 - 00:00:00.059009300	7.87%	37.78 V	AB, BC, CA



Sag / Swell Event # 2 - 5	**Emergency power system testing - with two severe voltage sags framing a period of lower / stable voltage. Imaging system does not appear to be operating during the emergency power system test.**

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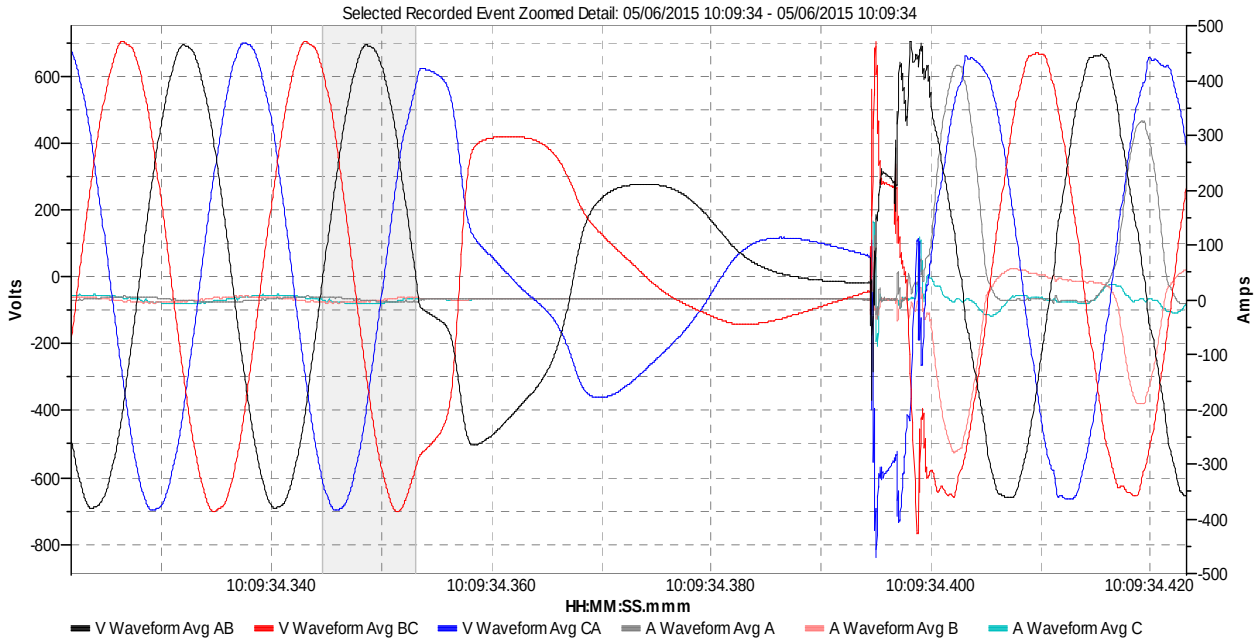
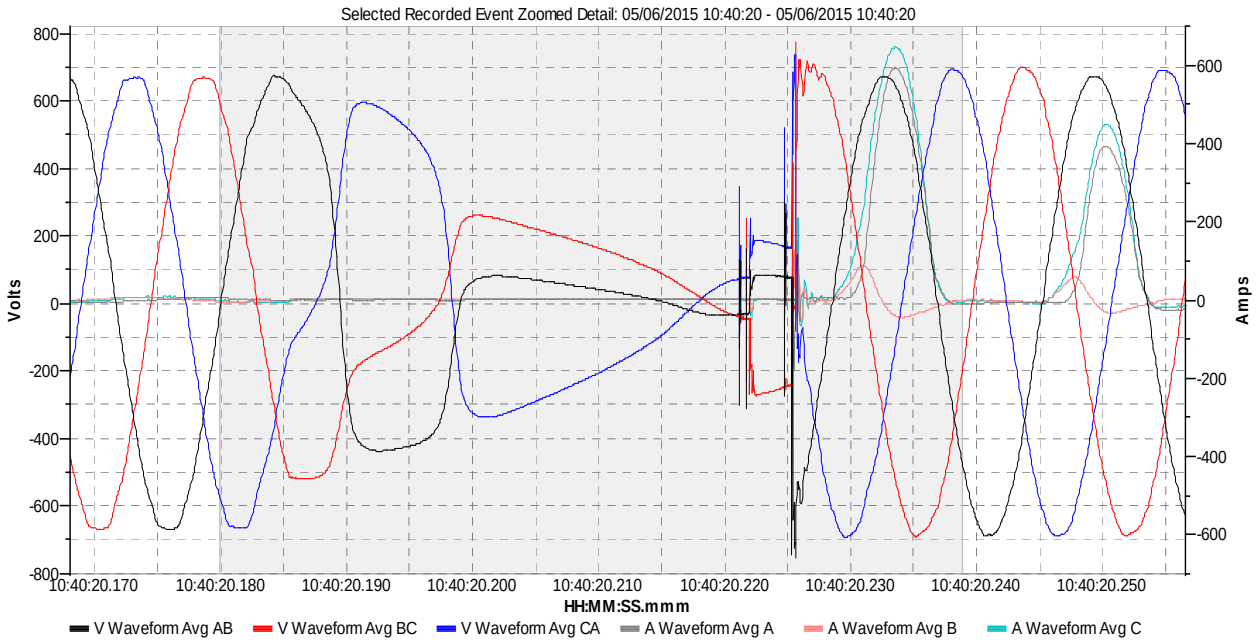
Emergency Power Testing – Example 2 (Short Outage / Sag)



Sag / Swell Event # 2 - 3	**Severe voltage sag related to emergency power system testing / transfer (here, utility power to backup power source). Note voltage transients and high inrush current (isolation transformer saturation).**



Sag / Swell Event # 4 - 5	**Severe voltage sag related to emergency power system testing / transfer (here, backup power source to utility power). Note voltage transients and high inrush current (isolation transformer saturation).**

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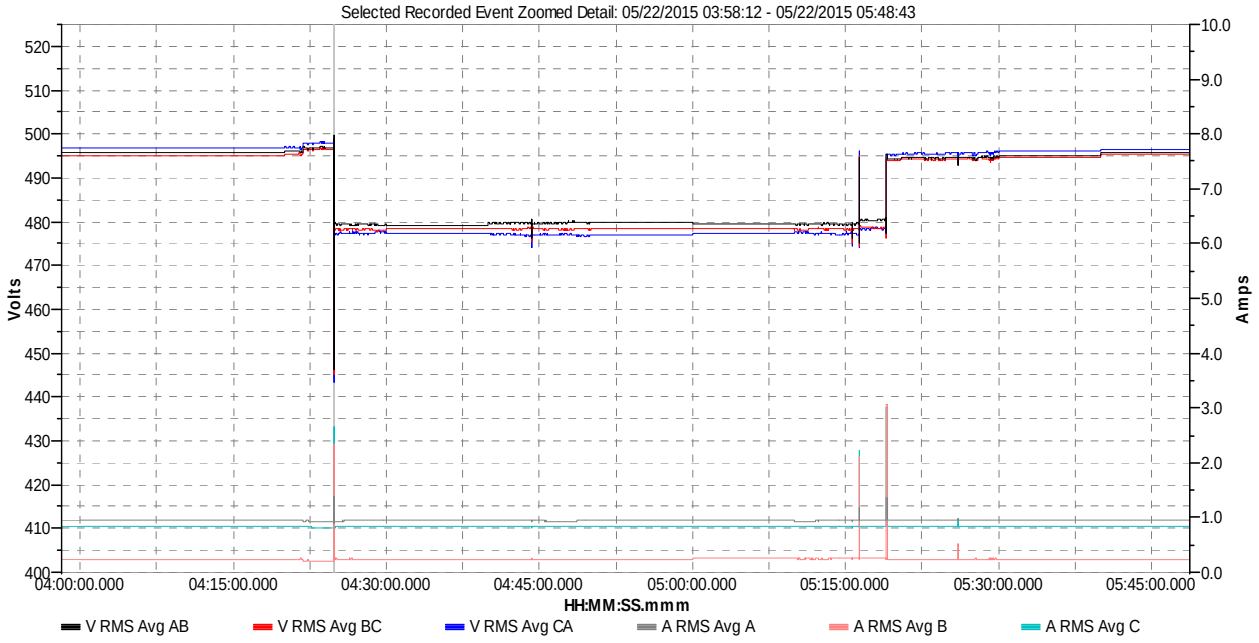
Emergency Power Testing – Example 3 (Minor Sag with Transients)

In this example, emergency power system transfer switches are “make before break” devices, with a minor voltage sag during transition, but also unusual voltage transients, probably related to electronic switching devices that couple both sources simultaneously.

The impact on RMS voltage here is minimal - the captured sags were not outside of equipment requirements, and were primarily related to nominal voltage differences between the utility and the backup power source.

However, the transfer switch technology (static / electronic, as opposed to electro-mechanical) produces voltage transients over a prolonged period (5-10 cycles) which may cause problems for some systems.

#	Date/Time	Type	Duration (Days - Hrs:Min:Sec)	% of Nominal	Absolute	Triggered Phase
9	05/22/2015 04:24:53.763.416	Dip	0 - 00:00:00.134920200	93.35%	448.10 V	AB, BC, CA
10	05/22/2015 04:24:54.018.336	Dip	0 - 00:00:00.159080300	92.68%	444.87 V	AB, BC, CA



Sag / Swell Event # 9 - 10	**Minor voltage sag - this appears to be related to an emergency power system test.**

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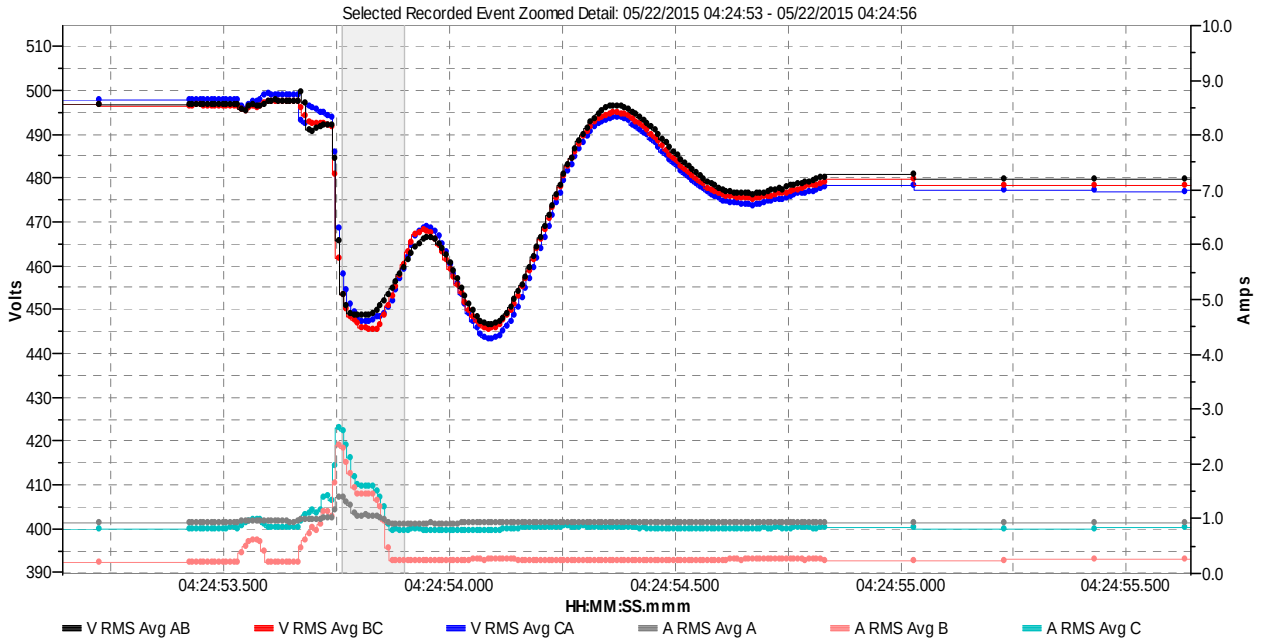
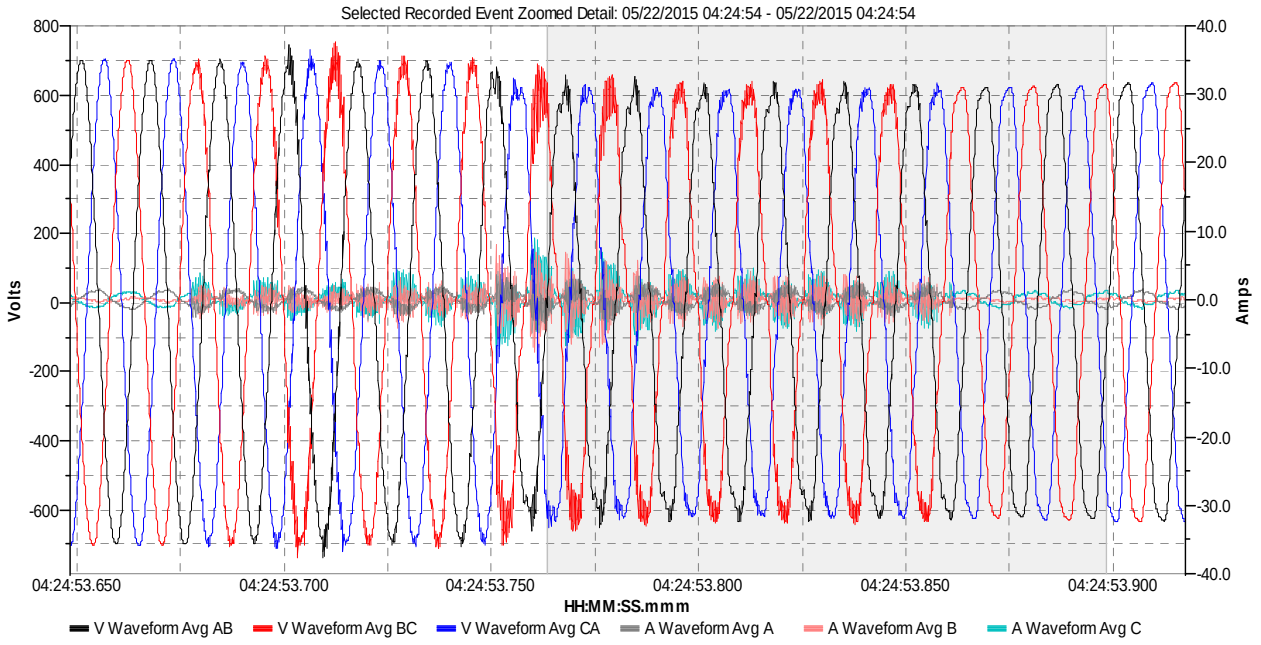
Emergency Power Testing – Example 3 (Minor Sag with Transients)



Sag / Swell Event # 9	Start of emergency power system test, with minor voltage sag and some voltage instability.



Sag / Swell Event # 9 - 10	Start of emergency power system test, with minor voltage sag and some voltage instability. Note high frequency noise / transients during transition.

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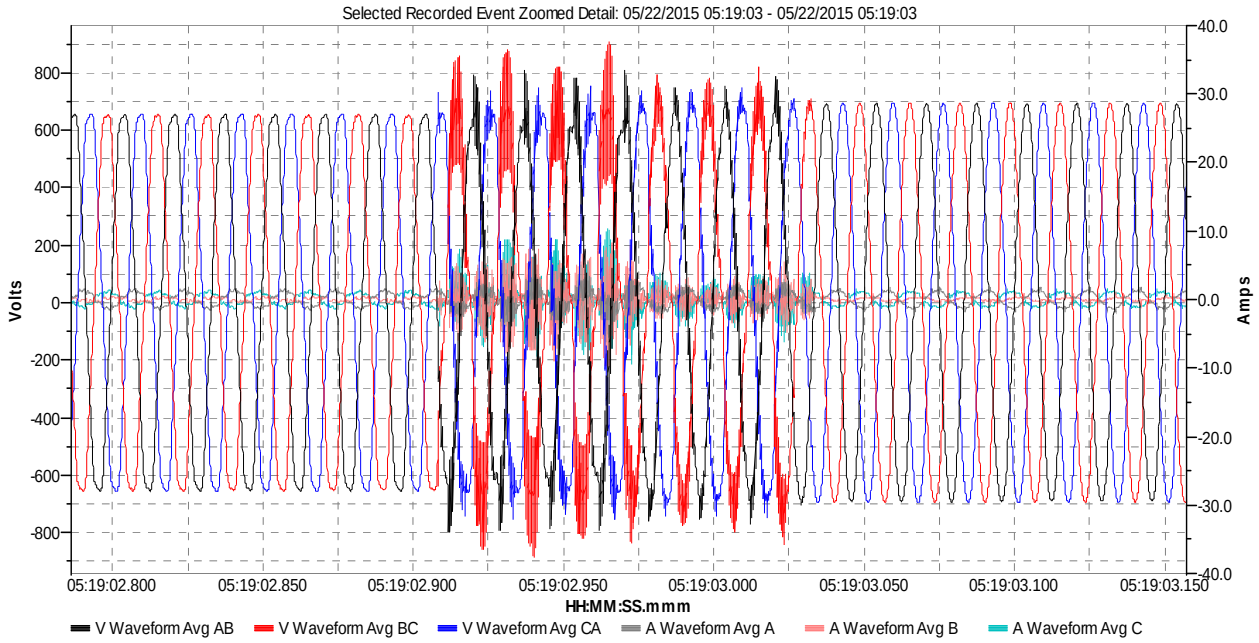
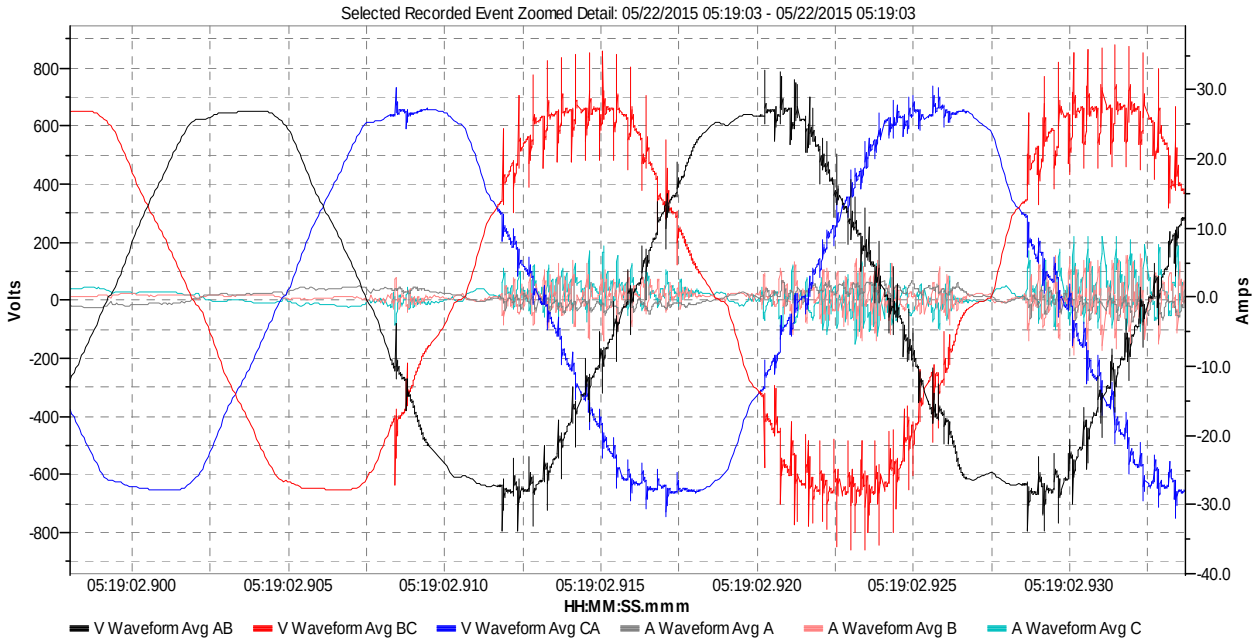
Emergency Power Testing – Example 3 (Minor Sag with Transients)



Sag / Swell Event # 9 - 10	**End of emergency power system test, with minor voltage sag and some voltage instability. Note high frequency noise / transients during transition.**



Sag / Swell Event # 9 - 10	**End of emergency power system test, with minor voltage sag and some voltage instability. Note high frequency noise / transients during transition.**

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