

Power Quality and the Dairy Cow

Power Quality Report #1, April 2000

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Transient Electrical “Surges” Decrease Milk Production of Dairy Herds, Destroy Computers, Manufacturing Equipment, and Wireless Services

Effects of “extraneous” voltage and electrical current on milk production, reproduction, and health of dairy herds has been a concern of dairy farmers and power companies since the 1970s. Then New Zealand research workers reported that small electrical currents inhibited milk production of dairy cows. American “stray voltage” research concentrated on normal 60 cycle (60 Hertz, Hz) voltage (rms) that was believed to be caused by improper grounding of the primary neutral (the third wire) coming on the farm from the power companies. Since the primary neutral was connected to the farmers secondary distribution system voltages were found at all cow-contact points--metal pipes of cow stalls, stanchions, feeders, and water bowls. Such voltages were generally normal 60 Hz, and of varying amplitude usually less than a dozen volts, and frequently less than ½ volt. The low voltages were the most troubling because cows on farms experienced production and health problems that researchers were not able to duplicate in their laboratories.

The effects of transients became known when Dave Stetzer an Industrial Electrician, at Blair, Wisconsin, was asked to look into the stray voltage problem. Using his oscilloscope and electrical event recorder he observed that the incoming power contained numerous transients and harmonics on some farms, while other farms had sags (low voltage) and frequent outages (no power). He followed the testing protocol recommended in the Final Report of the Science Advisors to the Minnesota Public Utilities Commission, i.e. oscilloscope measures were from leads attached to two metal plates bolted to the floor, five feet apart (approximating the distance between front and rear feet of cows.) Stetzer observed that as the number of transients recorded on the event meter increased, the amount of milk measured in the farmer’s tank by the milk company decreased. He had collected the same kind of electrical data on a Michigan farm and noted the same apparent trend. Don Hillman, PhD, Professor Emeritus, Department of Animal Science, Michigan State University, computed the relationship between transient events and milk production. Hillman confirmed that milk decreased as transients increased. See Figure 1 on the next page.

Milk decreased at similar rates as transient events increased from herds in Wisconsin and Minnesota. Martin Graham, DEE, Professor Emeritus, U. California at Berkeley, gave technical assistance, Charles Goeke, Statistical and Economic Analyst, and Jeff Goeke-Smith, Computer Scientist from Michigan State University and Mason, Michigan, analyzed data from Wisconsin, Michigan, and Minnesota herds. Videotaping cows while displaying transient events from the oscilloscope on the same screen confirmed that lifting feet and stepping during milking were cow responses to pain highly correlated with transient and harmonic surges from the power suppliers.

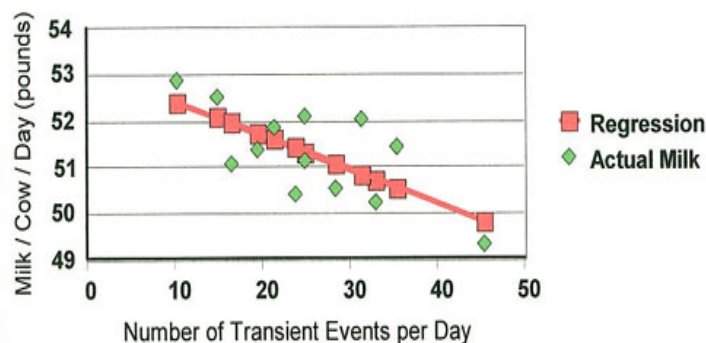
Transient pulses are distortions of current produced by capacitor switching from overloaded lines to other lines at substations to balance the electrical load. When the return circuit is too small to handle the surge from switching, or from large equipment starting at another location on the distribution line, the current spills to the earth at ground rods, and becomes ground currents. These currents were measured in barns, barnyards, and pasture fields, even when the power source was disconnected from the farm service. Transients and harmonics are nonsinusoidal waveforms, with frequencies ranging from less than 60 to more than 625 Hz, with amplitudes often $< .5$ to > 2.5 Vp and durations 25 to 50 ms. Cornell workers reported, at the 1999 ASAE meeting in Toronto, that Holsteins are sensitive to peak-peak voltages (Vp) composed of mixtures of 60 Hz and 180 Hz (synthesized) phase shift waveforms. Our data concur that cows are sensitive and produce less milk when exposed to hundreds of nonsinusoidal low Vp pulse currents daily at radio microwave frequencies. Minnesota Science Advisors also reported milk production was negatively correlated with voltage in stalls and herds less affected were standing and laying on rubber mats.

Health and reproduction of cows were also severely impaired on farms affected by transient and harmonic electrical pulses. At Ram farm, 30 of 156 cows died in 1998 and 26 of 141 in 1999.

Jennifer Granholm, Attorney General of Michigan, has filed suit with the Michigan Public Service Commission against Consumers Energy Company, asking them to require that Consumers follow the National Electric Safety Code which prohibits the use of the earth as a regular conduit in the circuit of electrical distribution. Ground rods are required as emergency outlets in case of lightning and short-circuits, such as occurs when an electric motor burns out.

The destructiveness of transients from capacitor switching was emphasized by the Electrical Power Research Institute (EPRI), the research and education arm of the electrical power industry, in a September 27, 1997, Newsletter to power company executives. A new publication and seminars were announced; and editors noted "Customer impacts from capacitor switching transients include lost production, restart expenses, and equipment repair and replacement costs." [Don Hillman at donag1@aol.com]

**Fig. 1, Milk Production vs No. Transient Events/ Day
RAM: Event Recorder & Milk Tank Wts.**



Cows: 110, N=13, d.f. 11, R Sq. .51
 $Y = 53.2 - .075 X$; sig t > 0, .995