

# Ferro-Resonance

## Recipe

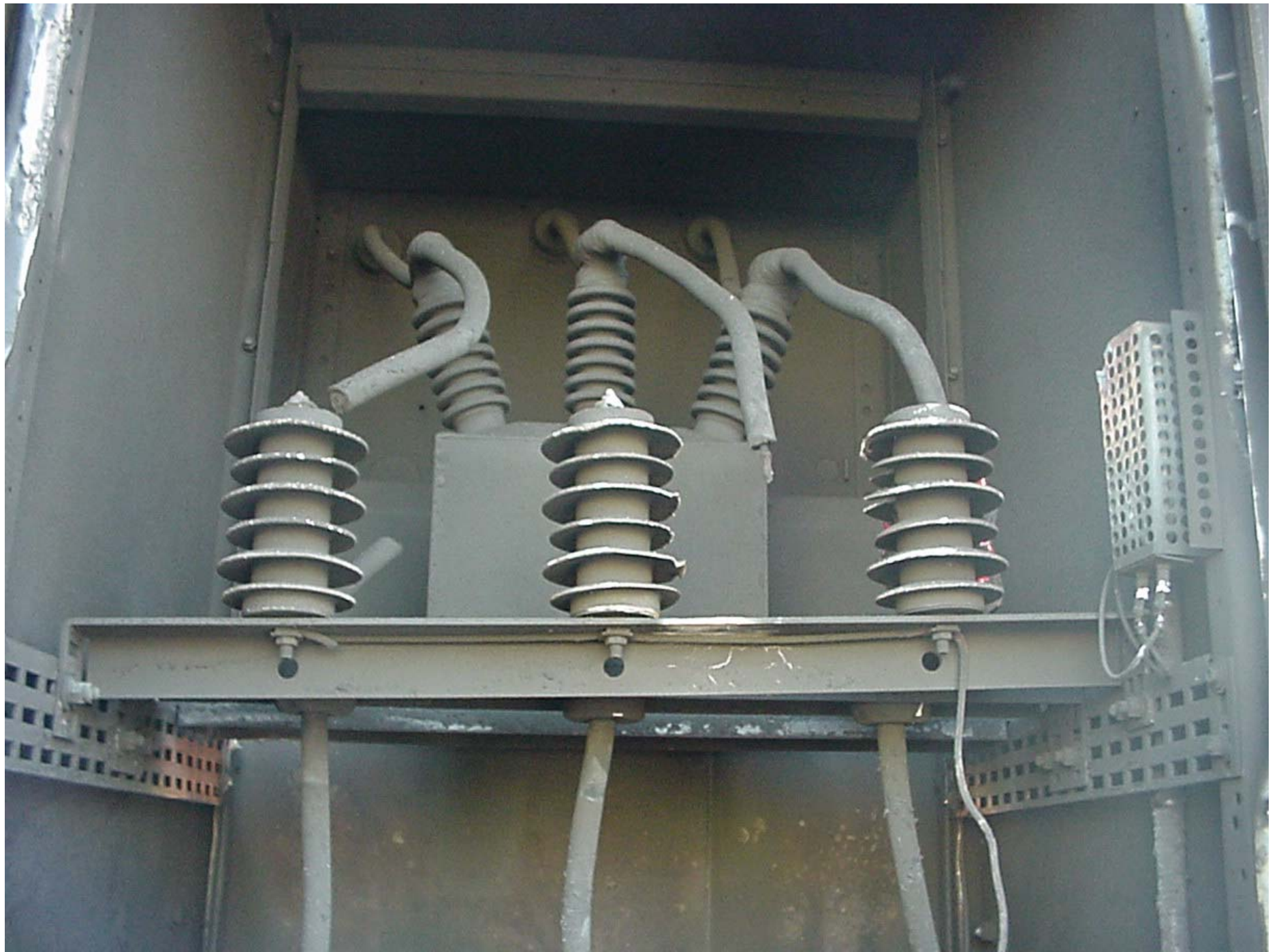
1.  $X_L \approx X_C$  ; Ratio of Capacitance and Inductance within a portion of the system.
2. Any type of switching event , including breaker operations  
(shock excitation)
3. Single phase switching of 3 phase transformers
4. Over voltage conditions of lightly loaded transformers
5. Underground cable ( $x_C$ ) + transformer ( $X_L$ )

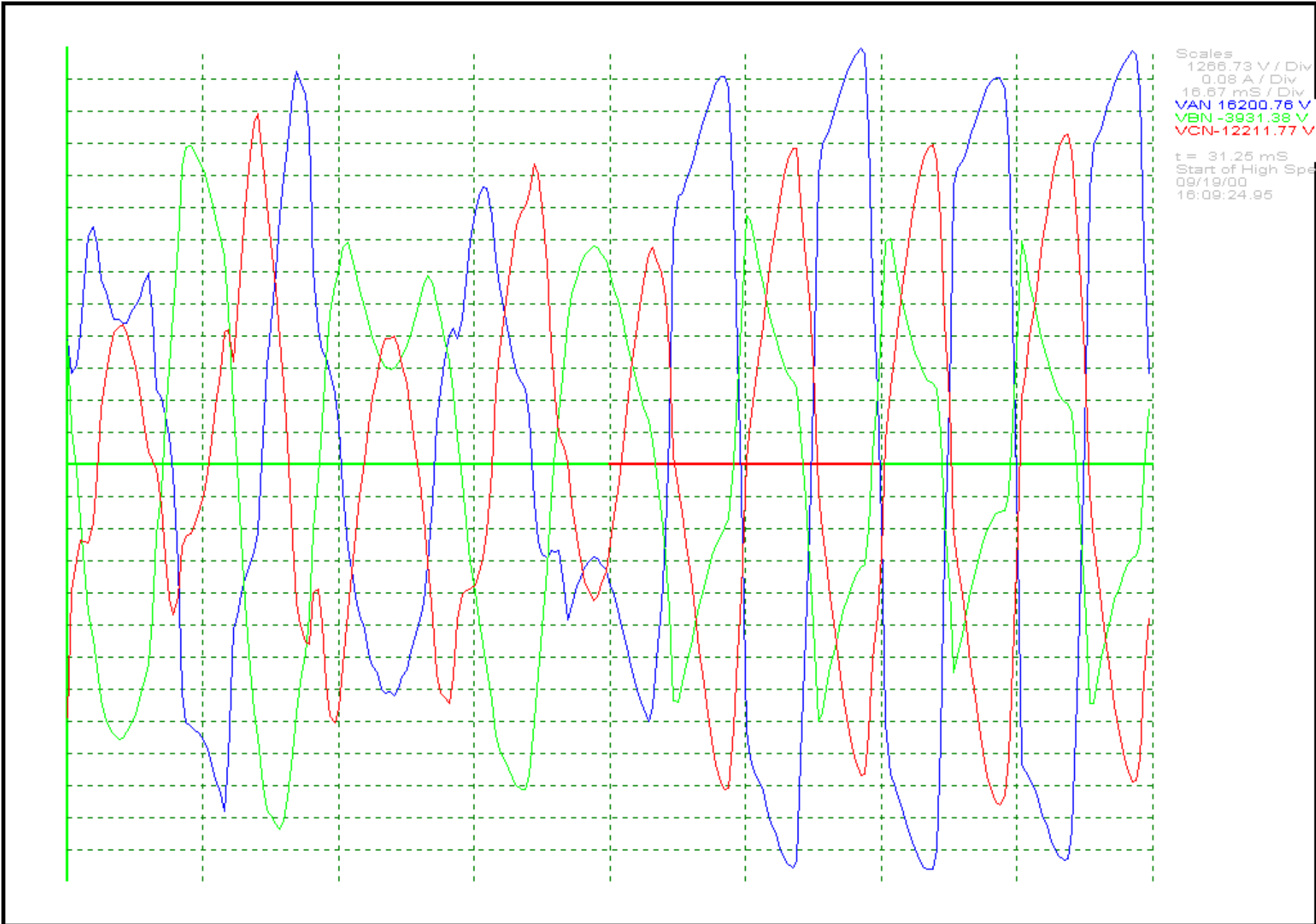
## Symptoms:

1. Failed arresters
2. Violent fuse clearing
3. Failed transformers
4. Premature failed UG primary cable
5. Higher than normal volts and amps  
(1.5X or more )



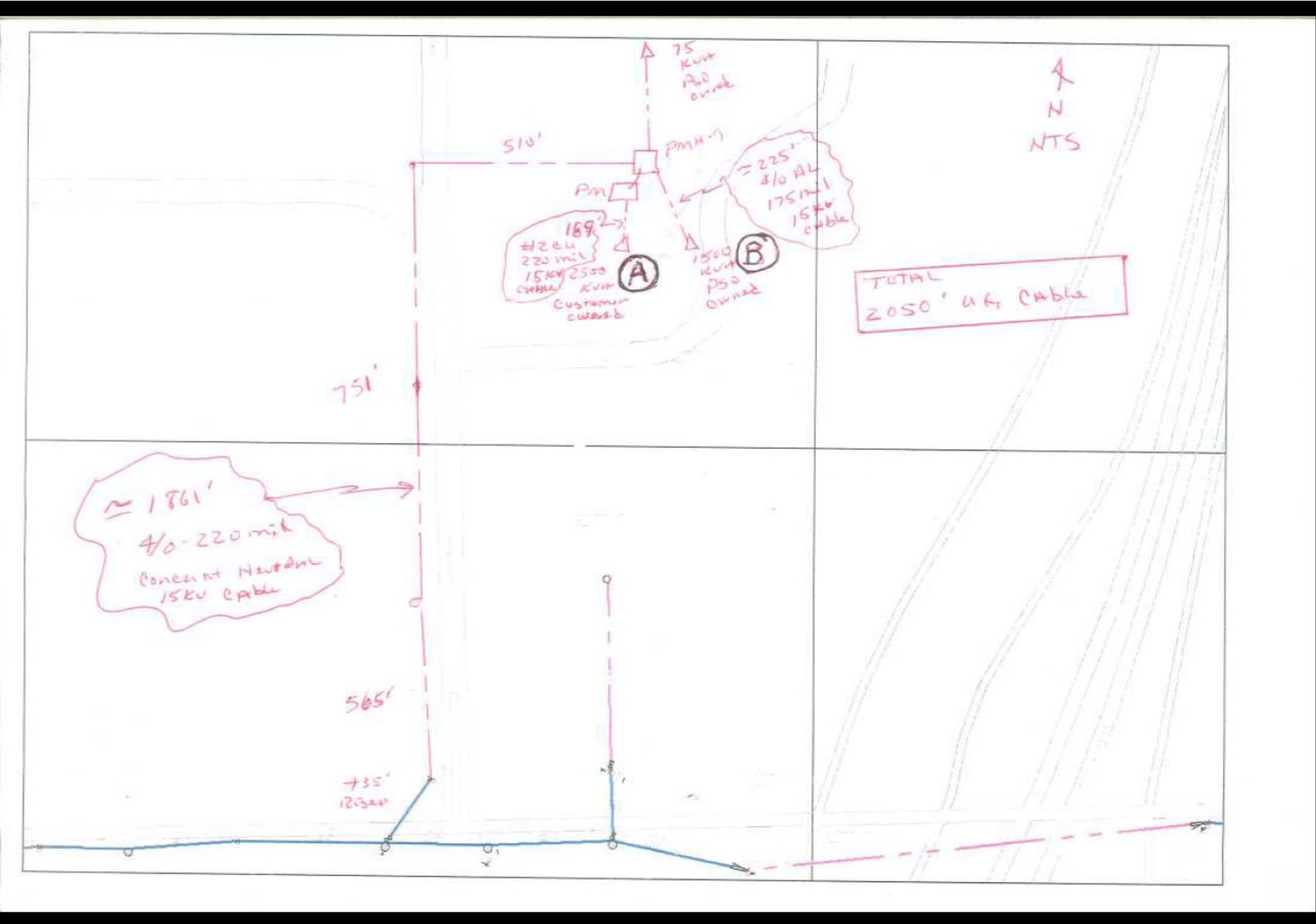
1. Open-Delta connected PTs
2. Surge capacitor
3. 187 ft 4/0 Al 15 Kv UG cable
4. Single phase switching





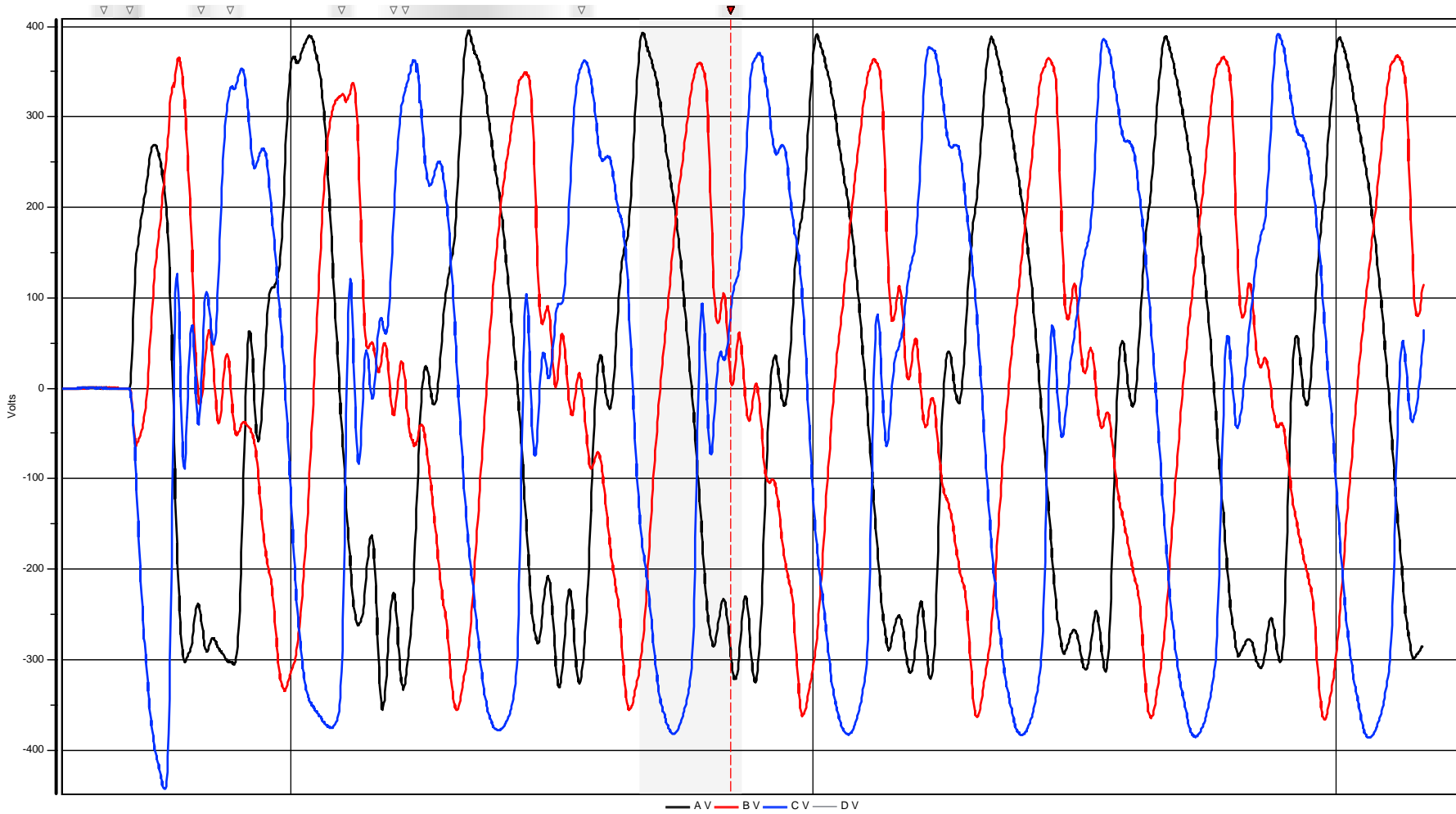
Van - 2.12 X  
Vcn - 1.602X

# One Line of Underground cable and Transformers



Event	Duration	Date & Time	V - Ph A	V - Ph B	V - Ph C	I - Ph A	I - Ph B	I - Ph C		
Dist Ckt Phase			C	A	B	C	A	B		
Sag	1271	7/13/2009 11:20:18	30.7	0.8	0.2	0	0	0		
Swell	3249	7/13/2009 11:20:18	167.1	112.4	113.8	0	0.4	0.4		11.697 Kv
Sag	2	7/13/2009 11:19:24	82.3	111.5	113.8	0	0.3	0.4		1.535X
Swell	3	7/13/2009 11:19:24	145.6	116.5	116.6	0	0.3	0.4		10.192 Kv
Sag	26	7/13/2009 5:06:54	94.2	113.9	112.9	0	0.4	0.5		1.337X
Sag	16	7/13/2009 5:06:13	111.6	100.2	115.5	0	0.3	0.6		
Swell	12	7/13/2009 2:05:07	109.5	115	118.4	5.2	0.8	0.6		
Swell	3	7/13/2009 2:05:07	108.6	115	117.1	6.7	0.8	0.5		
Swell	14	7/13/2009 2:05:07	108.4	115	117.7	6.7	0.9	0.5		
Swell	19	7/13/2009 2:05:07	110.8	115	118	4.9	0.9	0.5		
Swell	3	7/13/2009 2:05:07	110	115	116.9	5.4	0.7	0.6		
Swell	3	7/13/2009 2:05:06	106.2	114.9	118.1	10.8	1.1	0.5		
Swell	4	7/13/2009 2:05:06	110.8	114.9	116.8	4.9	0.8	0.5		
Swell	3	7/13/2009 2:05:06	111.2	114.9	117	3.7	0.8	0.5		
Swell	14	7/13/2009 2:05:06	111.1	115	118.3	4	0.7	0.5		
Swell	19	7/13/2009 2:05:06	111.3	115	117.6	3.5	0.6	0.5		
Swell	3	7/13/2009 2:05:06	111.5	115	116.8	4.2	0.7	0.5		
Swell	4	7/13/2009 2:05:05	110.5	115	116.9	5.9	0.7	0.5		
Swell	2	7/13/2009 2:05:05	110	115	117	6.3	0.7	0.5		
Swell	3	7/13/2009 2:05:05	111.4	115	116.7	4.1	0.7	0.5		
Swell	3	7/13/2009 2:05:05	110.7	115	116.8	5.3	0.7	0.5		

### Event Details/Waveforms



01:00:25.05  
08/03/2009  
Monday

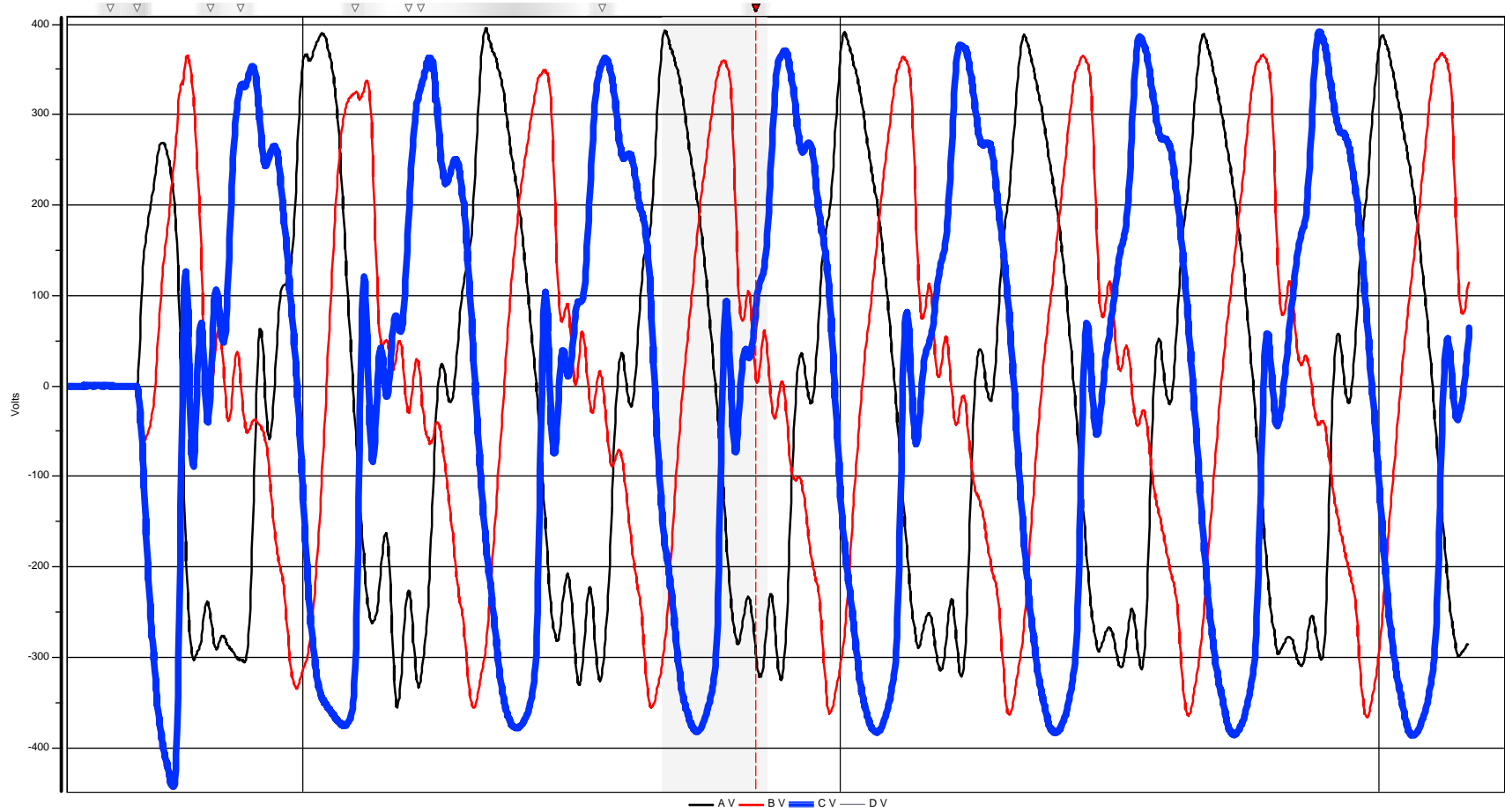
01:00:25.10

01:00:25.15

Event #247 at 08/03/2009 01:00:25.083  
BV Dropout 1/16 Cyc

	A	B	C	D	A-B	B-C	C-A
<b>Vrms</b>	236.3	203.6	246.8	0.1089	369.2	370.9	433.0
<b>VPeak</b>	393.1	360.4	381.9	0.2737	376.9	390.9	394.4
<b>Irms</b>	1755	1720	1342	136.5			
<b>IPeak</b>	2156	2377	1807	179.4			

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109 V<sub>Base</sub>  
 A = 236.3 2.16X  
 B = 203.6 1.86X  
 C = 246.8 2.26X