



# Public Service Commission of Wisconsin

Joseph P. Mettner, Commissioner

610 North Whitney Way  
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May 20, 1998

To: THE PARTY ADDRESSED

Re: Dairyland Isolator Device

The enclosed report explains the methods and results of tests performed on the new Dairyland Isolator Device from the fall of 1996. The data collected is not a totally comprehensive test covering exact thresholds and exact waveform time durations, but is sufficient to determine the working characteristics of the isolator. The REPS team feels the device functions well as designed and should be the device of choice for rural neutral isolation.

Please also note that tests were performed on methods of generating spurious signals to be recorded by the Dranetz which have nothing to do with voltages generated by normal primary or secondary neutral activity. This is to document that Dranetz recordings of large spikes can be created artificially by clever ruse or uninformed random activity and do not represent legitimate data from the connected measurand.

Sincerely,

Richard S. Reines  
Environmental Engineer  
Electric Division

Mark A. Cook, Electrical Inspector  
Stray Voltage Program Manager  
Rural Electric Power Services

RSR:MAC:ljv:s:\svat\isolation\dairyland isolator device

Enclosures

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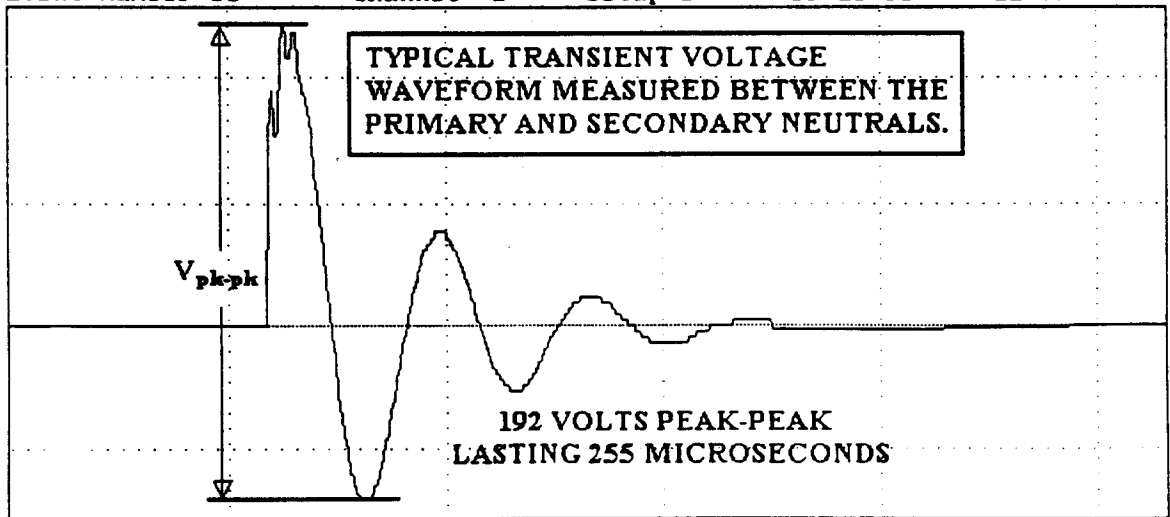
# NEW VARIABLE THRESHOLD ISOLATOR TEST

On September 25, 1996 the SVAT team met on a farm in rural Green County to supervise a test on the new Dairyland Electrical Industries, Inc.(DEI) isolator device. This device, the VT-170-45, differs from the previous model NI-170-36 in its ability to block higher transient voltages from passing between utility's / power supplier's primary system and the farms' loads. The blocking voltage level in this device is variable and is dependent on the initial magnitude and on the duration of the transient event, hence the name, variable threshold isolator.

For safety and reliability reasons, primary and secondary neutrals separated by an isolator device must be reconnected when the voltage level between them is above a certain prescribed magnitude. However, for short intervals of time, this magnitude can be increased without undue compromise in safe operation of the electrical system.

Initially the team investigated how to create transient spikes on the primary neutral system that would be of sufficient magnitude to cause the new isolator device to reconnect the primary and secondary neutrals. This would ensure that it is functioning in the manner required for system safety. As illustrated in the attached Figure A, the initial set-up shows the connection of an electric fencer between the pole ground at the farm's tap pole on the highway and the farm secondary neutral ground at the main disconnect pole. The readings from the Dranetz recorder and a portable oscilloscope confirmed that the spikes generated by the fencer were of sufficient magnitude to cause the isolator to reconnect the neutrals for short time periods when the voltage specifications were exceeded. Shown in Figure 1 below is a typical voltage waveform which illustrates the magnitude and duration of the type of transients generated by the fencer and recorded at the isolator location.

658 GRAPHICAL & HARMONIC ANALYSIS (c)1988-1994 Dranetz Technologies, Inc.  
TEST SEPT 25 LN BACRIS CIISO  
Event Number 68 Channel B Setup 5 09/25/96 11:31:00.54



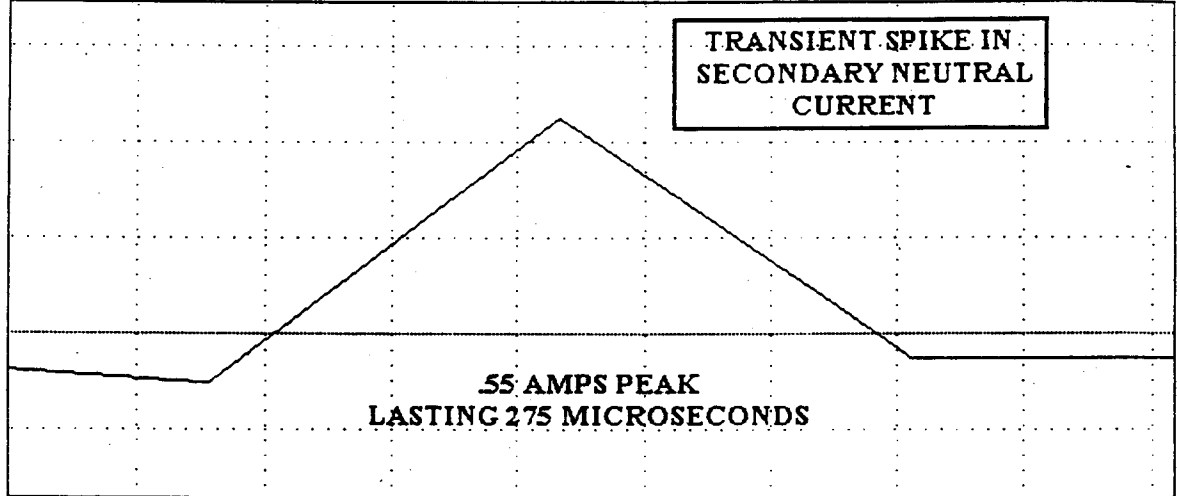
Horizontal 100 microseconds/division Vertical 50 Volts/division  
Urms: Prev=.3400, Min=.3300, Max=.3400 - Worst Imp= 121.0 Vpk, 345 deg

FIGURE 1

The 192 Volt peak to peak magnitude is sufficient, even when the event lasted only 255 microseconds (or about a quarter of a thousandth of a second), to reconnect the neutrals through the isolator. This allows a current spike to occur on the secondary neutral as seen in figure 2

which is over half an amp maximum current. Assuming a neutral ground resistance of about 2 ohms, this current would generate a secondary neutral voltage spike of about 1.1 Volts peak.

658 GRAPHICAL & HARMONIC ANALYSIS (c)1988-1994 Dranetz Technologies, Inc.  
 TEST SEPT 25 LN BACRIS CIISO  
 Event Number 68 Channel C Setup 5 09/25/96 11:31:00.54

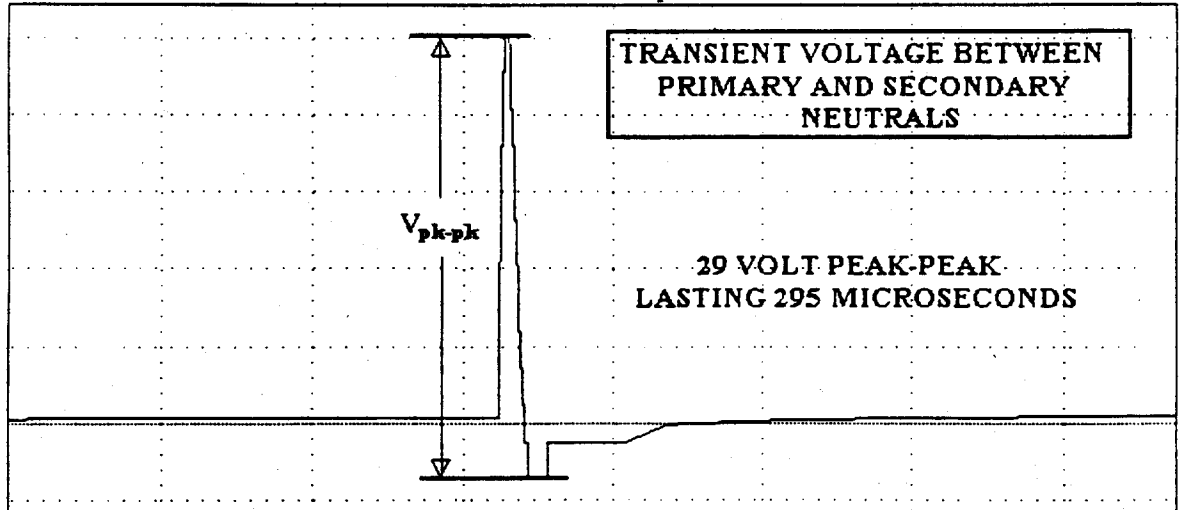


Horizontal 50 microseconds/division Vertical .2 Amps/division  
 Arms: Prev=.0799, Min=.0599, Max=.0700 - Worst Imp= 0 Apk, 0 deg

FIGURE 2

The second set-up of the fencer, illustrated in the attached Figure B, produced reduced voltage spikes at the isolator to demonstrate that transient spikes on the primary neutral are effectively blocked from causing secondary neutral transient activity. The waveform in Figure 3 shows a transient voltage spike that would have been of sufficient magnitude to have caused the NI-170-36 isolator device to reconnect the neutrals for a short duration of time.

658 GRAPHICAL & HARMONIC ANALYSIS (c)1988-1994 Dranetz Technologies, Inc.  
 TEST SEPT 25 LN BACRIS CIISO  
 Event Number 188 Channel B Setup 5 09/25/96 11:41:36.84

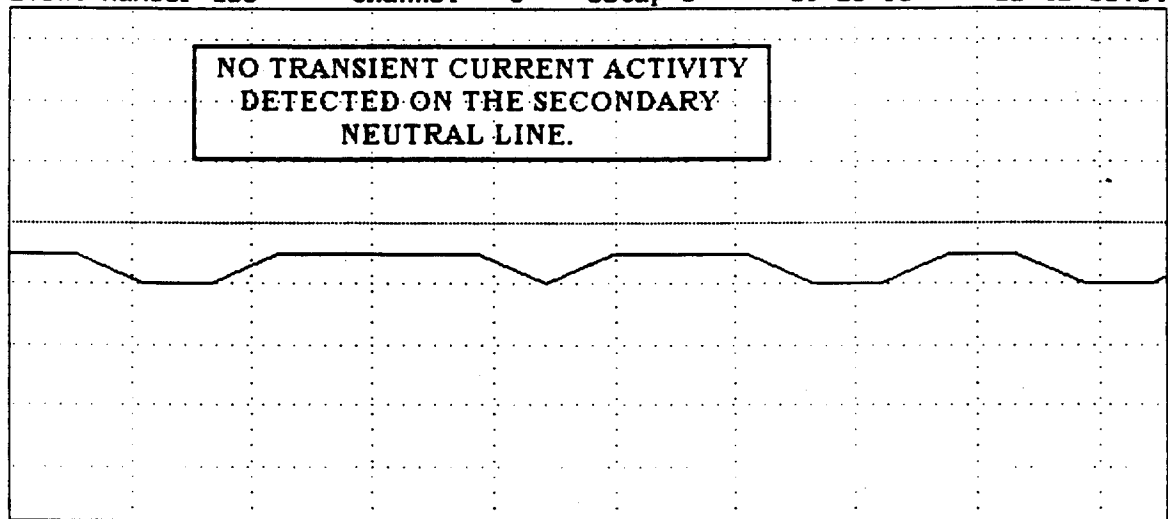


Horizontal 250 microseconds/division Vertical 5 Volts/division  
 Urms: Prev=1.230, Min=.3300, Max=.3300 - Worst Imp= 26.39 Upk, 77 deg

FIGURE 3

The waveform of figure 4 shows that no current spikes are detectable on the secondary neutral because the primary and secondary neutrals are effectively isolated.

658 GRAPHICAL & HARMONIC ANALYSIS (c)1988-1994 Dranetz Technologies, Inc.  
 TEST SEPT 25 LN BACRIS CIISO  
 Event Number 188 Channel C Setup 5 09/25/96 11:41:36.84



Horizontal 250 microseconds/division Vertical .1 Amps/division  
 Arms: Prev=.0700, Min=.0700, Max=.0700 - Worst Imp= 0 Apk, 0 deg

FIGURE 4

The Waverider recorder was set up in the main barn with the following channel allocations:

<u>CHANNEL</u>	<u>SIGNAL</u>
A	Cow Contact Voltage - waterline to floor
C	Voltage on main breaker panel ground to remote reference rod
D	Voltage on primary to secondary neutrals
F	Voltage on primary neutral to remote reference rod.

The waveforms captured during the same time period of Figures 1 and 2 above are pictured in Figures 5 and 6 below. This period of time had transient activity impressed between the primary neutral system at the main tap to the farm and the secondary neutral. The voltage was of such a magnitude that it caused the isolator to reconnect the neutrals for the time that the voltage on the primary neutral exceeds the safe design limit specified by DEI.

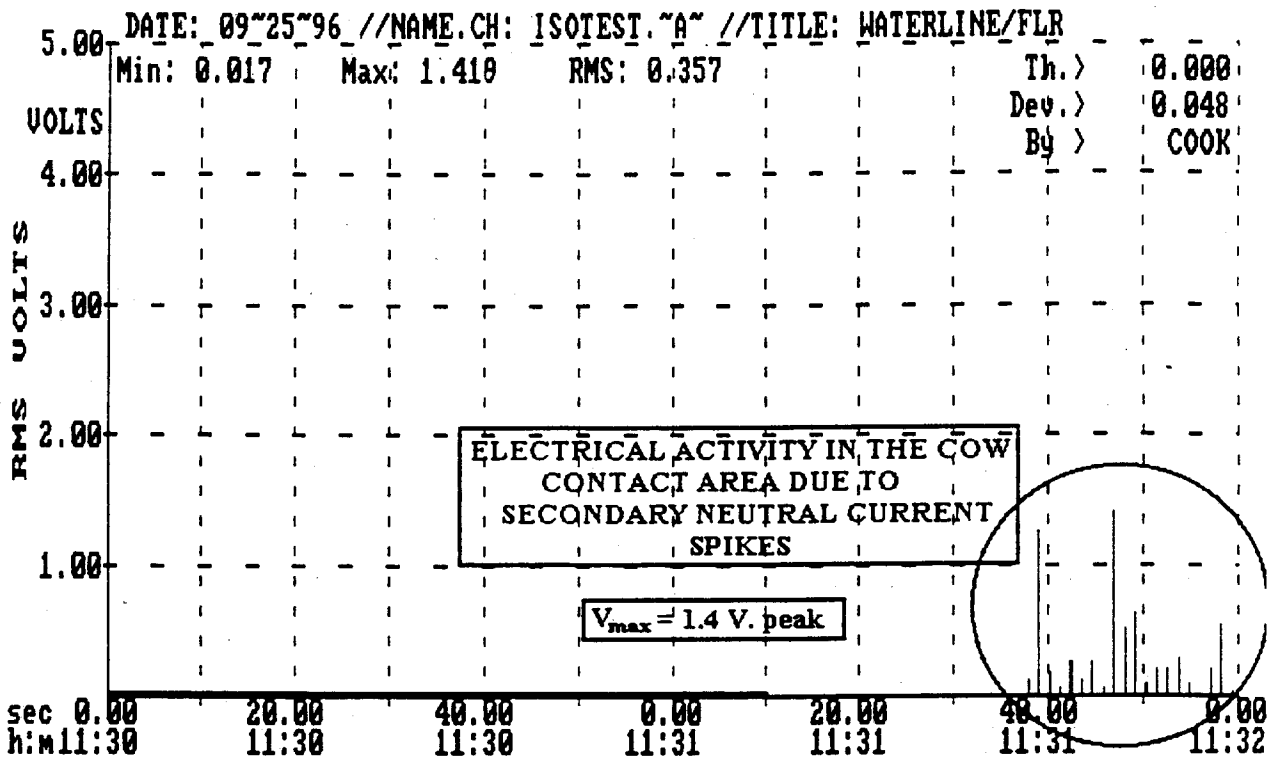


FIGURE 5

Note that electrical activity is present in the cow contact area during the intentional transient generation of the fencer. The isolator experiences an override condition due to the high magnitude of the fencer induced transients on the primary neutral system and therefore is allowing electrical activity from the primary system to reach the barn's cow contact area.

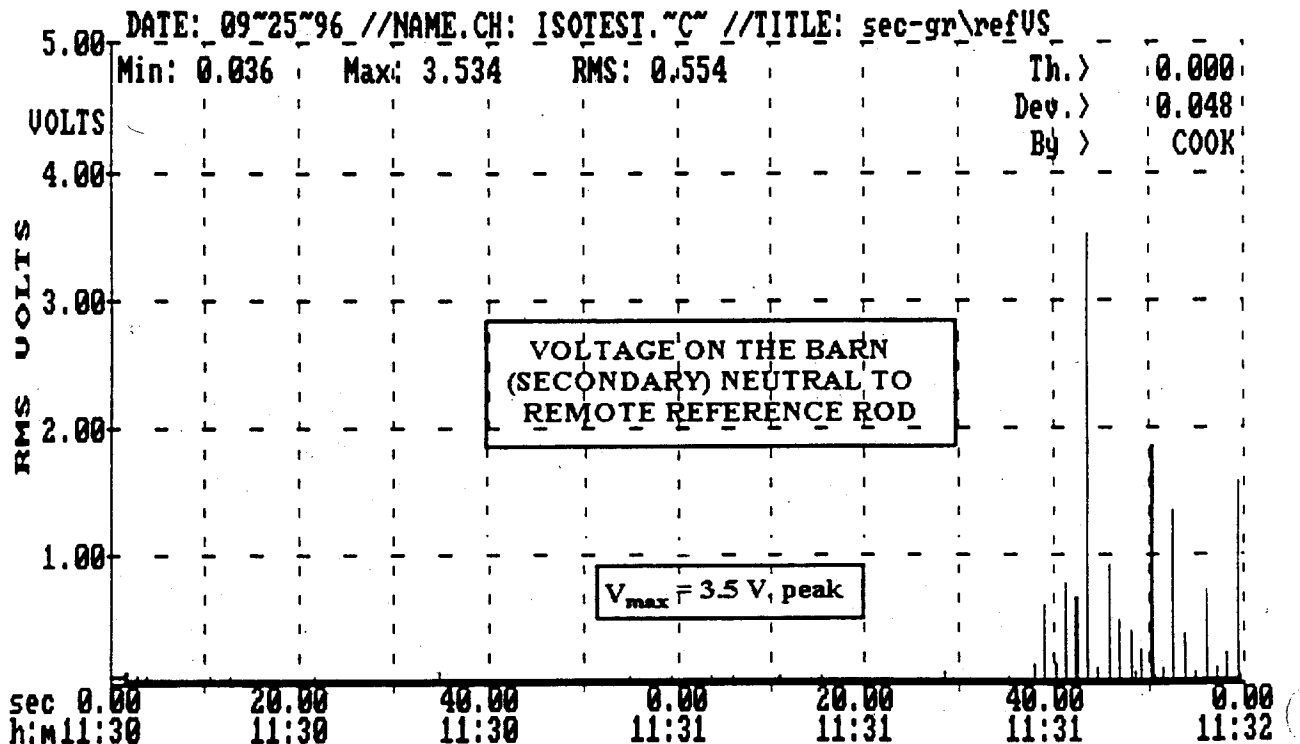


FIGURE 6

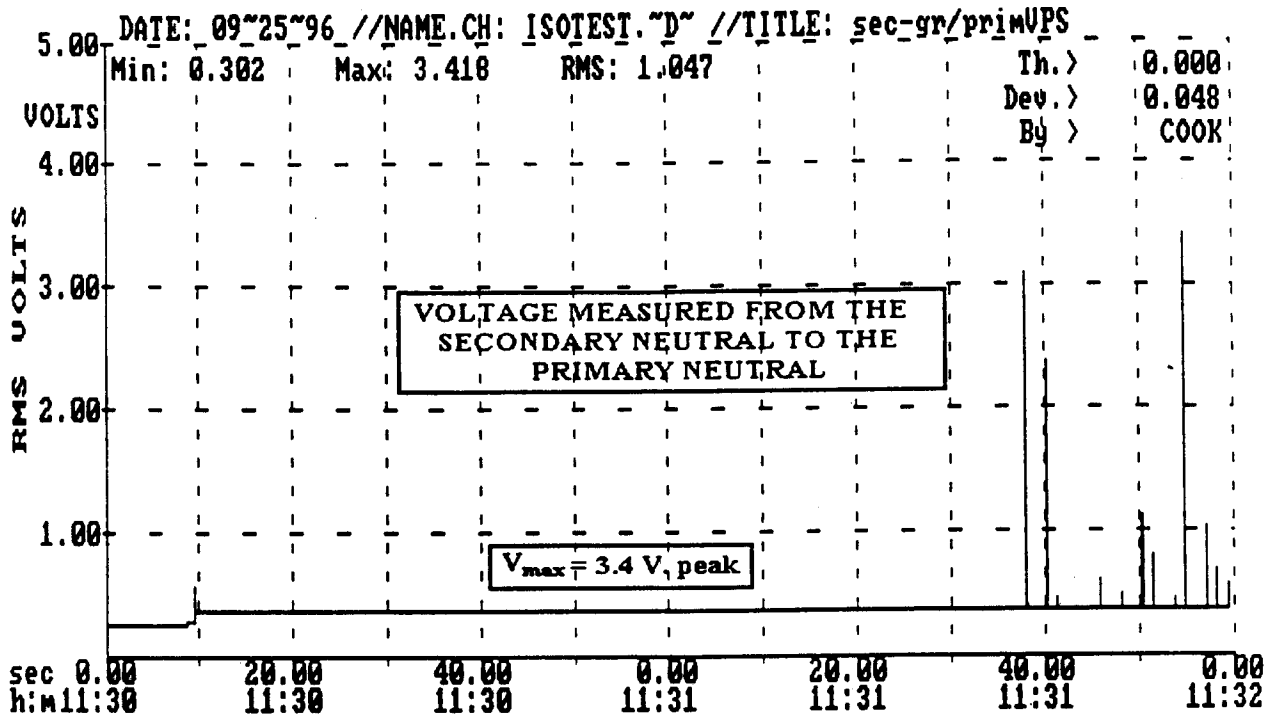


FIGURE 7

The following graphs of the electrical activity recorded by the Waverider during the time period of Figures 3 and 4 above show a different picture.

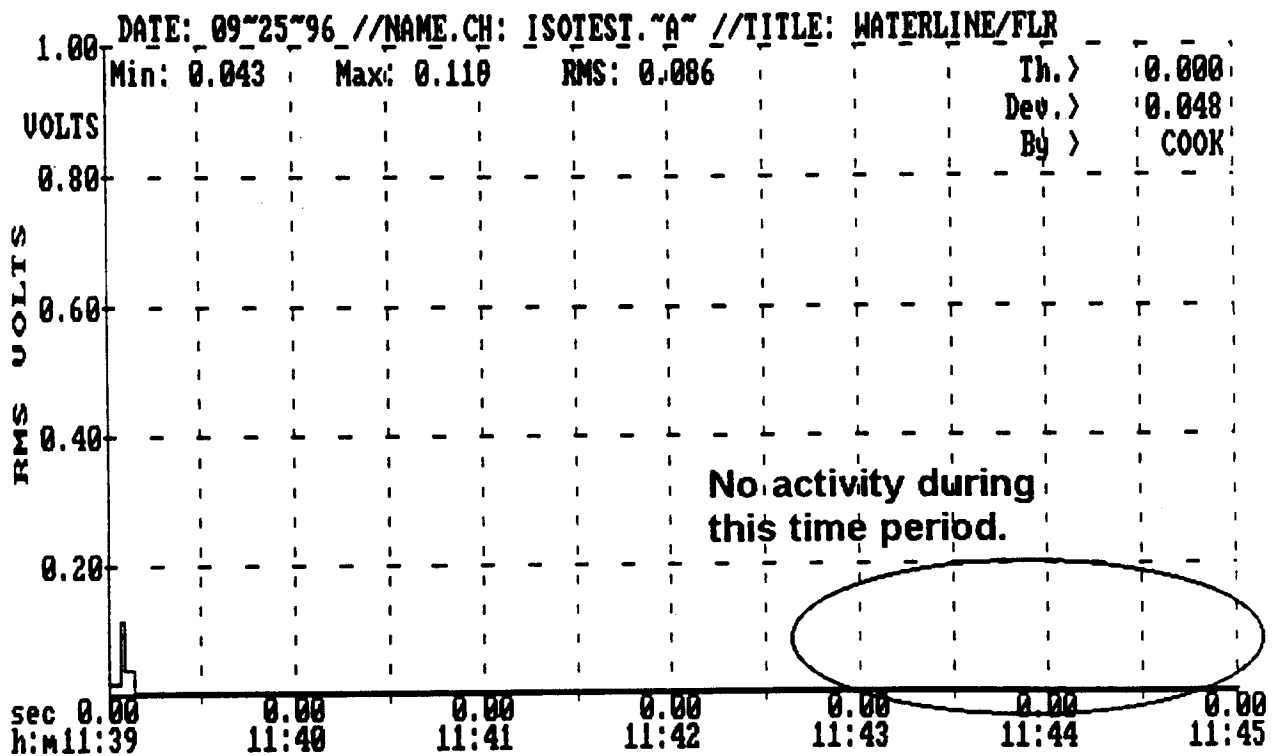


FIGURE 8

Note that there is no measurable voltage in the cow contact area during the time period of interest. The voltage across the isolator was 29 volts.

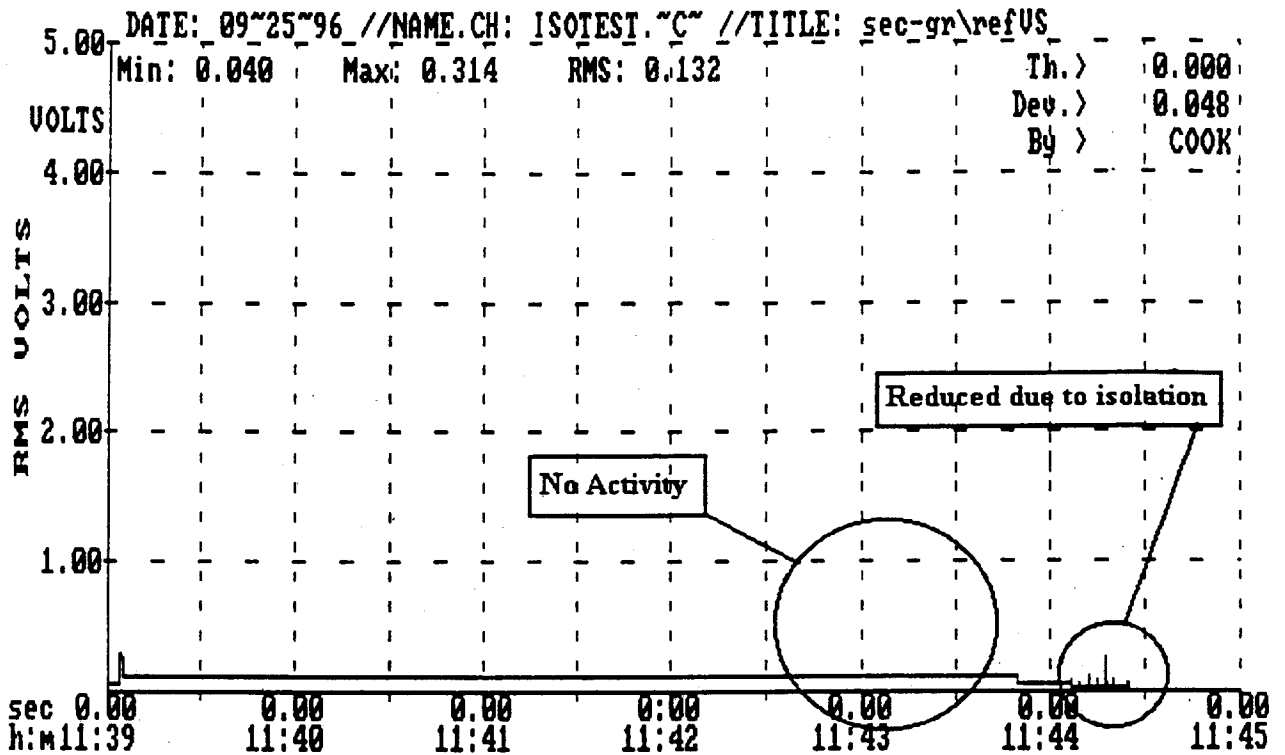


FIGURE 9

This shows a minimal voltage level on the secondary neutral to remote reference channel while high voltages are on the primary.

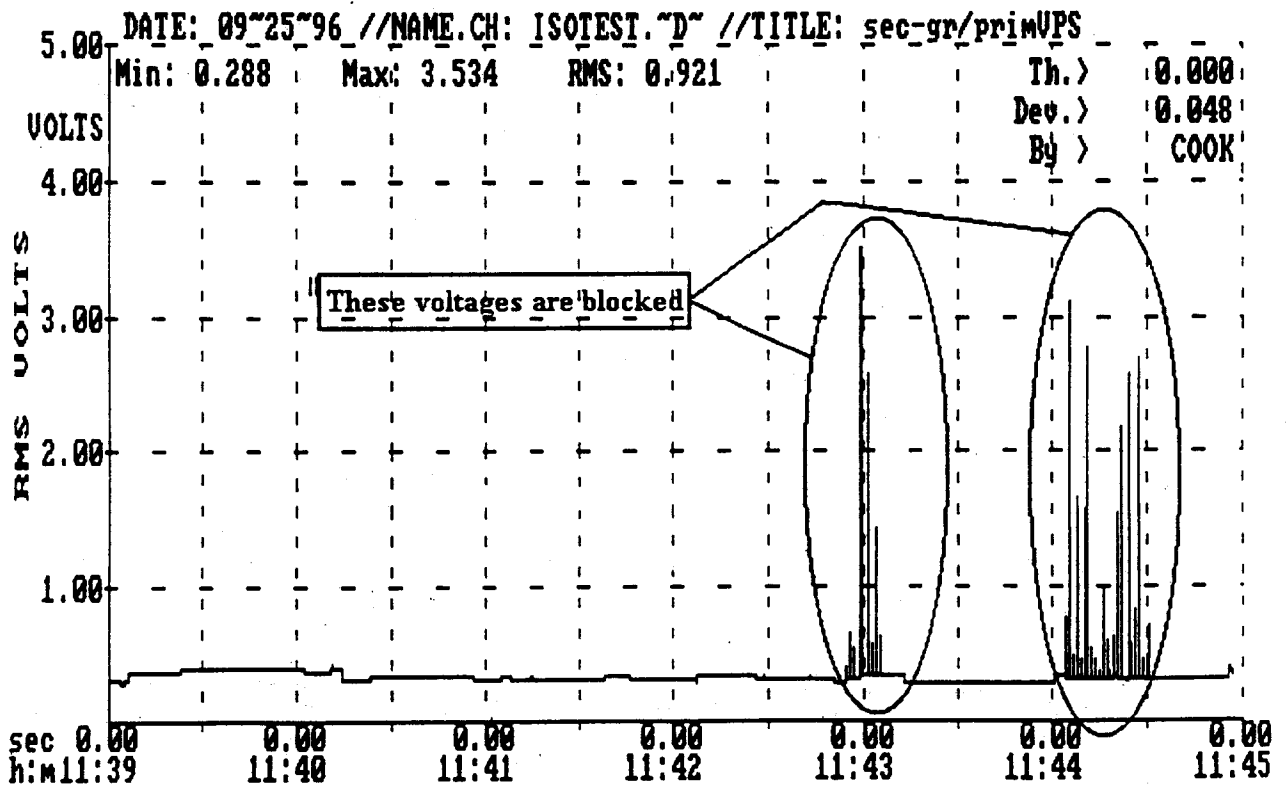


FIGURE 11

Again high voltage present on the primary to secondary neutral voltage channel in excess of 3.5 volts is blocked by the isolator.

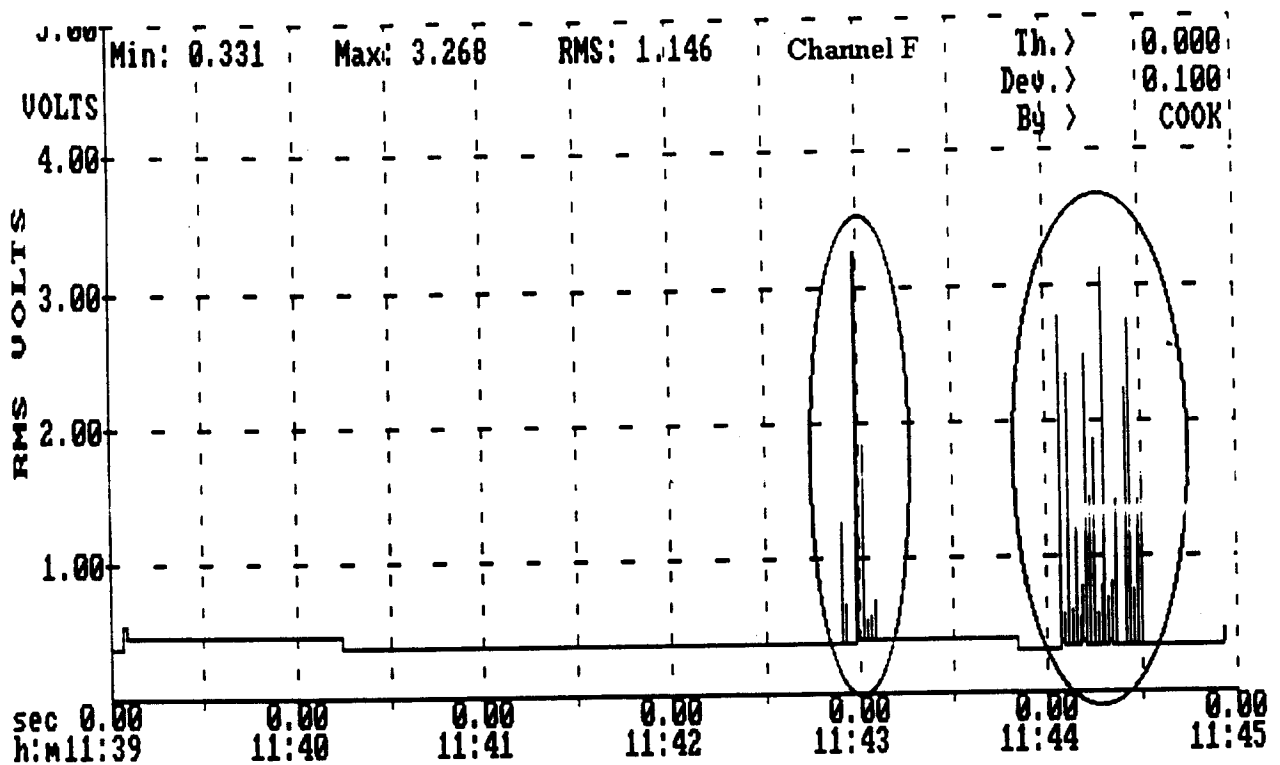


FIGURE 12

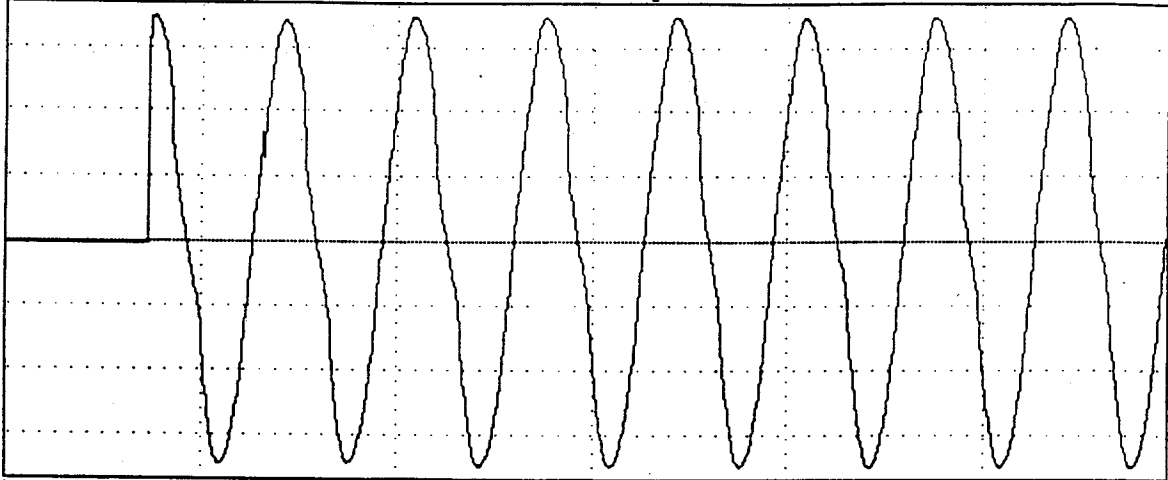
A level of up to 3.3 volts exists on the primary neutral to reference channel, but is blocked by the isolator.

A load box test was performed to characterize the farm electrically. The following chart shows the calculated data for both an isolated and a bonded condition.

PARAMETER	ISOLATED	BONDED
Total primary resistance	.25	.14
Primary neutral resistance	.24	.16
Farm resistance		2
K factor	11.4	41
Current ratio	98%	80%

The source resistance measured 106 ohms waterline to floor.

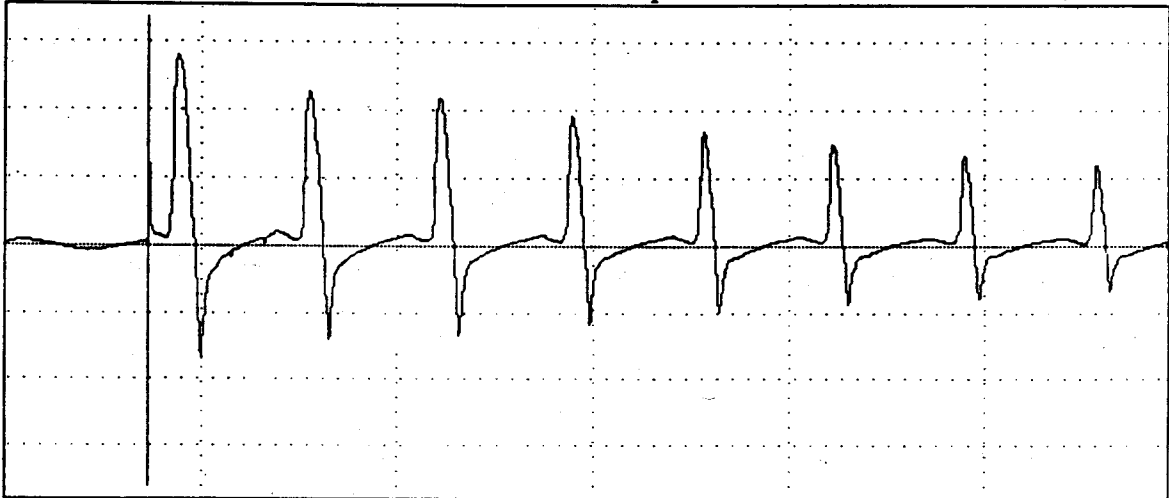
The final testing accomplished on the farm generated spurious signals on the Dranetz that had no relationship to actual events in cow contact from primary or secondary sources. The power to the Dranetz was cycled on and off several times to generate transient events on the device as it switched from its line operated power supply to its internal battery supply and vice versa.



Horizontal 25 milliseconds/division Vertical 50 Volts/division  
Urms: Prev=.5000, Min=.5000, Max=121.9 - Worst Imp= 168 Upk, 69 deg

FIGURE 13

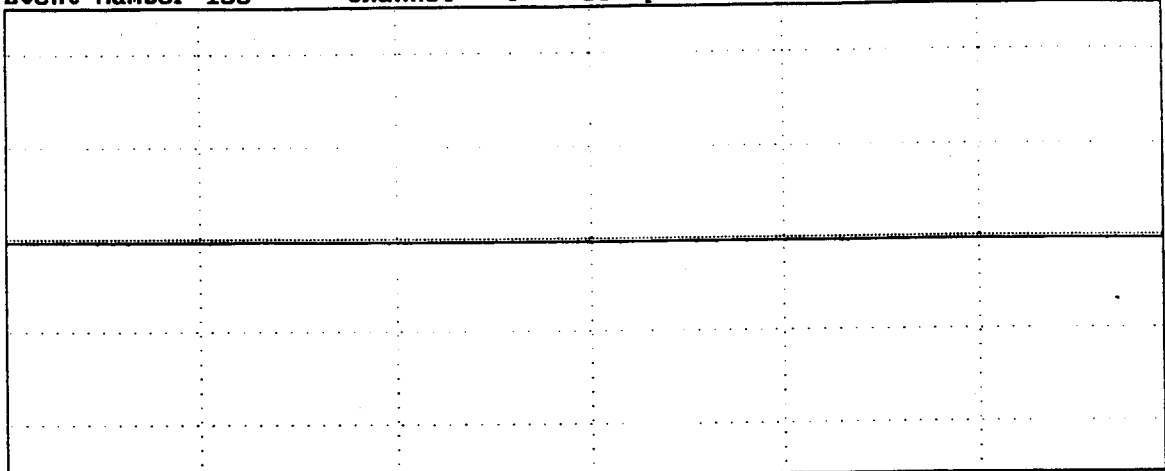
This chart shows a turn on of the main 120 v. AC power which stabilizes within the first cycle with only one glitch.



Horizontal 25 milliseconds/division Vertical 5 Volts/division  
Urms: Prev=.2399, Min=.2399, Max=1.509 - Worst Imp= -18.4 Upk, 8 deg

FIGURE 14

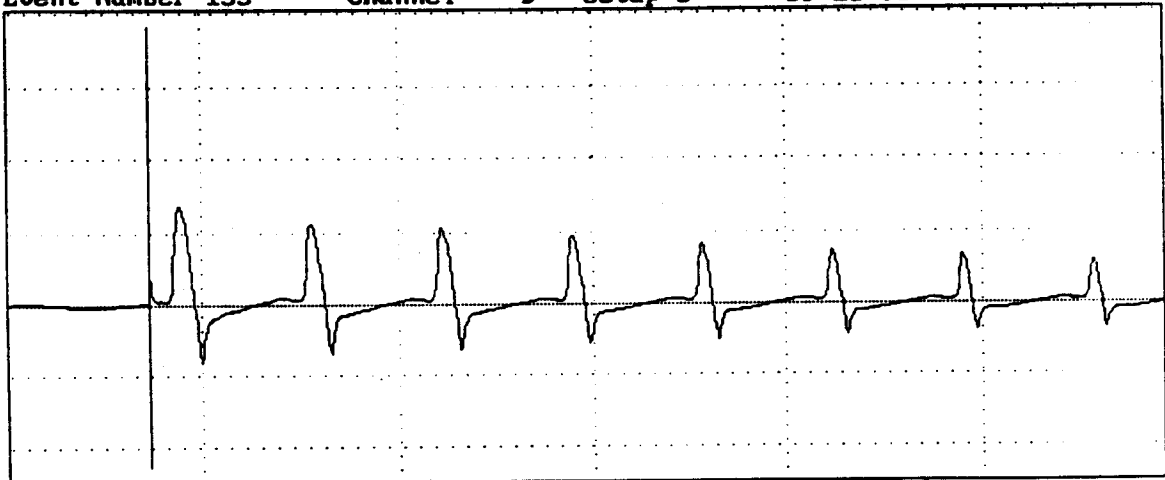
The above chart records the transient voltage spike and decreasing ringing transient on the secondary neutral to reference voltage channel. The initial spike is 35 volts peak to peak and lasts only a few microseconds. The leads to the secondary neutral to reference were not connected.



Horizontal 25 milliseconds/division Vertical 2 Amps/division  
 Arms: Prev=.0500, Min=.0500, Max=.0500 - Worst Imp= 0 Apk, 0 deg

FIGURE 15

This chart is the current channel associated with the previous voltage for the secondary neutral to reference. As can be seen no current spike or activity is evident as would be expected if the voltage event were caused by some electrical activity on the secondary neutral system.



Horizontal 25 milliseconds/division Vertical 10 Volts/division  
 Urms: Prev=.2000, Min=.1899, Max=1.519 - Worst Imp= 38.2 Upk, 2 deg

FIGURE 16

This chart shows the activity recorded on the cow contact channel. This voltage has been entirely generated by the Dranetz recorder. It is the same view of the secondary neutral to reference voltage of figure 14, only the spike is on the order of 60 volts peak to peak. One cannot have a larger voltage event in cow contact caused by a smaller voltage event on the secondary neutral. There is no physical mechanism for voltage amplification other than induced noise and coupling within the recording device. As one can also see, the timing of the spike event is exactly the same as in figure 14. The Waverider device was also set to record the activity on the secondary neutral to reference voltage and in cow contact.

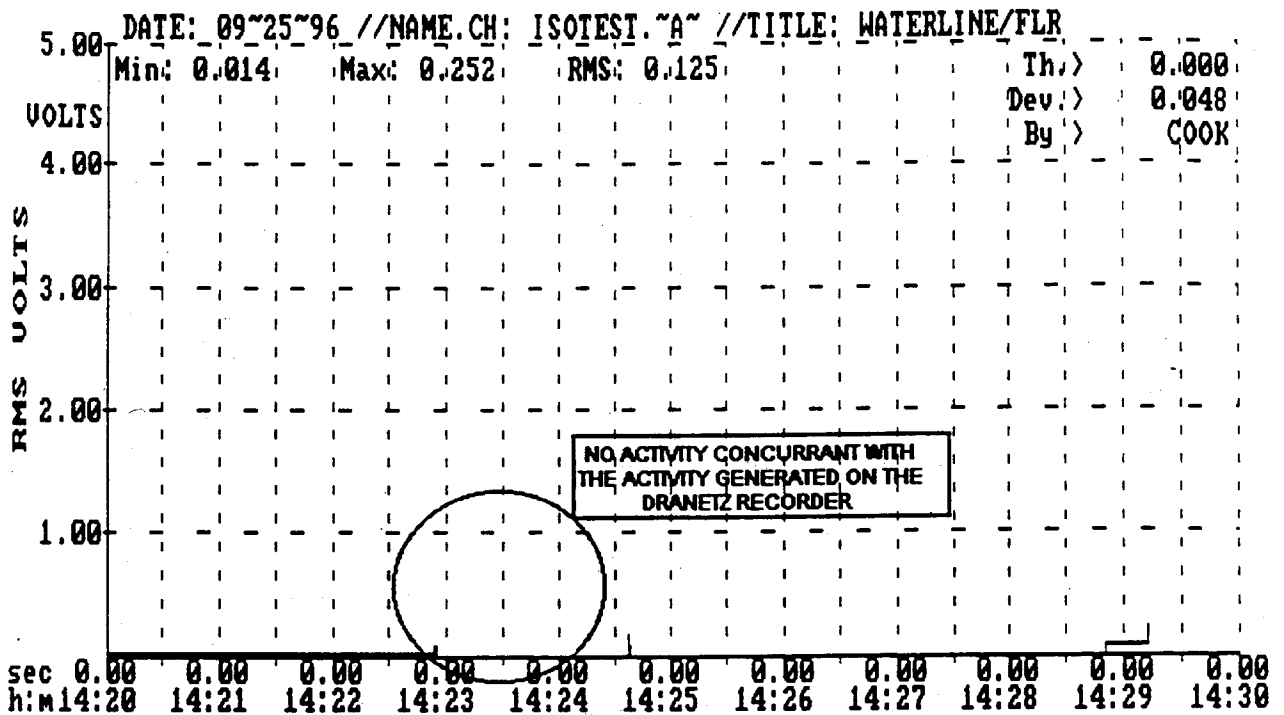


FIGURE 17

No voltage spikes were recorded in the cow contact area by this device during the period of power toggling of the Dranetz device.

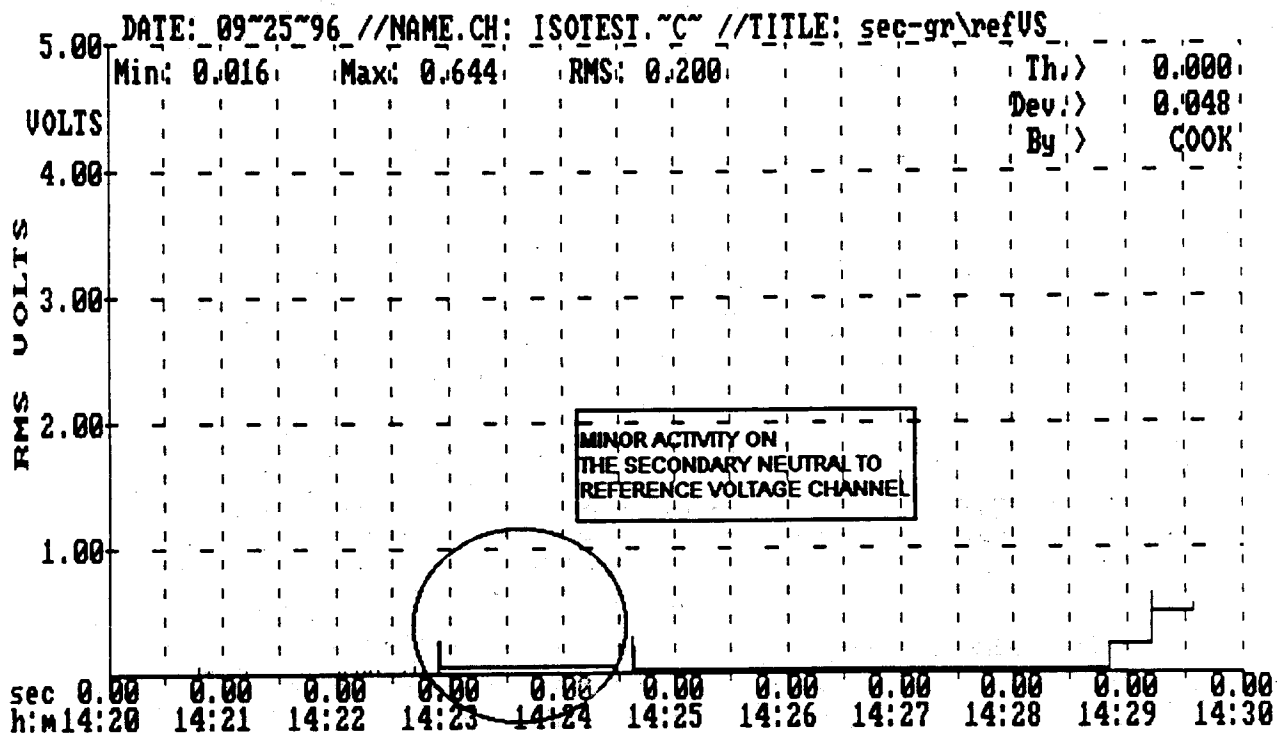
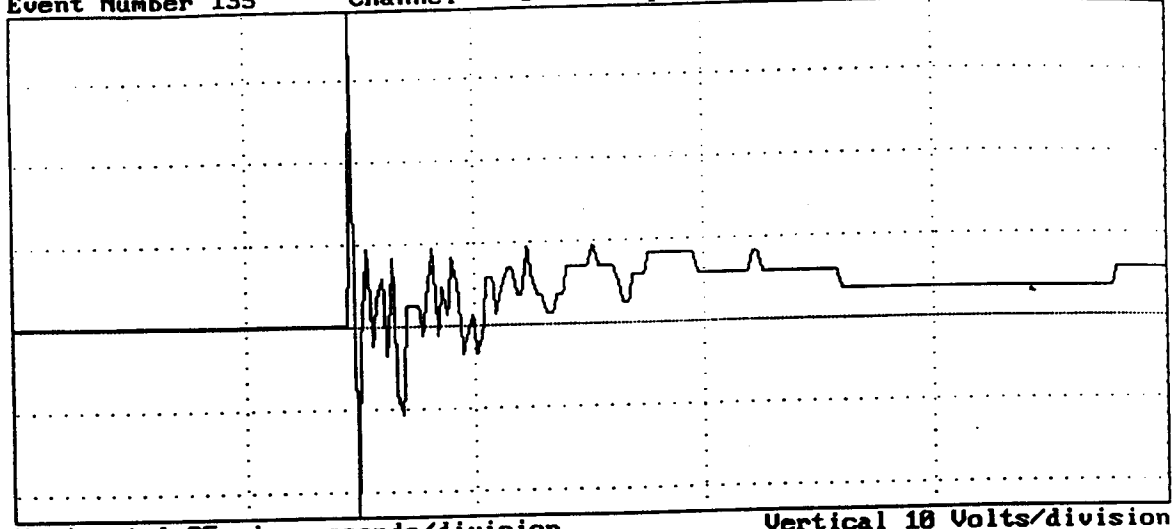


FIGURE 18

Only a few small spikes and steady state voltage levels were recorded by the Waverider during this time interval.



Horizontal 25 microseconds/division Vertical 10 Volts/division  
Urms: Prev=.2000, Min=.1899, Max=1.519 - Worst Imp= 38.2 Upk, 2 deg  
FIGURE 19

The single large pulse of Figure 16 is shown in this chart greatly expanded to seem like a large transient voltage event. The main section of the pulse lasts only about 3 microseconds representing a frequency of 333 kHz which means the signal will attenuate to about 1% of its value after traveling about 15 feet. Again, this transient was created by turning the Dranetz on and off. With this recording, someone could claim a problem existed when, in fact, the Dranetz had merely been turned off and on.

FIGURE A

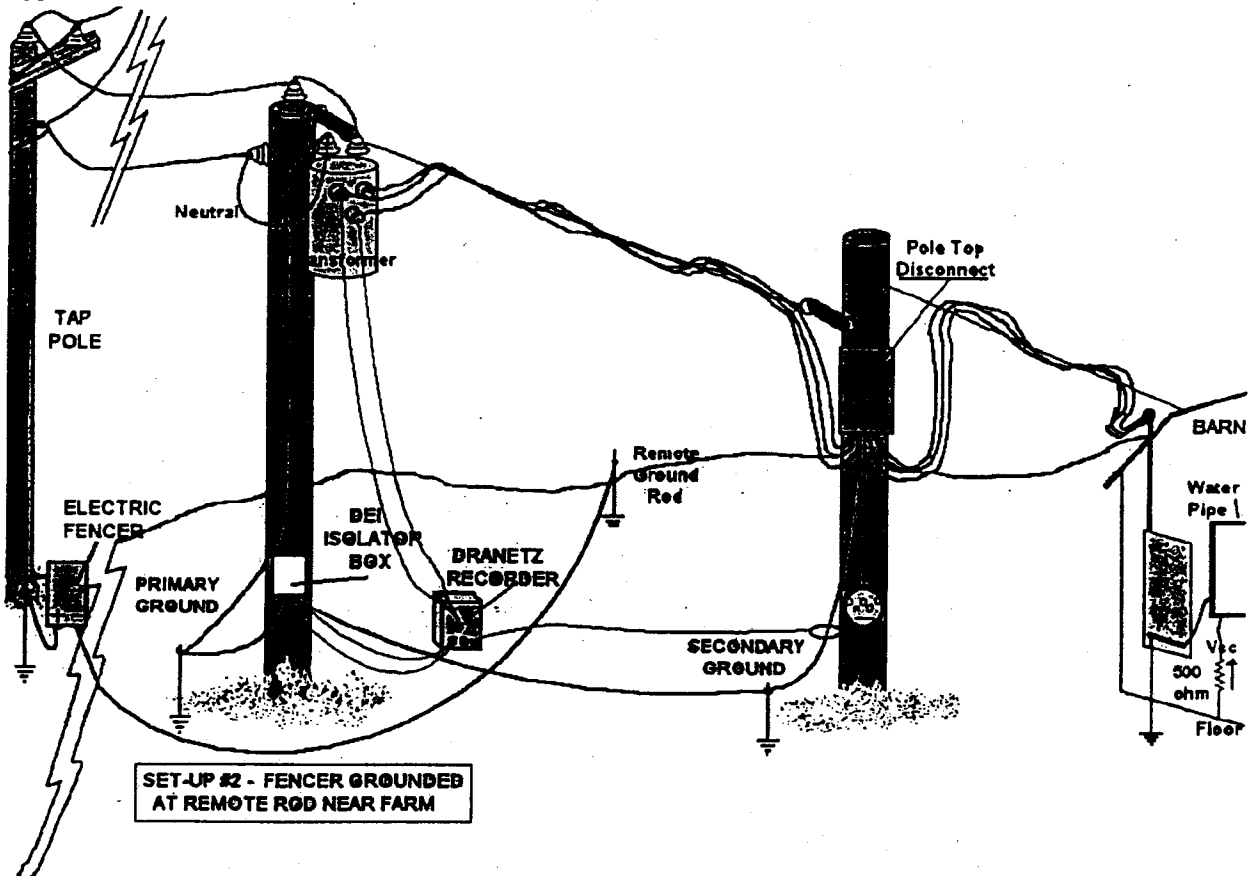
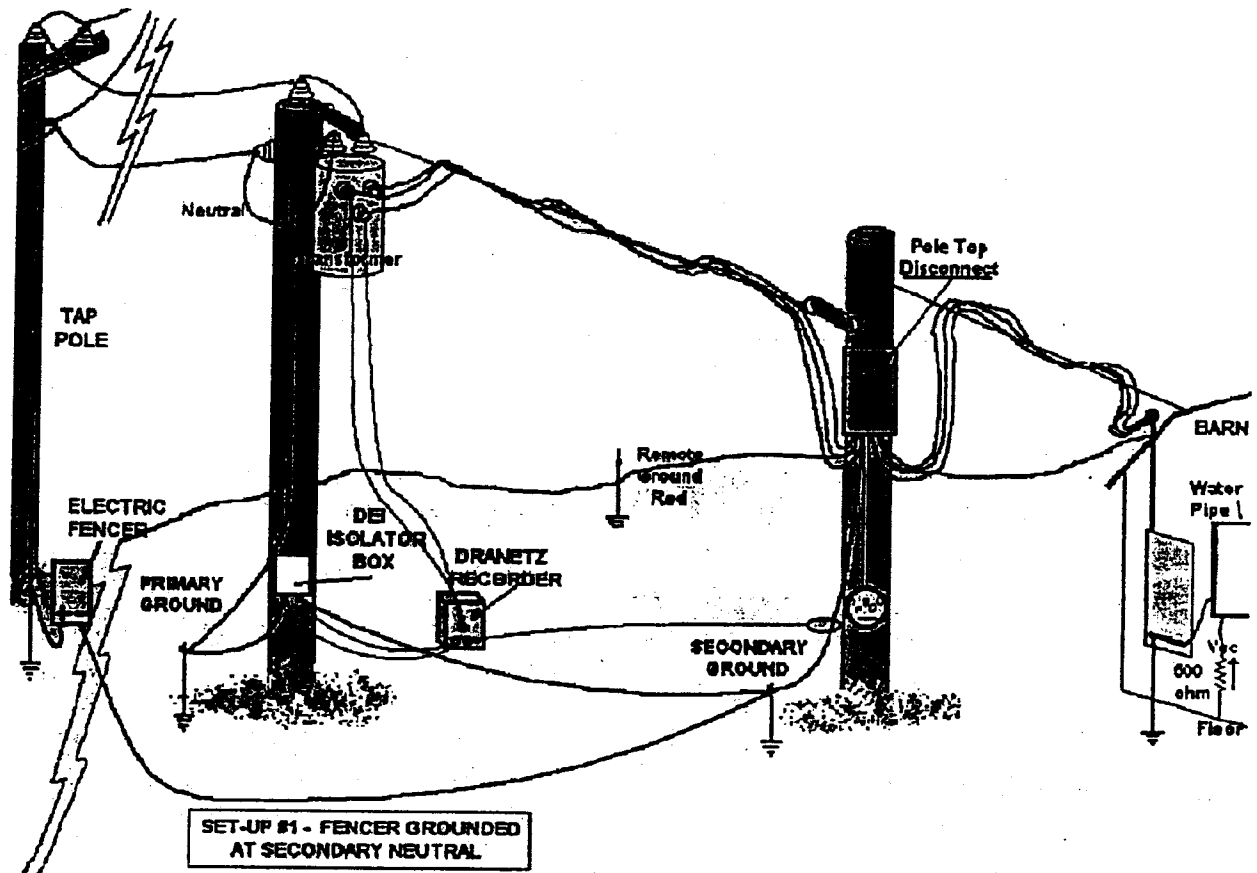


FIGURE B