Laboratory Experiment
Dairy Cow Response to Electrical Environment:
Summary of Final Report,
Part I. Comparison of Behavioral to Physiological Responses,
Part II. Comparison of Treatments Applied during Milking,
Part III. Immune Function Response to Low-Level Electrical Current Exposure

A laboratory study has been completed to determine whether exposure to low level step potentials can affect the health and/or milk production of dairy cows. The study resulted from an extensive inquiry (1994 - 1998) by a multidisciplinary group of science advisors to the Minnesota Public Utilities Commission (MN PUC, 7/98) into possible electrical effects on dairy cows. The laboratory study was funded by the PUC and was carried out by the Department of Biological Systems Engineering at the University of Wisconsin, Madison, under the direction of Dr. Douglas Reinemann, Associate Professor and principal investigator. The study began in May 1998 and ended in June 1999.

Three individuals were designated by the PUC as peer reviewers of this laboratory experiment: Larry Anderson, Ph.D., (Bioelectromagnetics Group, Battelle Pacific Northwest Laboratories, Richland WA), Harold Dziuk, D.V.M., Ph.D. (College of Veterinary Medicine, University of Minnesota, St. Paul MN), and Charles Polk, Ph.D. (Department of Electrical Engineering, University of Rhode Island, Kingston RI).

The study had four major objectives: 1) Investigate immune function response to continuously applied, low-level voltage. 2) Compare dairy cow sensitivity to voltage applied hoof-hoof with muzzle-hoof pathways. 3) Investigate the relationship between behavioral responses previously observed and other physiological methods of quantifying stressors. 4) Compare responses to low voltage exposure to other acute stressors. Two types of voltage/current exposures were performed. Short-term exposure (1 to 10 minutes) were used for objectives 2, 3, and 4. Longer-term exposures (2-weeks, 10 minutes on, 10 minutes off) were used for objective 1.

A first progress report was issued (DJ Reinemann, 6/98) and subsequently reviewed. A site visit was conducted in December 1998 and comments received. This material was summarized and forwarded to the PUC (RC Hendrickson, 1/99). A second progress report was issued (DJ Reinemann, 1/99) and reviewed (RC Hendrickson, 3/99). This present document summarizes the final report (DJ Reinemann, 6/99) and reviews.

Final Report (DJ Reinemann, 6/99)

Summary:

Part I (Comparison of Behavioral to Physiological Responses):

Cows were significantly more sensitive to current applied between one front hoof to rear hooves than to current applied between muzzle and four hooves.

Cows were exposed to current applied for five minutes between front hoof to rear hooves; observations were made of blood cortisol levels, activity in the stall, and flinch responses. The flinch response (a behavioral observation) was the most consistent and repeatable of the three. Activity in the stall (another behavioral observation) was not a consistent indicator. Cortisol levels (the physiological response) did not increase when current was applied up to 1.5 times the behavioral reaction level, but did increase in response to hoof trimming. Behavioral responses are a more sensitive indicator of perception or annoyance than blood cortisol levels.

Part II (Comparison of Treatments Applied During Milking): The response of cows to current exposure and to two types of milking machine problems were compared in the milking parlor. Current exposure (1 mA applied between front and rear hooves for duration of milking) resulted in no statistically significant main effects on milking variables. Milking machine pulsation failure resulted in decreased cow activity. Aged liners resulted in increased milk yield, average milk flow rate and number of liner slips.

Part III (Immune Function Response to Low-Level Electrical Current Exposure): Twelve cows were exposed to 1 mA (+/- 10%) of 60 Hz current between front and rear hooves continuously for 2 weeks, 10 minutes on and 10 minutes off. Twelve unexposed cows were controls. Immune function was assessed using blood measures for lymphocyte blastogenesis, oxidative burst, immunoglobulin production, and interleukin 1 and 2. No significant difference was found between control and treatment cows for any of the main response variables. A significant difference was found for one of the secondary response variables (*S. aureus*-induced blastogenesis) but did not appear to be consistent with other observations and was caused by a change in control, not treatment, cows. Collectively, the results suggest that this electrical exposure had no significant effect on the immune function of dairy cattle.

Review 1

Part I (Comparison of Behavioral to Physiological Responses), and
Part II (Comparison of Treatments Applied During Milking): (LE Anderson, 6/99)

Summary: The report was clear and concise with an excellent description of the rationale for selecting parameters of interest, experimental design used in the study, preliminary tests used to establish baseline values, and the description of results. Analysis, although brief, was straightforward and consistent with the data collected.

Clarification is needed for: 1) Statistical methods used. 2) Description of the cortisol assay procedure. 3) Environmental data during the tests. 4) Whether test was conducted "blind".

Conclusions are supported by results. Exposure to 60 Hz current is observable through behavioral changes, not changes in cortisol. Adverse responses in milking parameters were not observed upon exposure to 60 Hz current (1 mA) during milking.

Part III (Immune Function response to low-level electrical current exposure): Not available by 7/17/99.

Review 2

Parts I and II: (H Dziuk, 6/99)

Summary: Satisfactory progress continues. Care in planning and conduct of experiment was shown by use of controls, random selection of subjects, appropriate analysis and validation of equipment and assays.

Part I (Comparison of Behavioral to Physiological Responses): Reviewer concurs that behavioral changes are more sensitive than blood cortisol levels in detecting response to current, but: 1) Cortisol is only one measure of stress. Future studies should look for signs of chronic stress from a wide variety of sources, not only electricity. 2) Experts note that stress should be evaluated using a battery of tests, behavior being the most consistent and reliable. 3) Behavioral or other measures of stress do not necessarily mean impaired performance or health.

Part II (Comparison of Treatments Applied During Milking): Milking machine failure caused a greater response than exposure to 1mA of current for 5 minutes. This controlled comparison of responses is an important contribution which could not have been conducted on a privately-owned farm. Some additional discussion on the results of milking machine failure should be included.

Part III (Immune Function response to low-level electrical current exposure): Procedures were carefully set forth. Sensitivity and specificity of immune assays have been identified, and controls provided. Until submission of Part III of the final report, critical review of this part is not possible at this time.

Part III (cont.): (H Dziuk, 7\99)

All four research objectives have been satisfactorily completed. Reviewer concurs with the conclusions drawn by the authors, that exposure of dairy cows to 1 mA of 60 Hz electrical current for two weeks had no significant effect on immune function responses, standing and lying behavior, or time required to enter stalls.

Review 3 (C Polk, 7/99)

Part I (Comparison of Behavioral to Physiological Responses): This experiment tested only immediate perception of sudden application of constant current and pulsed current. While authors state that the two exposure methods resulted in little difference in reactions, no data to support this is found in the report. Reviewer questions method of current measurement and if the entire applied current actually flowed through the cow.

Part II (Comparison of Treatments Applied During Milking): Reviewer questions verification of current actually flowing through exposed and control cows. In stating "no statistically significant main effect", what does "main" mean? What were statistically significant non-"main" variables? Did these include interaction of current exposure and either pulsation failure or aged liners?

Part III (Immune Function response to low-level electrical current exposure): The conclusion of this part that "Collectively, these results suggest that exposure . . . had no significant effect on immune function of dairy cattle" is not justified, since: 1) *S.aureus* assay of lymphocytes cannot be expected to be consistent with other observations, as stated in the conclusion. 2) The "statistically significant response of B-cells" should not be discounted without considering the pregnancy factor. 3) The increase in interleuken-1 in exposed cows approaches significance, especially since its increase may well require longer exposure than two weeks. 4) Data from one of the control cows should have been eliminated from analysis because of a mastitis infection. 5) There were pregnancy differences between parts of the experiment which may make the validity of the test questionable. Reviewer concludes that there was a statistically significant effect only on B-cell response (*S. aureus*-induced blastogenesis) which indicates the need for further research. A longer exposure period and more precise and continuous monitoring of current flow through the animal are desirable

Submitted to the Minnesota Public Utilities Commission by:

Riley C. Hendrickson RCH
July 17, 1999

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MN PUC. Final Report of the Science Advisors to the Minnesota Public Utilities Commission: Research Findings and Recommendations Regarding Claims of Possible Effects of Currents in the Earth on Dairy Cow Health and Milk Production. MPUC, July 31, 1998. Polk C. Review of Progress Report dated 30, June, 1998 on "Dairy Cow Response to Electric Environment. Sept. 7, 1998.

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Reinemann DJ, MD Rasmussen, MC Wiltbank, LG Sheffield, J Britt. Dairy Cow Response to Electrical Environment, Progress Report to the Minnesota Public Utilities Commission, June 30, 1998.

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Reinemann DJ, MD Rasmussen, MC Wiltbank, LG Sheffield, SD LeMire. Dairy Cow Response to Electrical Environment, Final Report Part I: Comparison of Behavioral to Physiological Responses, and Part II: Comparison of Treatments Applied during Milking. Submitted to the Minnesota Public Utilities Commission, June 21, 1999.*

Reinemann DJ, LG Sheffield, SD LeMire, MD Rasmussen, MC Wiltbank. Dairy Cow Response to Electrical Environment, Final Report Part III: Immune Function Response to Low-Level Electrical Current Exposure, and Appendices. Submitted to the Minnesota Public Utilities Commission, June 30, 1999.*

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Dairy Cow Response to Electrical Environment
Final Report
Part I. Comparison of Behavioral to Physiological Responses
and
Part II. Comparison of Treatments Applied during Milking

Submitted to the Minnesota Public Utilities Commission
June 1999
by
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Abstract Part I. A series of experiments were performed to measure behavioral and blood cortisol concentration responses of cows exposed to current applied from front to rear hooves. Increased activity level was not a consistent indicator of response to current, whereas a startle response (flinch) was a consistent and repeatable indicator. Cows responded at lower current levels to the 1-front to 2-rear hoof pathway than to muzzle to 4-hooves pathway. Cortisol levels did not increase in response to current exposure at levels up to 1.5 times the behavioral reaction level. Cortisol concentrations were found, however, to increase in response to hoof trimming. It appears for these results that behavioral changes are amore sensitive indicator of response to current than blood cortisol levels. This result agrees with several past studies.

Abstract Part II. Experiments were performed to compare milking performance of cows subjected to electrical current exposure applied during milking to the response to two common milking machine problems. The electrical exposure of one mA, rms of 60 Hz electrical current was applied from front to back hooves during milking. The milking machine problems created were either a pulsation failure (no massage phase) or excessively aged milking machine liners. The response measures included milk yield, average milk flow rate, maximum milk flow rate, cow activity, and strip yield (hand stripping yield). There was no statistically significant main effect on any of these variables for current exposure. Pulsation failure produced a significant decrease in cow activity (5.8 fewer weight shifts during a milking). Aged liners produced a significant effect on milk yield (2.2 kg increase), average flow rate (0.77 kg/min reduction), maximum flow rate (1.2 kg/min reduction) and liner slips (21 more per milking).

Introduction and Literature Review

Behavioral observations have been used extensively as an indicator of dairy cow response to electrical current as cited in the review by Aneshansley and Gorewit (1991) and more recent studies (Reinemann et al., 1999, Aneshansley et al., 1997). The relationship between behavioral and endocrine response during electrical exposure has also been studied. Henke et al (1982) noted behavioral reactions in cows between 2 and 4 mA rms 60 Hz current applied from udder to 4-hooves and concluded that these behavioral reactions were more sensitive indicators than endocrine response. Lefcourt et al., (1986) reported the following based on a study in which seven lactating cows were subjected to 2.5 to 12.5 mA rms of 60 Hz electrical current.

> *At lower levels, cows became tense and showed limited movement. As the current level increased, cows became more agitated. Heart rate immediately after shock increased significantly from baseline at 10 mA (+17 beats/min.) and 12.5 mA (+30 beats/min.). Prolactin and glucocorticoids were unaffected by shock; however, both increased pronouncedly following a single recannulation prior to blood sampling. Norepinephrine was unaffected by shock or recannulation. Epinephrine doubled in two exceptional cows at 10 mA. The two exceptional cows showed consistent glucocorticoid responses, had consistently elevated baseline heart rates and prolactin, and were the only cows not shocked at 12.5 mA due to severe behavioral responses. The dramatic behavioral responses displayed by cows subjected to electrical shock were not correlated with significant or prolonged physiological responses.*

There have also been several studies of behavioral and endocrine response to electrical current applied to cows during milking. Lefcourt et al (1985) reported that subjecting cows to 3.6 and 6.0 mA of electrical current from one front to one rear leg during milking produced minimal physiological response but noticeable behavioral changes. There was no change in milk yield or milking time, but milk flow rates increased slightly.

Cows exposed to 0, 4, and 8 mA of electrical current from udder to hooves during milking showed some behavioral responses that decreased with time (Henke et al., 1985). Changes of milking performance and milk composition were not significant, however, changes of milking related cortisol responses during 8 mA current stimulation were significant.

Alternating currents were applied through the milk during milking in a study by Aneshansley et al (1992). They reported that first lactation cows kicked at the milking unit when current exceeded 5 mA (8 V), while multiple lactation cows began kicking at currents above 8 mA (16 V). There were no undesired behaviors or consistent significant differences in milking duration, milk yield, or composition for primary or residual milk for current application below these levels. Application of constant currents of 5 mA for first lactation cows and 8 mA for multiple lactation cows produced no undesired behaviors but did result in some differences in production variables. Milking duration decreased during application of constant current to first lactation cows. Serum cortisol concentrations increased from 5 ng/mL before milking to 15 ng/mL 10-m after milking. Cows exposed to 8 mA of current had slightly reduced serum cortisol concentration at 2 and 6-m after milking than did control cows.

In an overview of farm animal behavior Rushen (1995) stated:

> *"...a wide range of physiological disturbances that can result from behavioral problems or the emotional reactions of farm animals have been documented. Second, behavioral*

measures may be useful in indicating that the animal is in a state of stress. One of the main reasons to expect some link between behavioral and physiological responses to stress is that the same neuroendocrine systems have been found to control them. While the taking of behavioral measures may seem technically easier than taking physiological measures, we can not assume, unfortunately, that behavioral measures of stress will always be correlated with physiological ones. In fact, there are a number of cases where behavioral measures of stress have been found to be negatively correlated with physiological measures. This may result from the fact that behavioral and physiological reactions may be alternative ways that animals have of reacting to stress, or that behavioral responses actually serve to reduce the physiological responses to stress."

In the final report of the Science Advisors to the Minnesota Public Utilities Commission (1998) this panel of experts stated:

"Previous methods have relied primarily upon behavioral response as an indication of the sensitivity threshold to electrical exposure. Less subjective and more quantitative dairy cow behavioral response indicators and more reliable physiological response indicators are desired. ... Recent studies indicate that behavior and performance are reliable indicators of stress. These reports provide evidence that behavioral, endocrine and immune system studies combined with studies on performance criteria are required to fully assess potential harmful impacts of stressors."

The research reported in this paper, funded by the Minnesota Public Utilities Commission upon the recommendation of these science advisors, was undertaken to address these issues. Recent advances in the sensitivity of endocrine assays prompted a reinvestigation of the relationship between behavioral and physiological response. In most past studies groups of cows have been exposed to a prescribed voltage or current level with no attempt to account for individual animal sensitivity. Reinemann et al., (1999) reported on methods developed to apply electrical stimuli to cows relative to their individual behavioral response levels. This method of exposure produced more consistent aversive response than previous studies that did not take individual animal sensitivity into account. One of the objectives of this study was to determine if this method of exposure would provide more consistent results with physiological responses.

Numerous controlled research studies have shown that behavioral responses to electrical current begin at current levels above about 2 mA of current flowing through cows. Anecdotes from the field have suggested that increased cow activity during milking (stepping and kicking) may be attributable to current exposure of less than 1 mA though cows. These reports have not been documented in a controlled study. Further objectives of this study were to compare hoof-hoof exposure, as may occur during milking, to cow's sensitivity to other current pathways, and to compare the responses to current during milking to other milking machine problems.

Part I. Sensitivity Testing and Comparison of Behavioral to Physiological Responses

Objectives

The specific objectives of this part of the study were:

To compare dairy cow sensitivity to current applied from hoof-hoof with the muzzle-hoof pathway, and,

To investigate the relationship between behavioral responses and plasma cortisol concentration in cows.

Materials and Methods

Several pilot studies were conducted to develop methods to measure cortisol concentrations in cows, monitor normal daily cortisol concentrations, and measure cow behavior. An experiment was then performed to compare sensitivity of dairy cows to current applied between muzzle to 4-hooves and from 1-front to 2-rear-hooves. This was followed by an experiment to determine the relationship between behavioral response and cortisol concentration. A final study was done to examine the cortisol response to hoof trimming as a positive control.

Cortisol Assay Development

Three radio-immunoassay kits (DPC Coat-A-Count, DPC Double Antibody, and DSL Double Antibody), which are routinely used to assay cortisol in human serum, were tested for sensitivity of cortisol measurement in bovine serum. Concentrations of cortisol in human serum are normally above 100 ng/mL and the commonly used assays have been designed for accurate measurement of these values. The normal values in cattle are 2 - 20 ng/mL (Munksgaard and Simonsen, 1996; Ley et al., 1996).

Cortisol assays have been used previously on cows at times of high stress, such as near calving when circulating cortisol concentrations can be as much as 100-fold greater than normal (Peter and Bosu, 1987). We were interested in accurately evaluating potentially small changes in serum cortisol and, therefore, decided that we needed to design an assay with the ability to detect values near the normal serum concentration of cortisol in cattle.

Five different antibodies were evaluated. Antibodies were chosen based on sensitivity for cortisol and low cross-reactivity with other steroids (a monoclonal antibody, P01-92-92M, from Biostride Inc., Redwood City, CA). Like most antibodies, there was some cross-reactivity with other glucocorticoids (corticosterone = 22%; cortisone = 26%) but this was not considered to be a major problem in bovine serum. Unlike other antibodies, the one chosen was found to have less than 0.01% cross-reactivity with progesterone, 17ß-estradiol, estrone, estriol, and with other steroids that were tested. This was important because the mid-lactation cows used in our studies would potentially have substantial concentrations of progesterone (4 ng/mL) and estrogens (10-100 pg/mL).

This antibody was used in an enzyme-linked immunosorbent assay (ELISA). Cortisol conjugated to horseradish peroxidase was obtained from Biostride Inc. We performed

preliminary assays to establish an optimal antibody concentration (1:20,000 dilution) and an optimal amount of enzyme conjugated-cortisol (1:500 dilution).

In order to obtain sufficient precision and sensitivity, cortisol was extracted from the serum prior to analysis using a double extraction procedure with diethyl ether. The diethyl ether was then allowed to evaporate and the cortisol was re-suspended in assay buffer for analysis. This procedure results in over 90% recovery of cortisol from bovine serum. A 500 µL sample of serum was extracted and extracted cortisol was resuspended in 250 µL of assay buffer. This increased the sensitivity of the assay about 2-fold and produced a detection point of 50 pg/mL. The levels of sensitivity and specificity of this assay were considered optimal for accurate analysis of changes in cortisol concentrations during stress.

Stall Movement Pilot Study

A pilot study was conducted to determine the effects of moving cows from their normal stalls to the specially constructed test stalls. Four cows were placed in control stalls in the research barn. The normal amount of straw bedding was used in the control stalls. A light application of sawdust bedding was applied to the rear of the experimental stalls. The variability of current passing through the cow depends on the variability of resistance of the cow when standing and lying in the stall. Bedding increases the resistance and variability of resistance throughout the day. Complete elimination of bedding is problematic as cow discomfort and the risk of mastitis infection are increased. Application of sawdust bedding to the rear of the stalls was investigated to determine cow reaction to this amount and type of bedding and to determine the ability to control electrical current application. The experimental schedule and blood sample times are given below.

Day	Time	Treatment Group Cows 4056 and 3993	Control Group Cows 4170 and 4291
1	10:00 - 13:00	Cows cannulated and blood sampled	
2	8, 9, 10, 11	Blood sample	Blood sample
2	11:45 to 12:00	Move from barn stalls to test stalls	Move from barn stalls to yard and back to barn stalls
2	12, 13, 14, 15, 16,	Blood sample	Blood sample
2	Aprox. 17:00	Blood sample when cows enter parlor	Blood sample when cows enter parlor
2	Aprox. 17:30	Cows returned to stall without going into yard	Cows returned to stall without going into yard
3	8, 9, 10, 11, 12	Blood sample	Blood sample

All four cows were cannulated on the afternoon of first day of the study. The cannulas remained in place and continued to function satisfactorily for the two-day period. Techniques were developed to draw blood both in the barn and parlor stalls with minimal disruption to the cow.

At approximately noon on the second day of the study the cows were moved from their stalls to an exercise yard. The feed bunks in all stalls were filled with feed. The control group was then placed back in their original stalls. The treatment group was placed in the stalls designed for electrical exposure.

These results are summarized in Figure 1. The cortisol concentrations in this study fluctuated between 1 to 20 ng/mL and showed an average cycle time of several hours between relative maxima. The range of cortisol concentrations and patterns of fluctuation agreed well with studies by several other researchers (Munksgaard and Simonsen, 1996; Ley et al., 1996).

Test Stall Design

The stalls used for these experiments consisted of two concrete pads with embedded steel reinforcing bars suspended by a wooden framework (Figure 2). The entire stall assembly was suspended about 3 cm from the floor of the barn. The front and rear concrete pads were separated by a 9 cm air gap. The only physical connection between the front and rear concrete pads was a wooden framework along the sides of the stalls. These wooden components were treated with a rubber compound to keep the wooden components dry.

The test stall was suspended on a PVC pipe in the center of the front and 2 load cells on the rear corners. One of these load cells was monitored using a computer-based data acquisition system. A movement of the cow from side to side could be detected by monitoring the change in weight measured by the load cell over time. The measurements from this activity monitoring system were compared to human observations of hoof lifting and cow movement as described below.

A schematic of the circuit to deliver and monitor the current applied to cows is shown in Figure 3. A source voltage of 220 V was developed using a controlled voltage source and step-up transformer. The current delivered to cows was controlled by adjusting the source resistance and was measured as the voltage across a 1000 ohm resistor in series with the cow circuit and confirmed using a precision current clamp. Stalls were routinely checked for any current leakage paths using a standard cow-contact measurement device (copper plates placed 1-m apart and connected with shunt resistors ranging from 500 to 10,000 ohms).

For muzzle-to-hoof current application, current was applied to a ball-end, non-piercing nose ring used in previous experiments (Reinemann et al., 1999). The 4-hooves contact point was created by bonding the metal reinforcing bars in the front and rear concrete pads (Figure 2).

The current path was modified for the hoof-hoof pathway. Current was applied to the front concrete pad and returned through the rear concrete pad for the 2-front to 2-rear hooves pathway. In later experiments a 1-front to 2-rear hooves pathway was created in an attempt to amplify stepping behaviors. A wooden plate covered with two pieces of expanded metal mesh was used as the front hoof contact point. This front plate was divided in half with two sections of wire mesh separated by a raised wooden divider down the center. The rear hooves were in contact with the rear concrete pad that was wetted before tests to reduce the variability of contact resistance.

Activity Monitoring Pilot Studies

Several tests were done to calibrate the motion sensing system and develop an automated algorithm to detect changes in cow activity. The application of a steady current from 2-front to 2-rear hooves did not provide consistent results across cows. Human observers commonly noted a startle response (flinch) before the motion sensing system could detect a change in activity.

A pulsed current was compared to a steady current in an attempt to amplify activity changes in cows. Constant 60 Hz current, applied for 1-m was compared to pulsed 60 Hz current (0.5 s on and 2 s off, for 1 m). A 5-m observation period of each cow with no current applied was recorded at the beginning of each test. An ascending series of 0.7 mA rms increment was applied to 4 cows. Two cows received the pulsed and two cows received the constant current on day 1. The treatments were switched on day 2.

The activity measures did not produce consistent criteria for a behavioral response indicator. Human observers could clearly see changes in animal behavior, while the motion sensing system indicated no change, an increase or a decrease in activity. The most consistent behavioral change noted by human observers was a startle response (flinch), occurring immediately after the threshold current level was applied. This initial flinch may or may not have been followed by increased activity. There appeared to be little difference between the constant and pulsed exposure methods.

It was also clear during the pulsed exposure experiments that cows were being penalized for lifting their hooves. The current would be approximately divided between 2 hooves when all hooves were in contact with the platform. When one hoof was lifted (either front or rear), the current flow through the other would be approximately doubled.

The test stall was modified so that the front pad was divided into right and left quadrants as described above. Current was applied alternately to the right and left side of the pad so that current would flow through only one front hoof at a time. Previous results had shown that front hoof activity was a better indicator of response than rear hooves.

Experimental Designs and Results

Muzzle-Hoof Compared to hoof-hoof sensitivity

An experiment was performed to determine the relationship between muzzle-hoof and hoof-hoof exposure pathways. A total of 8 Holstein cows, 2nd to 4th lactation, 51 to 192 days in milk, and producing 65 to 103 pounds of milk per day were used for this experiment. The exposure path was from one-front to two-rear hooves. Exposure to the front hooves was alternated between front right and front left hooves every 2 seconds. Each series began with a 5-m observation, during which no current was applied, followed by 1-m exposure periods separated by 1-m periods with no exposure. An ascending series of 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 6.0 rms mA of current was used.

Reaction levels were defined as the current level at which two humans observed a flinch. One or two additional current increments were recorded to gather more motion data and to confirm the flinch observation. The results of this experiment are summarized in Figure 4 and the table below.

Reaction Level (mA, rms) for 1-front to 2-rear-hooves compared to muzzle to 4-hooves.

Cow Number	3963	4102	4106	4145	4169	4192	4205	4243	Mean	SD
1-front to 2-rear-hooves	3.5	2	3	3	3.5	3	2.5	3.5	3.0	0.53
muzzle to 4-hooves	5	5	8	8	5	5	3.5	3.5	5.4	1.7

A paired t-test showed that the difference between the reaction levels was significantly different for the two exposure pathways ($p = 0.01$) with cows being more sensitive to the 1-front to 2-rear-hooves pathway. These results for the 1-front to 2-rear-hooves pathway are in good agreement with the study by Currence et al., (1990), who used a similar exposure pathway.

Although on average there was a small increase in activity at and above the human observer identified point of reaction, some cows appeared to respond negatively (e.g., remained still). This justified the use of the flinch as the primary indicator of response to avoid subjecting cows to undue pain.

Cortisol and Behavioral Studies

A second experiment was done to examine the relationship between behavioral response thresholds to current exposure and cortisol response. The same group of 8 cows used for the experiment described above were used for this experiment. Blood samples were taken in 5-m intervals. Cortisol is excreted in pulses and has a half-life of about 20 m, consequently sampling every 5 ms will detect any release of cortisol. Each series began with blood samples beginning 20-m before the first current exposure. Each current exposure lasted for 5-m using the same alternating front hoof to 2-rear hooves method described above. The time between current exposures was 10 m. The current exposure levels used were 50, 75, 100 and 150 % of the human observer defined reaction level for each cow as determined in the first experiment (e.g. for cow 4106 the 50% level is 1.5 mA, the 75% level is 2.25 mA, the 100% level is 3 mA, and the 150% level is 4.5 mA). The 50% and 75% reaction levels were chosen to determine if a cortisol response would occur at levels below which a behavioral reaction could be observed. The 100% reaction level was chosen to determine if the level of stimulus required to produce an observable behavioral response would produce a cortisol response. The 150% level was chosen as a level of annoyance which was shown in previously studies (Reinemann et al., 1995) to cause avoidance of water bowls.

The cortisol data are summarized in Figures 5 and 6. The range of cortisol concentrations was similar to those recorded in the stall movement study. Two cows started toward the high end of the normal daily range, three toward the low end of the range, and three in mid range. The three cows that started with low cortisol concentrations showed an increasing trend toward the end of the experiment. This is probably due to the normal periodic fluctuation of cortisol concentration in the blood.

In Figure 6 the 15-m average cortisol immediately before each exposure interval are compared to the 15-m average immediately after that exposure. A positive value indicates that cortisol concentration is increasing after exposure, while a negative valued indicated a decreasing trend in cortisol concentration. None of the averages was significantly different from zero.

The average change in activity from the 5-m preceding the current exposure to the 5-m of current exposure is shown in Figure 7. The threshold used to count events was a change in load of 9 kg/s. This value was slightly more sensitive than steps as counted by human observers. On average there was a small but significant ($p<0.05$) increase in activity associated with the 100 % reaction level exposure. This was not consistent across cows, however. None of the other exposure levels had a significant ($p<0.05$) change in activity. Human observers noted that a flinch at the beginning of the exposure period was the most consistent behavioral change

It appears for these results that behavioral changes are more sensitive indicator of response to voltage than blood cortisol levels. This is in agreement with previous results (Henke et al., 1982; Lefcourt et al., 1986).

Hoof Trimming Positive Control Study

As a positive control for measuring stress induced cortisol increases, blood samples were taken from 8 cows before and after hoof trimming. The eight cows were scheduled for routine hoof trimming at the UW Arlington experiment station. The same assays as used previously were used to measure cortisol concentrations. Blood samples were taken with cows in their housing stalls prior to moving the cows to the trimming stall. Another sample was taken immediately after trimming while the cow was still in the trimming stall. Cow hoof trimming takes between 10 to 30 m. The cows are severely restrained in the trimming stall to avoid injury to the hoof trimmer or cow. Straps are run under the cow to hold it up while one leg is forcibly lifted and held in place during trimming. This is common practice on dairy farms. Information on the cows used for this study is given in the Appendix. The plasma cortisol concentrations measured before and after trimming are presented in Figure 8 and below.

Cortisol concentrations before and after hoof trimming.

Cow number	Before Trimming ng/mL	After Trimming ng/mL
4389	2.1	38.3
4230	16.7	41.1
4394	2.8	46.8
3966	1.1	52.2
4304	4.4	34.5
4350	7.2	24.4
4056	15.8	34.5
4428	2.5	34.6

The results of a paired T-test of the before and after hoof trimming data showed that the mean increase in cortisol concentration of 32 ng/mL (standard deviation of differences = 12 ng/mL) was significant ($p < 0.0001$). Box plots of the data from the hoof trimming study along with the cortisol measurements taken immediately before and after, hoof-hoof exposure to current at 1.5 times the behavioral reaction level are shown in Figure 8.

Conclusions

Dairy cows were more sensitive (reacted at lower current) to current applied from 1-front to 2-rear hooves than current applied from muzzle to 4-hooves. No increase in cortisol level was observed for cow subjected to 5-m of 1.5 times the current required to produce a behavioral response. A cortisol increase was observed in response to hoof trimming. Behavior responses are a more sensitive indicator of perception or annoyance than cortisol levels in dairy cows.

Part II. Comparison of Treatments Applied during Milking

Objectives

The specific objective of this part of the study was to compare commonly encountered milking machine problems to exposure to electrical current. The current exposure was 1 mA of current applied from front to rear hooves during milking. The milking machine problems applied were either a pulsator failure producing no massage (D phase), or the use of excessively aged liners.

Materials and Methods

The experimental design was a completely randomized two-level factorial ($CRF_{2,2}$). One factor was current applied from front to rear hooves. The other factor was one of two commonly occurring milking machine problems (either pulsation failure or aged liners). These experiments were conducted in one stall of the four-stall milking parlor in the UW-Madison Dairy Cattle Research and Instruction Center. Tests took place during three consecutive evening milkings. All cows were milked using normal procedures and equipment on the first and third milkings (low level milking line, BouMatic Flow star Claws, BouMatic Detachers, milking vacuum level approximately 36 kPa). The 2x2 factorial was administered on the second milking. Four groups of four cows each received no treatment, milking machine problem, 1 mA of current exposure, and a combination of milking machine problem and current exposure. The milking machine was allowed to automatically detach without any human interference for all tests.

The test cows were systematically sampled from the groups of four from the available study cows in the barn. Characteristics of the cows used in these studies are given in the Appendix. The cows were let out of their housing stalls and brought to the milking parlor in groups of four with the experimental cows being directed into the instrumented stall. The same operator milked all the cows used in this study for the three nights of testing.

A schematic of the current exposure apparatus is shown in Figure 9. Two aluminum plates were placed in the milking stall. These plates were supported by rubber strips around the edges and one support down the center. The rear plate was fitted with a load cell on one of its edges (Figure 10). When current exposure was called for, an operator would apply a voltage from the front to rear plates when the milking unit was attached to the cow. The operator adjusted the source resistance while monitoring the current flow so that 1 mA rms current was passing through the cow for the duration of the milking. The current was removed when the milking unit detached.

Pulsation failure

For the treatments requiring pulsation failure, a one-way valve was placed in each of the two long pulse tubes. This one-way valve would allow the pulsation chamber to be evacuated (opening the liner) in its normal fashion. When the pulsation chamber was opened to atmospheric pressure the valve would shut and prevent the liner from closing completely. This resulted in the absence of a D (massage) phase of pulsation. A malfunctioning pulsator is a problem commonly encountered in the field and was expected to produce mild discomfort to the cows. A 2x2 factorial using 16 cows with treatments of pulsation failure and current exposure was replicated twice with a total of 32 cows.

Aged liners

The liners used for this study (BouMatic R-2CV) were artificially aged by soaking them in clarified butter oil at 100°C for 72 hours. This artificial aging process reduced the tension that the liners were mounted under from 74 N to 38 N. This reduction in tension was expected to reduce the massage applied to the cows' teats during milking, thus causing mild discomfort to the cows. A 2x2 factorial using 16 cows with treatments of aged liners and current exposure was performed.

Response Measures

The response variables measured in these studies were milk yield, maximum milk flow rate, average milk flow rate, liner slips, cow activity, and strip yield. All responses were taken as the value of the variable on the p.m. milking of the treatment day minus the average of that variable for the same cow for p.m. milkings on the two control days (before and after treatment).

Milk yield was recorded using the milk meters installed in the UW parlor (BouMatic - Perfection). A computer-based data acquisition system was used interfaced with the milk meter to record milk flow rate every 5 s. The maximum milk flow rate was taken as the maximum 30-s rolling average of these milk flow rates. Average milk flow rate was taken as the milk yield divided by the time of milking. Cows release the hormone oxytocin during milking to contract the alveoli in the udder and eject milk. The maximum and average milk flow rates may be affected by changes in the milking machine and could also be affected by changes in the oxytocin release of cows during milking. Changes in these parameters, therefore, could indicate changes in the endocrine response of cows due to current exposure.

Milking vacuum was measured in the short milk tube as recommended by Rasmussen et al (1999). The time of milking was taken as the interval during which the 5 second average milking vacuum was greater than 5 kPa. A liner slip occurs when the seal between the cow's teat and the liner of the milking machine is broken. This results in an inrush of air into the milking unit and is considered to increase the risk of mastitis infections. Increased liner slips may be caused by changes in milking machine parameters or by increased activity of cows during milking. Liner slip events were recorded when the milking vacuum dropped by more than 8 kPa with a rate of change exceeding 500 kPa/s based on the work of Rasmussen et al (1999).

Cow activity was quantified by monitoring the load cell placed under one edge of the rear aluminum plate in the parlor stall (Figure 10). Load was measured at a frequency of 100 Hz.. A weight shift event was defined as the derivative of the change in load over time in excess of 25 kg/s. This rate of change in load corresponded approximately to a cow lifting its hoof, as confirmed by human observers.

Strip yield is a measure of the completeness of milk removal by the milking machine. Strip yield may be affected by changes in the milking machine and is also another measure of changes in endocrine response during milking. Strip yield was measured by hand milking immediately after the automatic detacher removed the milking unit. The number of quarters that yielded more than 10 mL of milk were recorded for each cow.

Results and Discussion

The mean difference measures and standard deviation of differences for each response variable were as follows. Response measures that were statistically significant ($p<0.05$) are indicated in bold.

	Experiment I (n = 32)		Experiment II (n = 16)	
	Pulsation Failure	1 mA Current	Aged Liners	1 mA Current
Milk Yield (kg)	1.2^{+} (2.1)	0.1 (2.1)	**2.2* (1.3)**	-0.6 (1.8)
Average Flow Rate (kg/min)	0.54^{+} (0.78)	0.32 (0.83)	**-0.77* (0.56)**	-0.13 (0.68)
Maximum Flow Rate (kg/min)	0.29^{+} (0.42)	0.04 (0.45)	**-1.2** (0.54)**	-0.26 (0.75)
Activity (weight shifts / milking)	**-5.8** (4.5)**	-1.3 (5.3)	-8.9 (11)	-0.31 (13)
Strip Yield (% of quarters > 10 mL)	-10 (19)	8.6 (19)	-3.0 (27)	-16 (27)
Liner Slips / milking	-0.38 (1.5)	-0.88 (1.6)	**21** (4.0)**	0.1 (12)

*Note: values given are mean effect size and (standard deviation) Statistical treatment effects are indicated by + = $p<0.10$, * = $p<0.05$, ** = $p < 0.01$.*

There was no statistically significant main effect for current exposure for any of the response variables for either experiment. Pulsation failure produced a significant decrease in cow activity (5.8 fewer weight shifts). Aged liners produced a significant effect on milk yield (2.2 kg increase), average milk flow rate (0.77 kg/min decrease), maximum milk flow rate (1.2 kg/min decrease), and liner slips (21 more per milking).

Some interaction effects were significant, but none of these were repeatable across experiments. The interaction between pulsation failure and current exposure was significant for milk weight in experiment I ($p=0.03$), with current exposure increasing milk yield 1.4 kg with pulsation failure but not without. The interaction between pulsation failure and current exposure was also significant ($p=0.003$) for activity in experiment I, with current reducing the effects of activity observed when pulsation failure was applied alone. Neither of these interactive effects was repeated in the second experiment. The interaction between aged liners and current exposure was significant ($p=0.006$) for strip yield in experiment II, with the combination of aged liners and current exposure tending to reduce strip yield (cows milked out better). One cow, which had lower strip yield on the treatment day, was a major contributor to this effect.

Conclusions

Several significant effects were measured when commonly encountered milking machine problems were applied to cows. No adverse effects were observed for cows exposed to 1 mA of current applied from front to rear hooves. Exposure to 1 mA rms of 60 Hz electrical current

produced no significant change in milk yield, milk flow rate, strip yield, cow activity or liner slip. Some interactions between milking machine problems and current exposure were significant in some experiments, but the magnitudes were small and they were not repeatable across experiments.

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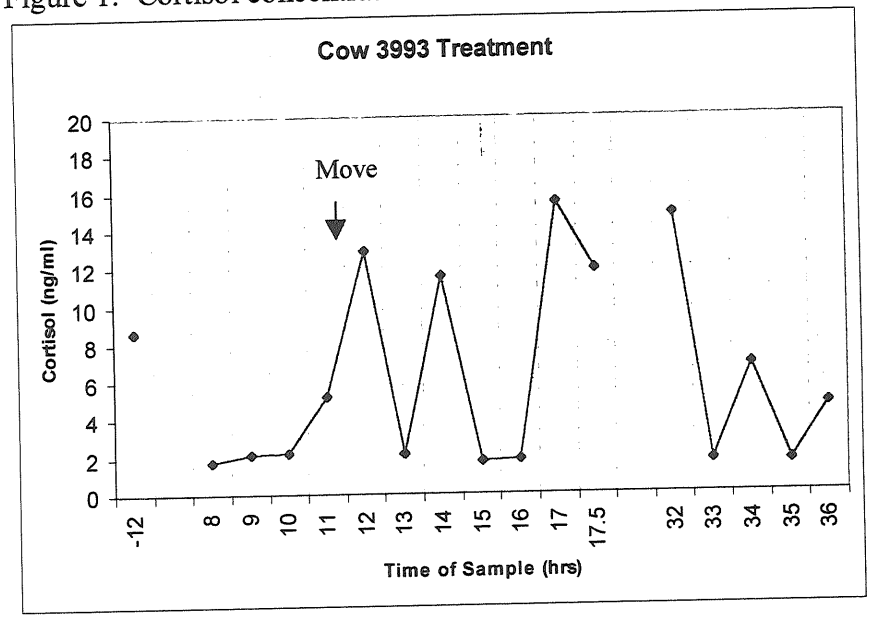
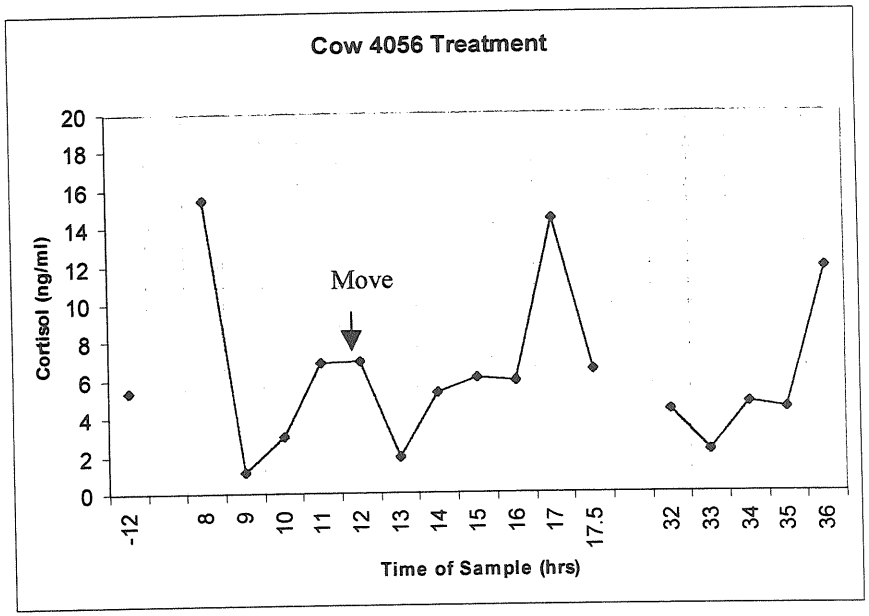
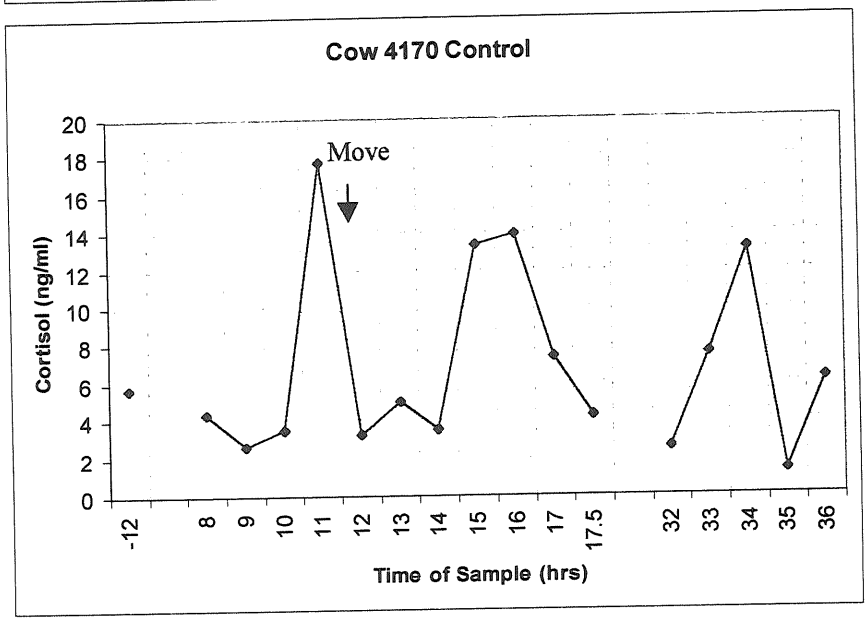
Figure 1. Cortisol concentrations for stall movement study.







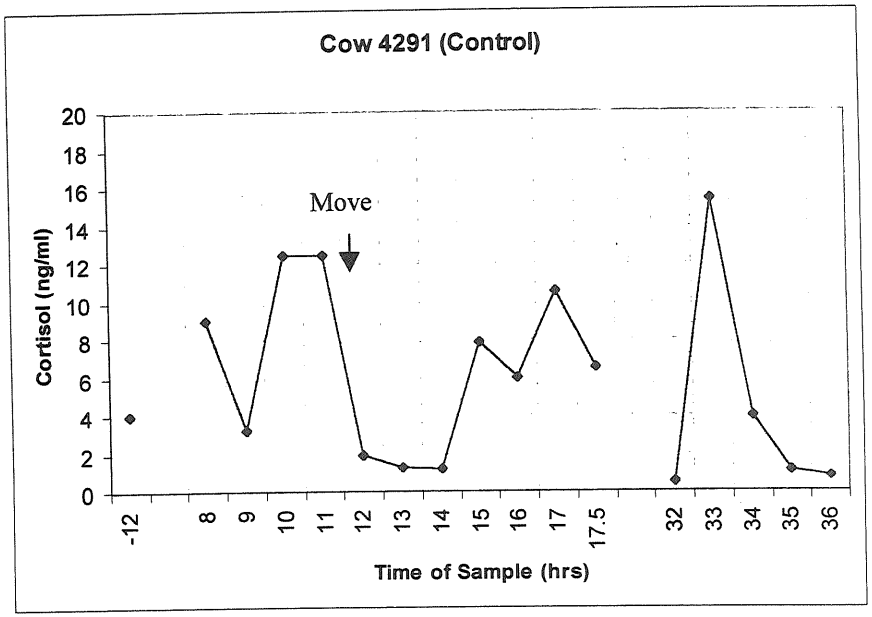


Figure 2. Diagram of experimental stall.

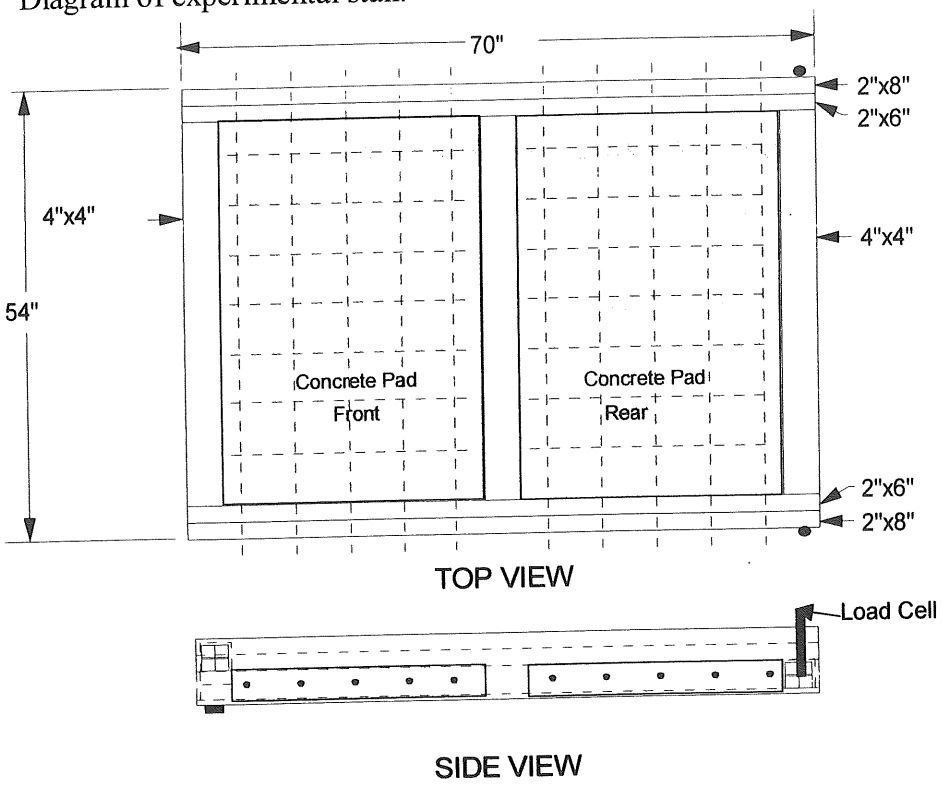


Figure 3. Schematic of current circuit for behavioral and cortisol studies.

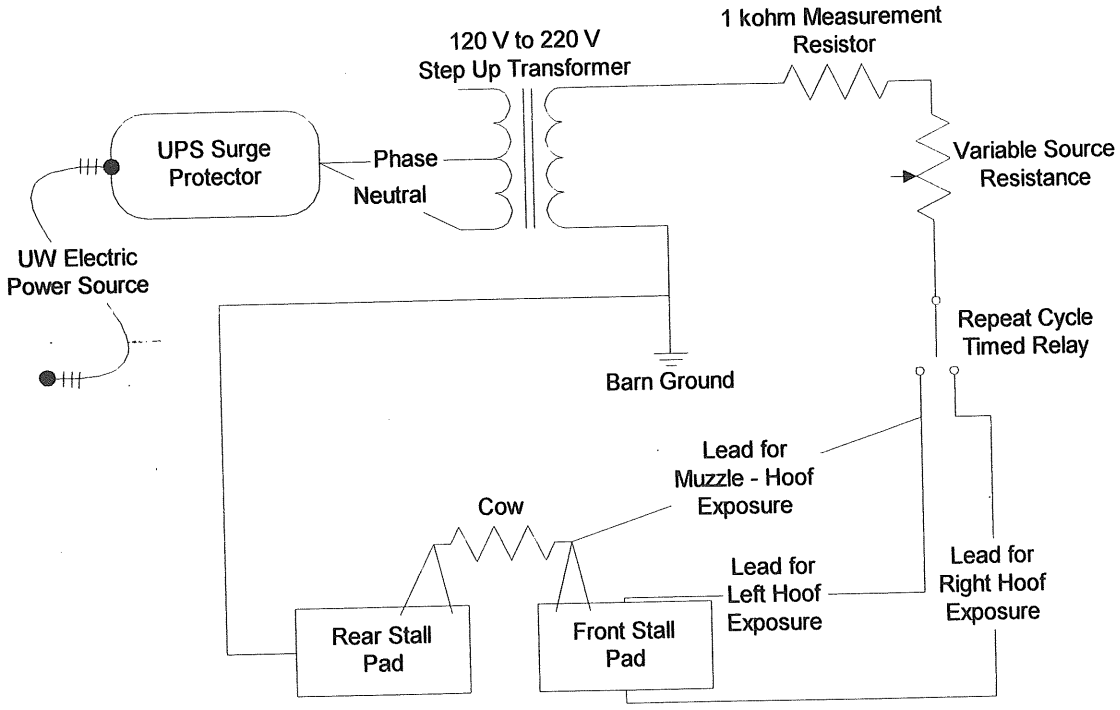


Figure 4. Box plot of muzzle to 4-hooves behavioral reaction threshold compared to 1-front to 2-rear hooves behavioral reaction threshold. The horizontal white line is the mean of the data. The box includes +/- 25% of the data from the median. The horizontal black lines are the maximum and minimum values.

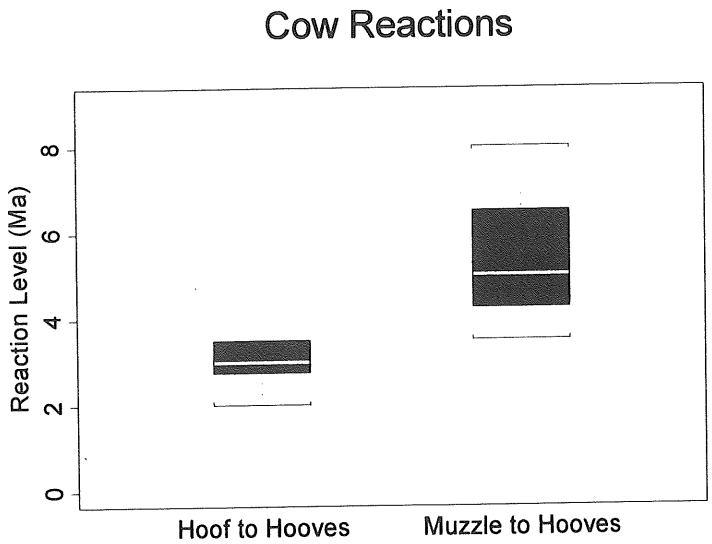


Figure 5. Cortisol concentrations for increasing current exposure.

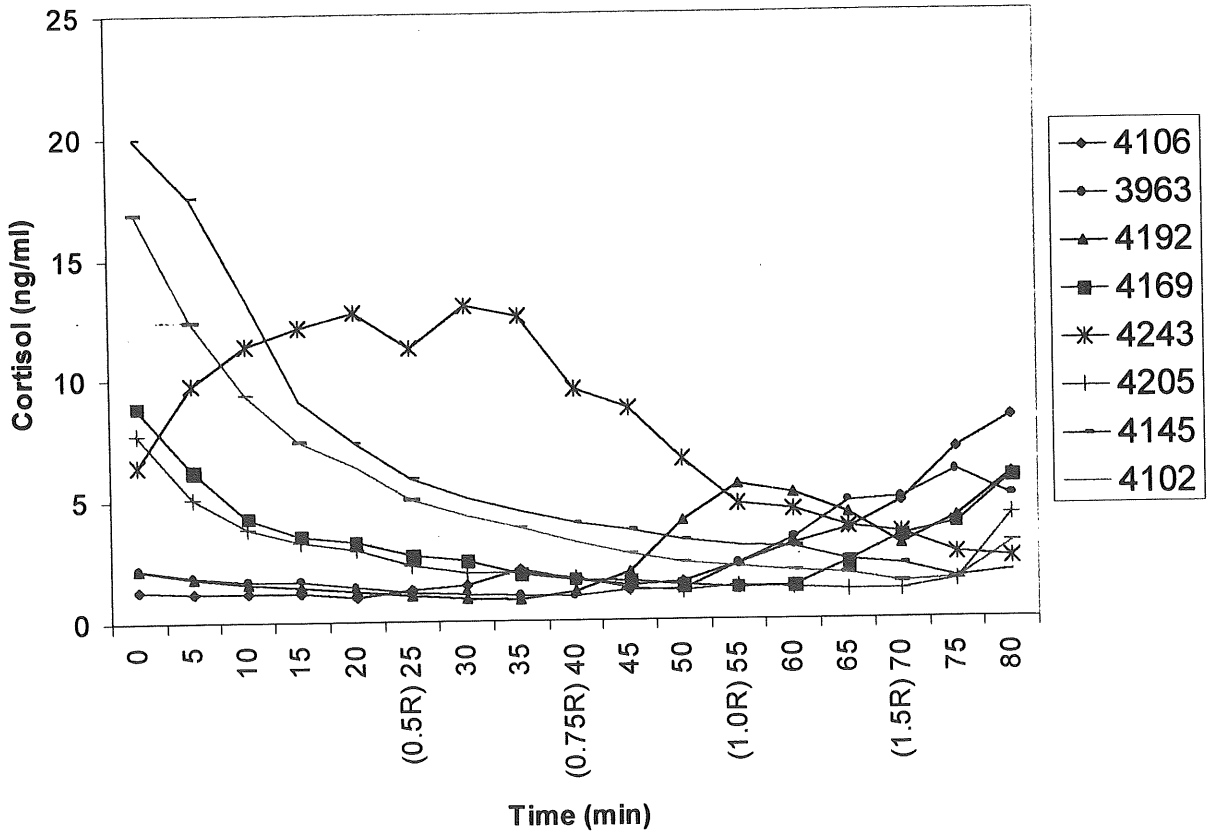


Figure 6. Box plot of the change in 15-m average cortisol concentration for cows exposed to 0.5, 0.75, 1.0 and 1.5 times the current required to produce a behavioral response (R).

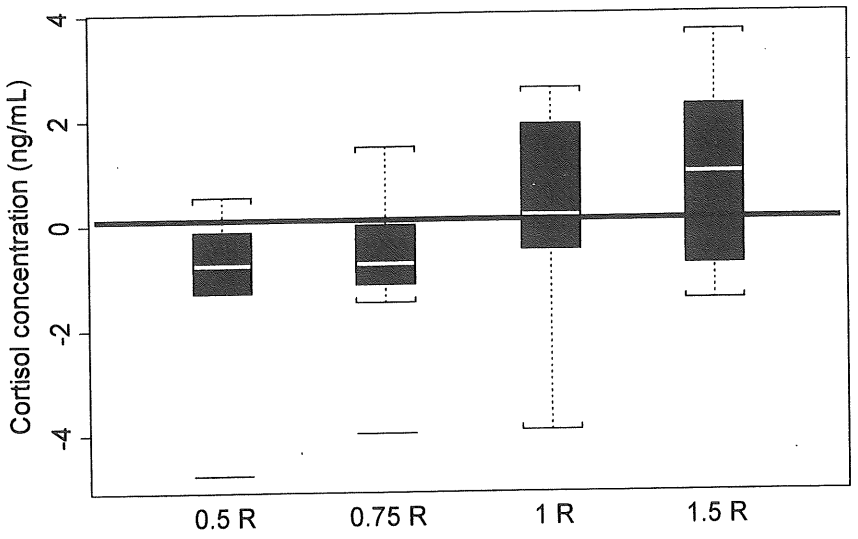


Figure 7. Box plot of 5-m average change in activity of cows exposed to 0.5, 0.75, 1.0 and 1.5 times the current required to produce a behavioral response (R).

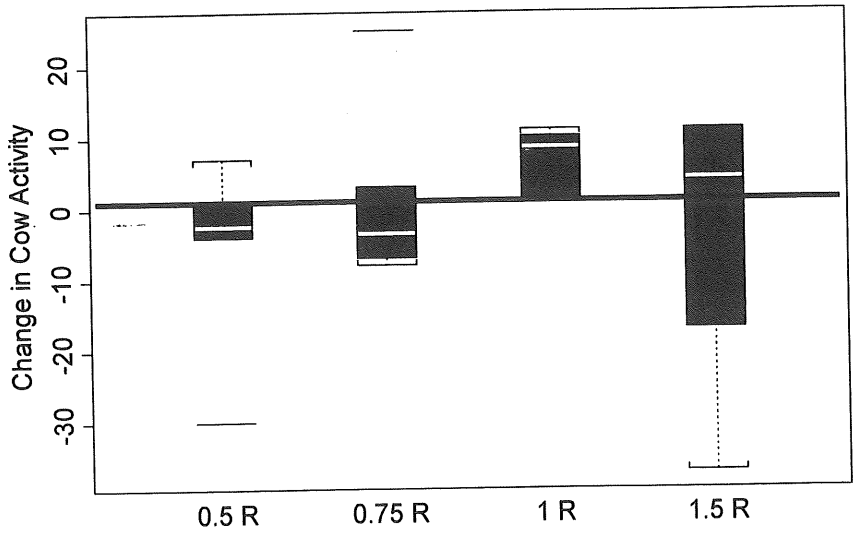


Figure 8. Box plot of cortisol concentrations of 8 cows before and after hoof trimming, and 8 cows before and after exposure to 1.5 times the current required to produce a behavioral response (1.5R).

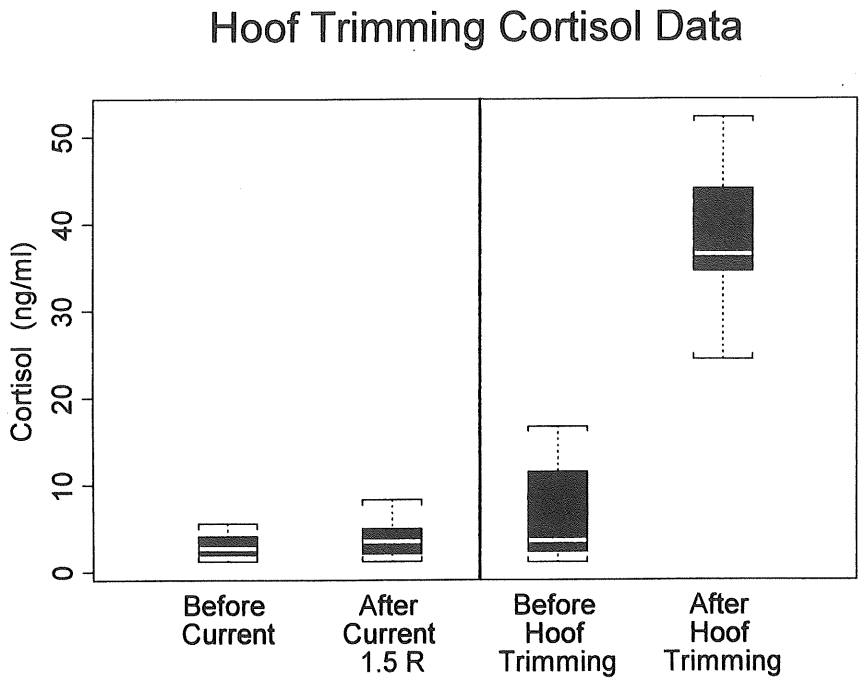


Figure 9. Schematic of electrical apparatus for milking time tests.

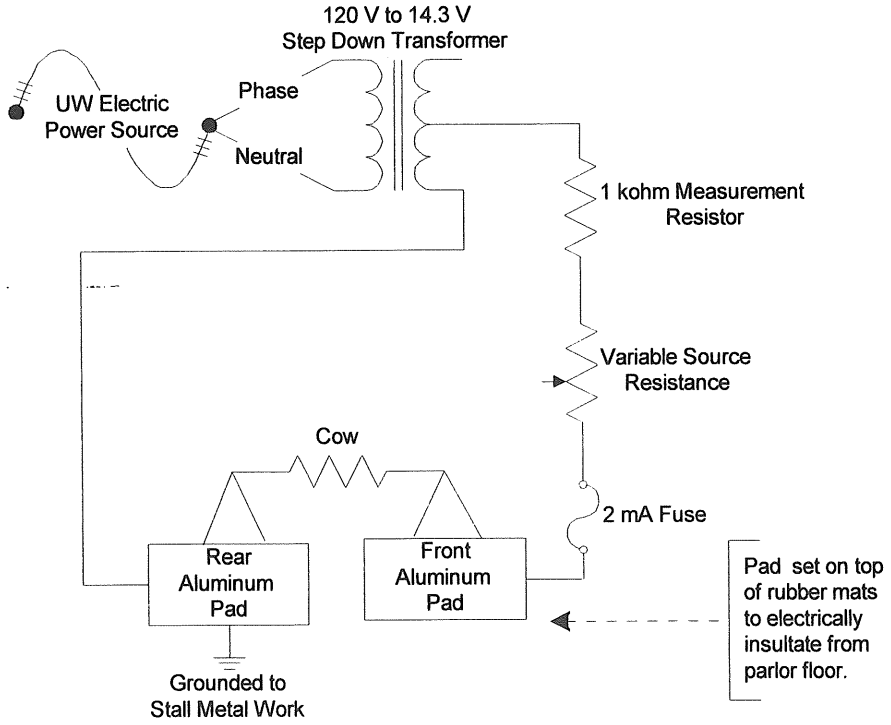
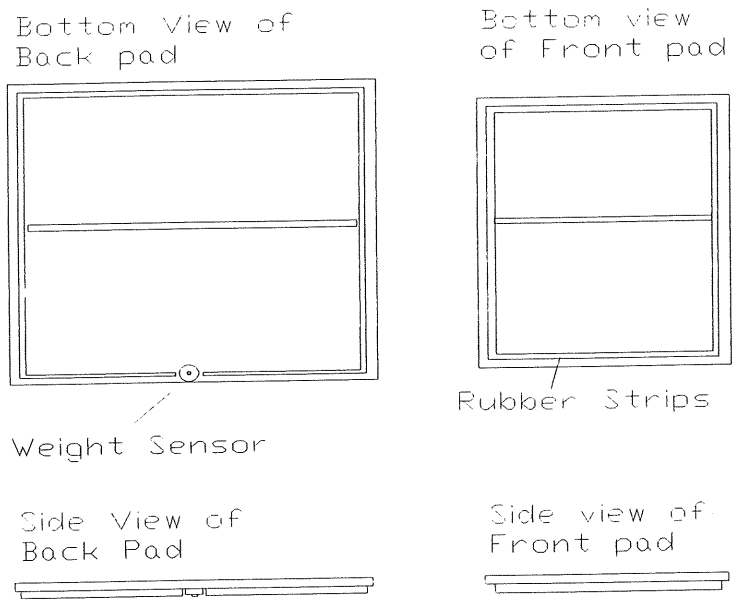


Figure 10. Activity monitoring device for milking time tests.



Data Appendix

Cows used in cortisol/behavior study

Cow Number	Days in Milk	Lactation Number	Daily Milk Yield (lbs)
3963	53	4	84
4102	51	3	82
4106	54	3	103
4145	56	3	91
4169	192	2	65
4192	187	2	71
4205	52	2	88
4243	51	2	73

Cows used in hoof trimming study

Cow Number	Days in Milk	Lactation Number	Daily Milk Yield (lbs)
4389	205	1	80
4230	313	2	62
4394	214	1	65
3966	241	4	40
4304	460	1	65
4350	317	1	---
4056	628	2	90
4428	91	1	72

Cows used in milking time experiment, pulsation failure and current exposure.

Cow Number	Days in Milk	Lactation Number	Cow Number	Days in Milk	Lactation Number
2336	88	7	4128	168	3
3744	121	6	4029	164	4
3963	102	4	3744	230	6
3970	67	4	3990	138	3
3992	166	4	4252	172	2
3996	69	4	938	284	5
4005	49	4	4286	135	2
4066	223	3	4219	315	2
4131	64	3	4015	70	4
4134	96	3	4405	152	1
4212	254	2	4419	150	1
4226	152	2	4225	288	2
4237	175	2	4397	201	1
4278	68	2	4408	139	1
4284	68	2	4425	135	1
4425	26	1	4145	214	3

Results of milking time experiment, pulsation failure and current exposure. *Note these differences are the average of the variable on the control days minus the value of the variable n the treatment day (a positive value indicates a reduction in the value on the treatment day).*

Cow	Current	Pulse Failure	Strip Yield difference	Milking Time Difference (s)	Peak flow Diff (kg/min)	Activity Diff	Milk Yield Diff (lb)	Ave flow Diff (lb/min)
4212	yes	no	-0.125	27.5	-0.25	-2.5	4	0.14
4134	no	no	-0.125	12.5	0.05	-3.5	2.5	0.16
4278	yes	yes	0.00	-5	0.1	0.5	-8	-0.84
3963	no	yes	0.00	17.5	-0.65	2	1.5	-0.14
4005	no	yes	0.00	-22.5	-0.25	1.5	-4	-0.17
3970	yes	yes	0.125	7.5	-0.35	6	-0.5	-0.06
4131	yes	no	0.00	-5	0.4	-0.5	9	1.37
3996	no	no	0.125	10	-0.5	-6	-5	-0.89
3744	yes	yes	0.375	70	-0.4	6.5	3	-0.57
2336	no	no	-0.125	-45	0.4	-5.5	1.5	0.65
3992	yes	no	0.00	17.5	0.15	-8.5	5	0.36
4237	no	yes	0.00	32.5	-0.4	13	2.5	0.01
4066	no	yes	-0.125	7.5	-0.2	10	4	0.31
4284	yes	yes	0.00	82.5	-0.6	-4.5	-9.5	-2.70
4425	no	no	0.25	42.5	0.15	-3.5	3.5	-0.09
4226	yes	no	0.00	32.5	-0.05	4	2	-0.14
4128	yes	yes	0.125	-2.5	-0.475	3	-6.35	-0.97
4029	no	yes	0.125	-10	-0.64	2.5	-8.65	-1.07
3744	no	no	0.00	-115	0.15	-6	-3.3	0.82
3990	yes	no	0.00	-32.5	0.375	-1	-4.15	-0.07
4252	yes	yes	0.00	20	0.605	0	-1.25	-0.59
938	no	no	0.50	-130	0.37	-9	-4.75	0.60
4286	no	yes	0.50	-50	1.12	1	5.74	1.40
4219	yes	no	-0.25	37.5	-0.65	3.5	2.15	-0.52
4015	no	no	0.00	47.5	-0.03	-6	3.2	-0.19
4405	no	yes	0.50	-2.5	0.005	2.5	4.55	0.88
4419	yes	no	0.125	65	-0.315	8.5	7.85	-0.46
4225	yes	yes	0.375	7.5	-0.445	0.5	-0.85	-0.25
4397	yes	no	0.00	-65	0.42	-1.5	-1.75	0.80
4408	no	no	0.375	-10	0.405	-4.5	0.75	0.45
4425	yes	yes	0.125	-37.5	-0.145	1	-1.3	0.64
4145	no	yes	0.25	45	-0.91	6	-0.26	-1.51

Cows used for milking-time experiment, aged liners and current exposure.

Cows	DIM	LACT	SSC	AVE Milk (lb)
4128	196	3	87	78
4015	98	4	16	108
3744	258	6	76	85
4252	200	2	47	76
938	312	5	60	86
4279	191	2	58	101
4226	289	2	34	59
4264	293	2	198	73
4244	258	2	38	74
4082	309	3	136	62
4399	198	1	196	71
4412	176	1	19	76
4436	126	1	41	76
4405	180	1	39	71
3763	222	7	197	94
919	252	6	NA	86

Results of milking time experiment aged liners and current exposure. *Note these differences are the average of the variable on the control days minus the value of the variable n the treatment day (a positive value indicates a reduction in the value on the treatment day).*

Cow	Current	Aged Liners	Strip Yield Diff	Milking Time Diff (s)	Peak flow Diff (kg/min)	Activity Diff	Milk Yield Diff (lb)	Ave flow Diff (lb/min)	Slips Diff
4128	yes	yes	0.25	-85.0	1.32	10.5	-4.95	0.82	-19
4015	no	no	0.25	27.5	-0.11	3.5	3.15	-0.01	-2
3744	yes	no	-0.125	52.5	-1.28	5.5	-1.10	-0.86	0
4252	no	yes	-0.125	-85.0	0.40	15	-8.85	0.37	-27
938	yes	no	0.00	-25.0	-0.83	7	-4.25	-0.20	0
4279	no	no	-0.25	-30.0	-0.01	8	-0.40	-0.06	1
4226	yes	yes	0.625	-152.5	1.86	-0.5	-1.45	1.49	-11
4264	no	yes	-0.25	-65.0	0.65	14	-4.85	0.39	-26
4244	yes	yes	0.00	-2.5	0.84	7.5	-1.00	-0.16	-26
4082	yes	no	-0.25	17.5	0.35	-4.5	5.90	1.02	0
4399	no	no	0.00	25.0	-0.22	13	0.00	-0.59	0
4412	no	yes	-0.5	-67.5	0.53	-12.5	-5.40	0.21	-17
4436	yes	no	-0.25	7.5	0.53	0	0.35	-0.20	-3.5
4405	no	yes	-0.25	-112.5	0.91	26	-5.20	1.35	-18
3763	no	no	0.125	-27.5	-0.15	-6	-2.80	0.09	2.5
919	yes	yes	0.00	-147.5	1.25	38	-7.15	0.88	-28

DAIRY COW RESPONSE TO ELECTRICAL ENVIRONMENT

FINAL REPORT

PART III. IMMUNE FUNCTION RESPONSE TO LOW-LEVEL ELECTRICAL CURRENT EXPOSURE

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by

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ABSTRACT

Twelve lactating Holstein cows, housed in a stanchion barn, were exposed to 1 mA of 60 Hz electrical current from front to rear hooves for two weeks. Twelve cows acted as controls. Immune function was assessed by analyzing blood samples taken twice a week for thirteen different response variables. The measures for lymphocyte blastogenesis (concanavalin A and phytohemagglutanin mitogens), and oxidative burst (PMA-induced chemiluminescence) were chosen *a priori* as the best indicators of immune function response. Immunoglobulin production and interleukin 1 and 2 were also assessed. There was no statistically significant difference between control and treatment cows for any of the main response variables. The difference between the control and treatment cows was statistically significant for one of the secondary response variables but did not appear to be consistent with other observations. Collectively, these results suggest that exposure to 1 mA of current for two weeks had no significant effect on the immune function of dairy cattle.

INTRODUCTION AND LITERATURE REVIEW

The Minnesota Legislature authorized the Minnesota Public Utilities Commission to establish a committee of science advisors in response to claims by some dairy farmers that electric currents in the earth from electric utility distribution systems are somehow responsible for problems with behavior, health and production of dairy cows. A multidisciplinary group with expertise in the fields of agricultural engineering, animal physiology, biochemistry, electrical engineering, electrochemistry, epidemiology,

physics, soil science, and veterinary science were assembled to serve as science advisors. The consensus of the science advisors was that currents in the earth can only interact with dairy cows through their associated electric fields, magnetic fields and voltages, and that these parameters should be the focus of analysis. Five possible mechanisms were identified by which the electrical distribution system could conceivably affect dairy cows. A field study was conducted to investigate the magnitude of these hypothesized electrical factors on 19 Minnesota dairy farms. The combined electrical data from the field study indicated that while none of the five electrical hypotheses could be ruled out, only one of them was a priority for research. This hypothesis is that *continuous or frequently repeated contact of confined cows to sources of low level stray voltage may result in electric fields inside the cow at levels high enough to produce biological effects without producing observable or measurable behavior modifications.* The front to rear hoof step potential measured in the field study resulted in the continuous and longer-term exposure required to satisfy this low level voltage hypothesis. If a physiological response is to occur in dairy cows, it is more likely to be produced by step potential exposures in the stalls rather than outside because: 1. step potentials in the stall are larger than outside, and, 2. step potentials in the stall last longer because of long periods of cow confinement.

A physiological response in dairy cows that are exposed to low level voltages (1-100 mV) has not been specified. Various types of physiological responses (e.g., circulating hormones or their metabolites) to electric and magnetic field exposures have been shown in the published literature to occur in various animals other than dairy cows. These are neither equivalent to, nor indicative of, pathological effects that cause poor health and production in dairy cows. Since it is not possible to extrapolate to dairy cows, further studies were recommended that specifically examine exposure of dairy cows to step potentials lower than those threshold levels already known to elicit behavioral responses.

There have been several studies that have investigated the physiological response of dairy cows exposed to electrical current. Endocrine response experiments are summarized in the previous sections of this report. Gorewit et al. (1992) reported that dairy cows exposed to up to 4 V of 60 Hz while drinking, during the entire lactation, showed no difference in milk yield, somatic cell count, cow health or reproductive performance. Reinemann et al. (1996) reported that cows exposed to transient currents for three weeks showed no significant treatment effect for the following parameters: sodium, albumin, potassium, enzymatic CO_2, chloride, calcium, phosphorus, glucose, creatinine, and creatine kinase. The absence of significant changes in these laboratory data in treatment cattle over time (each cow serving as her own control), as well as the lack of difference between treatment and control cows, indicate that there was no alteration in circulating volume or acid-base balance, nor was there significant stress (as measured by glucose concentration) or muscle injury inflicted by the treatment. In both studies (Gorewit et al. 1992; Reinemann et al. 1996) cows were exposed to electrical current only while drinking, not continuously.

Physiological responses of farm animals to electrical environment have also been studied. Burchard et al. (1998) reported that nocturnal melatonin concentrations in dairy cows did not show any variation that could be attributed to exposure to a vertical electric field of 10 kV/m and a uniform horizontal magnetic field of 30 μT. Thompson et al. (1995) reported that cortisol concentrations, weight gain, and wool fiber length and diameter did

not differ between the controls and ewes exposed to a mean electric field of 6 kV and mean magnetic field of 40 mG.

Physiological responses of farm animals to stresses other than electrical exposure have been studied. Cummins and Brunner (1991) reported that housing in metal pens decreased cortisol, plasma ascorbate, IgG and specific antibody titres in dairy calves relative to calves housed in hutches. Elvinger et al. (1992) reported that the major effect of heat stress on immune function of dairy cows was decreased migration of leukocytes to the mammary gland after chemotactic challenge. In a study by Minton et al. (1995), reduced lymphocyte proliferative responses (PHA, Con A, PWM) were reported for lambs subjected to restraint and isolation stress for 6 h on three consecutive days. Treatment did not affect IL2 or MHCII.

OBJECTIVES

The specific objective of these experiments was to test the hypothesis proposed by the Science Advisors to the Minnesota Public utility Commission by measuring immune function response of dairy cows to continuously applied hoof-hoof voltage exposure below the level that would produce a behavioral response. Assays were chosen as rapid, routine measures to provide important initial information on immune system function.

MATERIALS AND METHODS

Test facilities were constructed for groups of 8 cows. Treatment animals were exposed to 1 mA of current flow for a period of 2 weeks. Each replicate used 4 control and 4 treatment animals. Blood samples were taken from all 8 cows twice a week for one week before electrical exposure and for the 2 weeks of electrical exposure. The change in immune function measures was compared between treatment and control groups. Three replicates of 8 cows each were performed using a total of 24 cows. Treatment and control cows had identical stall conditions except for the current treatment. The treatment and control stalls were selected in the systematic pattern shown in Figure 1. Cows were randomized to the stalls and hence the treatment conditions. The cows for this trial were selected on the following criteria:

Lactation number no less than 2 and no greater than 4 (multiparous).

Days in milk (DIM) greater than 150 (mid lactation).

Somatic Cell Count (SSC) less than 150,000 (no mastitis infection).

Days Carrying Calf (DCC) greater than 40 (confirmed pregnant).

The cows in this research herd normally receive BGH injections every 2 weeks. BGH was not administered during this trial so all cows would have missed one scheduled injection during these experiments. The information for the cows used in this study is given in the appendix.

The cows were released from their stalls for milking at approximately 5:30 a.m. and 5:30 p.m. After each milking, the cows were let out into an exercise yard. Cows were returned to the test stalls within 1 hour of being released.

Twelve cows were exposed to 1 mA of current for two weeks (treatment group) and 12 cows were not (control group). The statistical analysis method defined a priori was to take the difference between response variables measured on day 21 (at the end of the treatment period) minus the average of days 3 and 7 (during the pre-treatment period) for each cow. The response is, therefore, the difference from baseline for each cow with the experimental unit defined as an individual cow. The differences of the treatment cows were compared to the differences of the control cows using an independent t-test.

Test Stalls

The test stalls were constructed to allow precise control and measurement of electrical stimuli to individual cows and to eliminate interference from other electrical stimuli occurring in the cow environment. The test stalls consisted of a wooden framework filled with two 120x76 cm (48x30 in.) concrete pads (Figure 2). A 15x15 cm (6x6 in.) welded grid of 9.5 mm (3/8 in.) reinforcing steel was embedded in each pad. There is a 9 cm air gap between the front and rear pads. Cows were secured with head-locking stanchions supported on a wooden framework. When a cow stood in the stall, the front hooves were on the front concrete pad and the rear hooves were on the rear pad.

The front of the test stall was supported by a single 7.3 cm diameter PVC pipe section 5 cm high, located at the center of the stall front end. The rear of the stalls were suspended about 3 cm off the barn floor by two hangers attached at the back corners of the wooden stall frame and metal posts anchored in the concrete. This arrangement provided electrical insulation for all current other than the cow.

Several experiments were carried out to determine the best stall surface for maintaining current exposure levels over extended periods. Single day trials with bare concrete and several different types of organic bedding proved unsatisfactory. The back of the stall surface was periodically wetted with urine and then drained dry. This variable level of moisture in combination with accumulation of organic bedding on the animal hooves changed the animal resistance by a factor of 1000 times or more. It was not possible to maintain current exposure within +/- 10% unless very high source voltages were used.

The concrete surface of the pads were then covered with electrically conductive rubber mats 1.4 cm (9/16 in.) thick (American Health and Safety Inc., item number 1-786.3X5S). These resilient mats allowed the cows to be kept comfortably in the stalls without the use of organic bedding and reduced the risk of injuring feet and legs. The conductive mats with no bedding provided much better control of current exposure with cows both standing and lying than the bare concrete surface either with or without organic bedding.

The stalls were maintained twice a day when the cows were let out of the test stalls for milking. At each of these times the cow contact current level was checked as described below and recorded. Following this current check the stalls were cleaned by removing manure and other foreign material from the stall surface as well as areas surrounding the stalls. The rubber stall surfaces were then washed with a disinfectant (Muliquat, No. 455, Hydrite Chemical Co). The cow contact currents were then rechecked. If the current deviated by more than 10% of the treatment current (1 mA), the current level was adjusted by changing the source resistance. The water cups were also checked to make sure they were dispensing water properly.

Current Application

The intended treatment current was 1 mA through the cow's body. Current was applied continuously for two weeks in a 20-min cycle (10 min on, 10 min off). This cycled pattern was used because previous research suggests that the effects of electric fields may be more pronounced for changing electric fields than for steady fields.

A source voltage of 240 V was created using 120 V output from an uninterruptible power supply (UPS) with power conditioning capabilities and stepped up to 240 volts with an isolated transformer (Figure 3). Power was switched on and off in 10-min intervals using a repeat cycle timer/relay (Syrelec #ODRU, Dallas, Texas).

Current to each of the four treatment stalls was controlled by an adjustable source resistance (decade box power resistor) for each stall. Each current application wire also had a 1k ohm resistor in series to measure the total current flow in that line by measuring the voltage drop across this resistor. The return wire from the rear pad of each test stall was grounded using a separately derived ground located just outside of the barn near the test stalls.

The treatment current level was measured in each treatment stall just before and after the twice-daily stall maintenance. The current exposure was measured using standard methodology used in field investigations of stray voltage. Copper plates (9x9 cm) were placed over wetted paper cloth at the center of the front and rear stall pads. A 3.6 kg weight was placed on the copper plates and the voltage across the plates was measured with 1k ohm shunt resistor and a Fluke 87 true rms multimeter. Leakage current was estimated by comparing the current measured at the 1k ohm resistor in the control box with the "cow contact" current measured at the 1k ohm resistor between the front and rear pads. The amount of leakage current is a function of the resistance of the intended path (pad-cow-pad) the resistance of alternate paths (debris bridging pads or from front pad to ground and wood rails connecting pads).

Periodic measurements of the step potential in control stalls were also made during the second replicate of this study using this method. The range of the measured values was 1.4 mV to 1.7 mV rms. The step potential values were much less than 5% of the 400 mV range specified as the lowest limit of accuracy by the manufacturer. As specified by the manufacturer, the offset of the Fluke 87 meter was checked with the test leads shorted and found to be 1.4 mV. This is a result of internal amplifier noise in the meter. Within the accuracy of this meter, the step potential was not different from zero.

Magnetic Field measurement

Background magnetic field levels were measured using an EmdexC magnetic field meter. This meter is designed to measure the resultant 3-axis 50-60 Hz magnetic field. Field readings were taken directly in front of each stall, in the center of the stall, and directly behind each stall at a height of 1 m from the floor. The average magnetic field at all test stall locations with all electrical devices in the barn running (lights and fans) was 0.3 mG. The magnetic field levels were between 0.14 and 0.4 mG at all locations except at the front of stall 1, which had readings of up to 0.54 mG.

Immune Function Assays

Blood samples were collected by tail bleeding twice weekly for assessment of immune function. Samples were collected for one week before exposure and for the two weeks of exposure. A sample was allowed to clot and resulting serum analyzed for immunoglobulin content by ELISA and IL1 and IL2 by bioassay (Wudhwa et al., 1991). Remaining blood was used to collect leukocytes, as previously described (Lohuis et al., 1990). Hypotonic lysis was used to remove red blood cells, and percoll gradient centrifugation was used to enrich target leukocyte populations. Leukocytes were used immediately for lymphocyte blastogenesis, antibody production and oxidative burst assays.

For lymphocyte blastogenesis (Lane et al., 1979), cells were diluted in Fisher's medium and 50 μL containing 10^5 cells plated onto 96-well culture dishes. Responses to standard mitogens, including *S. aureus*, phytohemagglutinin, pokeweed mitogen and concanavalin A were determined. Phytohemagglutanin and concanavalin A activate largely T lymphocytes, pokeweed mitogen T and B lymphocytes and *S. aureus* cells B lymphocytes. After 72 hours, 1 μCi ^{3}H-thymidine was added, cells incubated an additional 4 hours and cells harvested using a 96-well plate harvester. Incorporation of ^{3}H-thymidine into DNA was used as an index of mitogenesis.

To assess immunoglobulin production (Lane et al., 1979), $3x10^6$ cells were suspended in 300 μL media. Cells were treated with or without pokeweed mitogen for 5-10 days and immunoglobulin production assessed by ELISA, using antibodies against specific bovine immunoglobulins.

To assess oxidative burst (Trush et al., 1978), chemiluminescence in response to standard activators of macrophage and neutrophil function was used. Leukocytes (10^6) were placed in 0.5 mL phenol red free Dulbecco's Modified Eagle's Medium (DMEM) containing 100 mg/mL luminol. Baseline luminescence was assessed after 10 minutes incubation. Next, 0 or 10 ng/mL phorbol myristate acetate (PMA) was added, cells incubated 1 minute and light emission determined again. The difference was used to estimate PMA-induced chemiluminescence.

The measures for lymphocyte blastogenesis using concanavalin A, and phytohemagglutanin mitogens and oxidative burst as measured by PMA-induced chemiluminescence were chosen *a priori* as the best indicators of immune function response. These questions were selected from the response variables to control the Type I error for the experiment's most important questions.

Other Responses

In addition to the blood measures, daily water volume and feed consumed, cow temperature and daily milk production were monitored. Each test stall was equipped with a water meter that was read once daily during the morning milking. Feed intake was monitored for each cow by measuring daily feed supplied minus leftover feed found in the feed bins. The amount of feed supplied was intended to keep some feed in the bins 24 hours a day. The milk meters in the milking parlor (BouMatic - Perfection), recorded milk yields.

The time and pattern of standing and lying were recorded on one of the control days and again near the end of the treatment period during the third replicate. The time for cows to reenter stalls after milking was measured. If the voltage/current exposure were perceived, the time and pattern of lying or time to enter stalls could be changed.

RESULTS

Current Application

The results of the twice-daily measurements of cow contact current are summarized in Table I. The average cow current was within the +/- 10% target value for all cows except 4262 in replicate II. This cow was fistulated and leaking rumen fluid caused the stall surface to remain wet and created a leakage path. The average value of 0.6 mA is probably an under-estimate of the true average as these measurements were taken at the end of each 12-hour observation period, when the stall condition was likely at its worst. Immediately after these measurements were taken, the stalls were cleaned and the current levels readjusted to 1 mA.

Table I. results of the twice-daily measurements of cow contact current.

Cow Number	Replicate	Average Current (mA)	Standard Deviation (mA)
3910	I	1.00	0.15
4066	I	1.04	0.06
4161	I	0.93	0.34
4192	I	1.10	0.21
3861	II	0.94	0.20
4243	II	1.00	0.16
4262	II	0.60	0.28
4084	II	0.97	0.23
3987	III	0.98	0.03
4057	III	1.03	0.02
4157	III	0.98	0.05
4279	III	0.99	0.02

Further measurements were done to estimate the stability of the cow current in the time between the twice-daily cow current measurements. Tests were done periodically using shunt resistor values of 0.5k, 1k, 5, and 10k ohms. The cow contact current was within +/- 0.1 mA for all resistance values except the 10k resistor, which fell just outside the

10% deviation with an average cow contact current of 0.89 mA. The test stalls were thus able to maintain a cow contact current within +/- 10% for the practical range of cow and contact resistances.

The average source resistance, recorded twice daily was 196k ohms. Values were between 170k and 230k ohms for all tests except for cow 4262 in replicate II (leaky fistula) in which case the source resistance was typically 100k to 150k ohms. The resistance of the rest of the circuit (pads, mats, cow and contact resistance) was between 10k and 70 k ohms with a standard deviation of individual stalls between 1k to 3k ohms (or less than 2 % of the total circuit resistance). The only exception to this was the cow with a leaking fistula in which case the standard deviation increased to 32k ohms or 13 % of the total circuit resistance.

The current measured at the 1k ohm resistor in the control box was monitored for 24 hours on all test stalls during the third replicate. The 12 hour average current was compared to the last 10 minute interval (corresponding to the twice-daily cow-current checks). The ratio of the 12 hour average current to the last 10 minutes was between 94 and 99 % with standard deviations between 8 and 10 %. The voltage between the wires connected to front and rear pads was also monitored for 24 hours for each stall during replicate III. The expected range of voltages for this measurement is 10 to 70 V corresponding to the source voltage and 10 to 70k ohm resistance measured for this part of the circuit. The 24 hour average measured pad to pad voltage was 28 V with a standard deviation of 18 V. Less than 1% of the data points were in excess of 76 V. These values are within the expected range and indicate that the current exposure was stable during the treatment periods.

The combination of these measurements show that the average cow contact current was within the design range of 1 mA +/- 0.1 mA except for the cow with a leaking fistula in which case the average current exposure was probably about 0.8 mA +/- 0.3 mA.

Immune Function Responses

The summary statistics for the 3 replicates of current exposure experiment are given in Table II. Box plots of the main response variables are given in Figures 4-7. Statistical analysis was done after taking the natural log of all immune response data. This log transform yielded a more normal distribution of the data. The difference from baseline level for each measure was used as the response variable for each cow. The difference values for the treatment animals were then compared to the difference values for the control cows using an independent, two-tailed t-test. The questions for this work have been divided into two groups--the main questions and other questions. The comparison-wise Type I error for the main questions was p=0.05.

Table II. Summary statistics for immune function measures. The main questions are indicated in Bold. *Data analyzed as difference of natural logs, n of controls = 12, n of treatments = 12, DPM = Disintegration per minute, RLU = Relative Light Units*

Main Response Variables	Mean Change of Controls / Mean Change of Treatments	Mean Difference (Treatment–Control)	P-value Two Tailed Independent Test
Conconavalin A ln(DPM)	1.267 / 1.020	-0.247	0.724
Phytohemagglutanin ln(DPM)	0.799 / 0.671	-0.128	0.647
Chemiluminescence PMA, ln(RLU)	0.483 / 0.069	-0.414	0.280
Secondary Response Variables			
S. aureus, ln(DPM)	0.632 / -0.005	-0.637	**0.038**
Pokeweed, ln(DPM)	0.668 / 0.382	-0.286	0.272
IgG Serum, ln(mg/mL)	-0.034 / -0.017	0.017	0.771
IgG in vitro, ln(mg/mL)	-0.154 / -0.189	-0.035	0.862
IgA Serum, ln(mg/mL)	-0.005 / 0.012	0.017	0.796
IL1 Serum, ln(pg/mL)	-0.085 / 0.450	0.535	0.071
IL1 in vitro, ln(pg/mL)	-0.063 / -0.022	0.041	0.410
IL2 Serum, ln(pg/mL)	-0.041 / -0.139	-0.098	0.218
IL2 in vitro, ln(pg/mL)	-0.060 / -0.263	-0.203	0.351
Cortisol, ln(ng/mL)	-0.427 / -0.383	0.044	0.900

Positive Control

An experiment was done to validate the immune assays using the well-know immune response of cows to dexamethasone as a positive control. Four non-pregnant cows were injected with dexamethasone for 4 days. Each of the treatment cows received two injections of 15 mg of Dexamethasone (Dexamethasone, Sodium phosphate, Steris Laboratories Inc. Phoenix, Arizona 85043 USA) per day at 12-hour intervals for four days (Monday, Tuesday, Wednesday, and Thursday, approximately 7 a.m. and 7 p.m.). Blood samples were taken prior to the injection on Monday and at 7 a.m. Friday.

The 3 control cows received a placebo shot of the saline solution only. These shots were given at the same time that the treatment cows receive their shots. The cows had identical stall conditions. Blood samples were taken prior to the injection on Monday and on Friday for the control cows as well. Cows were handled in the same way as in the current exposure experiments except that no current was applied during this study. Seven cows were available for this trial, 4 were randomly selected as treatments and 3 as controls. Cows were selected on the following criteria:

Lactating and no less than 2 and no greater than 4 if possible.

DIM greater than 40.

SSC less than 150 If possible.

Non-Pregnant.

Good feet and legs.

Information on the cows used for this trial is given in the appendix. Summary statistics of the positive control experiment are given in Table III and raw data in Figure 8.

One of the control cows (2336) injured her right front teat on the morning of 5/9/99 and subsequently developed a mastitis infection. She was treated and stayed in the experiment. This cow showed a reduction in all 3 of the main immune function responses.

Table III. Summary statistics for immune function measures for positive control experiment, dexamethazone injection. The main questions are indicated in Bold. *Difference of natural logs, n of controls = 4, n of treatments = 3, DPM = Disintegration per minute, RLU = Relative Light Units*

Main Response Variables	Mean Change of Controls Mean Change of Treatments	Mean Difference (Treatment–Control)	P-value Two Tailed Independent Test
Conconavalin A ln(DPM)	-1.858 **-4.149**	**-2.291**	**0.044**
Phytohemagglutanin ln(DPM)	-0.898 -0.530	0.368	0.767
Chemiluminescence PMA ln(RLU)	-0.418 **-1.454**	-1.036	0.278
Secondary Response Variables			
S. aureus, ln(DPM)	-1.060 **-0.810**	0.250	0.799
Pokeweed, ln(DPM)	-0.739 0.106	0.845	0.336
IgG serum, ln(mg/mL)	-0.089 -0.088	0.001	0.997
IgG in vitro, ln(mg/mL)	0.0563 -0.787	**-0.843**	**0.010**
IgA serum, ln(mg/mL)	0.248 0.216	-0.032	0.958
IL1 serum, ln(pg/mL)	0.347 0.016	-0.331	0.580
IL1 in vitro, ln(pg/mL)	-0.025 **-0.405**	**-0.380**	**0.005**
IL2 serum, ln(pg/mL)	-0.173 0.034	0.207	0.362
IL2 in vitro, ln(pg/mL)	0.031 -0.525	-0.556	0.163
Cortisol, ln(ng/mL)	2.055 **-2.961**	**-5.017**	**0.003**

Other Responses

The standing and lying behavior of cows was analyzed in two ways. First the percentage of time spent standing was calculated for each of the control and treatment cows during the pre-exposure period. The change in this value for each cow was compared for control and treatment cows measured again at the end of the current exposure period. The same analysis was done using the percentage of periods in which cows changed status (from standing to lying or from lying to standing). The results of these tests are summarized below.

Percent of time standing	Pre-Exposure	End of Exposure
Control Cows	56%	48%
Treatment Cows	44%	37%

A two tailed t-test indicated that the difference between control and treatment cows was not significant ($p = 0.95$)

Percent of time Change in Status	Pre-Exposure	End of Exposure
Control Cows	11%	9%
Treatment Cows	17%	7%

A two-tailed t-test indicated that the difference between control and treatment cows was not significant ($p = 0.35$)

The time required for the cows to move from the center alley into the stalls was measured on 3 consecutive days near the end of the exposure period of the third replicate. None of the cows showed any hesitation to enter the stalls. The mean of the treatment cows was 3.5 s with a standard deviation of 1.0 s. The mean of the control cows was 4.2 s with a standard deviation of 1.6 s. The difference between the control and treatment animals was not significant ($p=0.46$).

Data for cow temperature, daily milk weights, water consumption, and twice-daily current measurements are given in the appendix.

DISCUSSION

Lymphocyte mitogenesis (blastogenesis) is a well-documented response to lectins and is generally recognized as a useful measure of systemic immune function (Lohuis et al., 1990). Chemiluminescence is widely used as a measure of respiratory burst in phagocytic cells, a key event in phagocytosis and intracellular killing of bacteria (Thrush et al., 1978). These two measures together provide important measures of lymphocyte and phagocyte function in response to various treatments. These measures represent several of the major immunological processes and are the most likely to be altered if systemic immune function is suppressed by the treatments. The two-week exposure period appears justified as previous work on housing stress in farm animals has shown significant immune system response within 3 days (Minton et al., 1995) and one of the

control cows in this experiment showed a change in immune function within 4 days in response to a mastitis infection.

The assays used in the present study are standard methods of assessing immunological function in mammals. Lymphocyte blastogenesis in response to concanavalin A and Phytohemagglutanin measures activation of T lymphocytes, while *S. aureus* measures B lymphocyte activation and pokeweed mitogen measures both T and B lymphocyte activation (Lane et al., 1979). Of these measures, only *S. aureus*-induced blastogenesis was significantly affected by 2 weeks of voltage exposure. This response would suggest a change in responsiveness of B cells (cells that eventually differentiate to produce immunoglobulins). However, no other measures, including pokeweed mitogen-induced blastogenesis, pokeweed mitogen-induced immunogolbulin production or in vivo antibody concentrations were affected. In addition, the difference in *S. aureus* was caused by an increase in the control cows while the treatment cows showed no change. Thus, it is possible that this response was a type I error. Concanavalin A-induced blastogenesis was inhibited in positive controls cows (dexamethasone treated).

Chemiluminescence is a widely used measure of respiratory burst, a key event in intracellular killing of bacteria (Thrush et al., 1978). The present study found no effect of voltage exposure on chemiluminescence, suggesting that bactericidal activity of circulating phagocytic cells was unaffected by treatment. Treatment with dexamethasone (a glucocorticoid used as a positive control) significantly inhibited chemiluminescence.

In addition, immunoglobulin levels in vivo and in vitro in response to pokeweed mitogen were measured as indices of immune function. As indicated earlier, these responses were unaffected by voltage exposure of cattle. However, dexamethasone significantly inhibited pokeweed mitogen-induced antibody production in vitro.

Two major cytokines regulating immune function, interleukin 1 and 2, were measured. Measurements included both serum concentrations and pokeweed mitogen-induced interleukin production in vitro. Interleukin 1 concentrations in serum were slightly elevated upon voltage exposure for 2 weeks ($P<0.07$), but serum interleukin 2 concentration and interleukin 1 and 2 production in vitro were unaffected. IL1 change in the combined date (all 3 replicates) appeared to be strongly influenced by one replicate (replicate 2, $p < 0.06$), with minimal change in the other two replicates ($p = 0.96$ and $p = 0.46$). The bioassays used do not differentiate between a and b forms of interleukin 1 (Wudhwa et al., 1991), so the possibility that one isoform was selectively affected cannot be excluded. In positive controls, dexamethasone decreased interleukin 1 production.

CONCLUSION

Collectively, these results suggest that exposure to 1 mA of 60 Hz electrical current for two weeks had no significant effect on immune function of dairy cattle. One of 13 response variables was statistically significant but did not appear to be entirely consistent with other observations.

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Figure 1. Location of treatment and control stalls in the barn. .

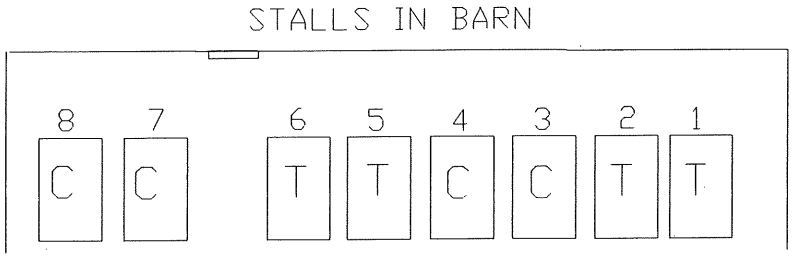


Figure 2. Diagram of test stalls.

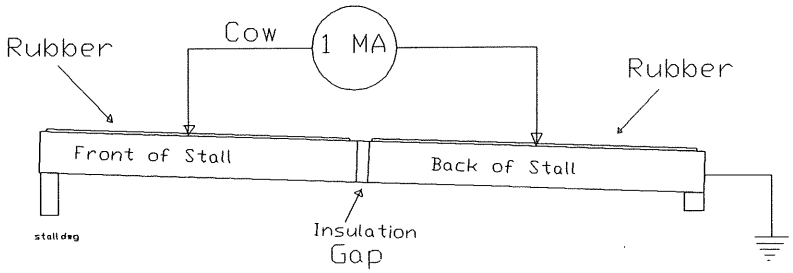


Figure 3. Schematic of electrical exposure circuit.

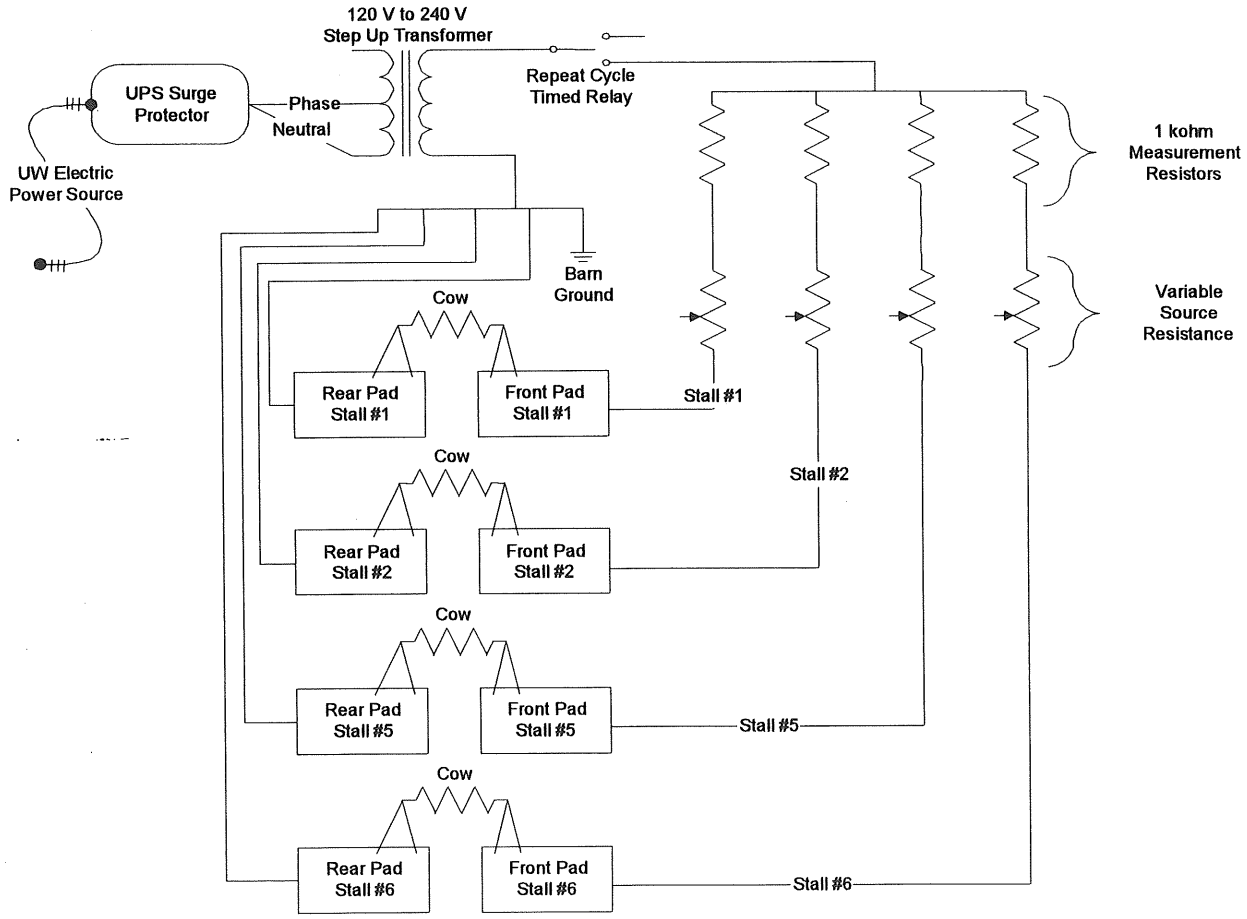


Figure 4. Box plots of the main response variables. The horizontal white line is the mean of the data. The box includes +/- 25% of the data from the median. The horizontal black lines are the maximum and minimum values. Current exposure started on day 8.

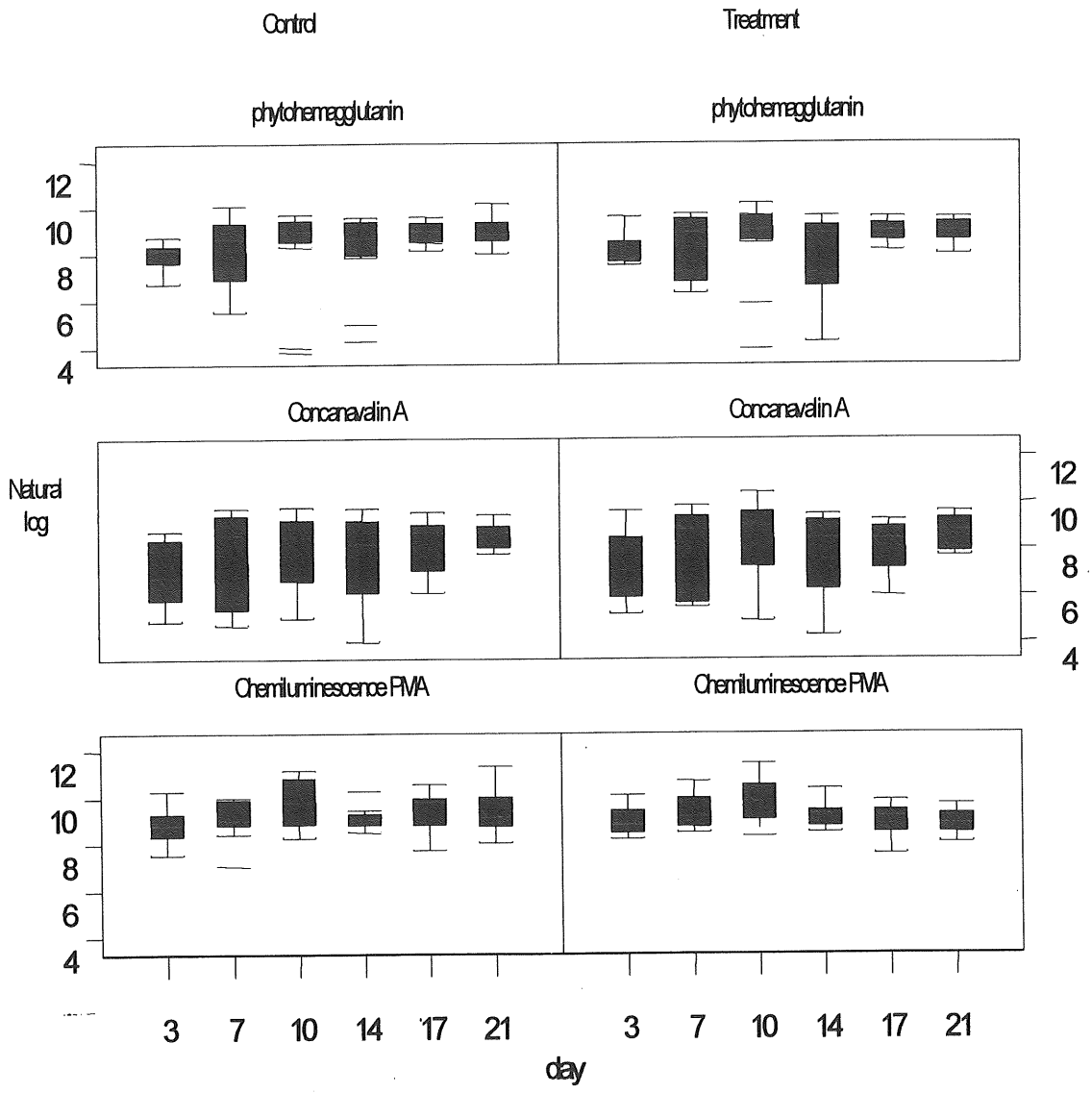


Figure 5. Natural Log of Chemiluminescense Control and Treatment (Difference Values)

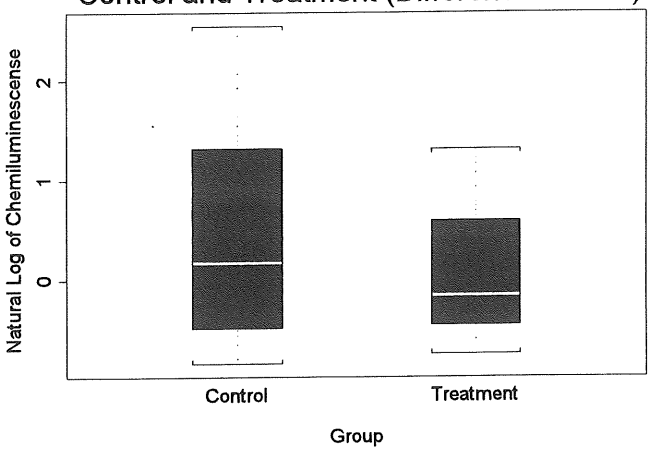


Figure 6. Natural Log of Conconavalin A Control and Treatment (Difference Values)

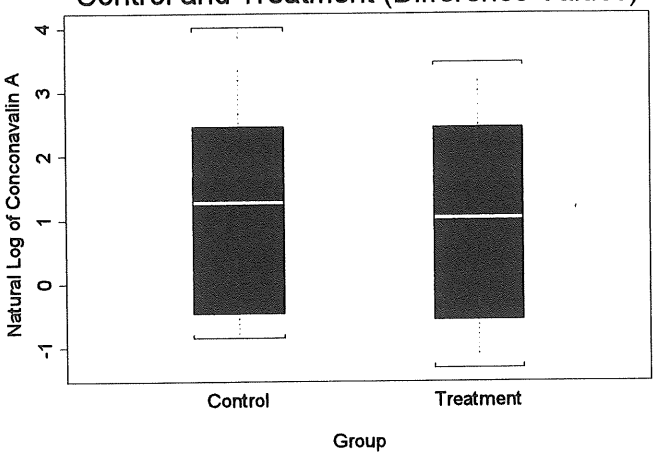


Figure 7. Natural Log of Phytohemagglutani Control and Treatment (Difference Values)

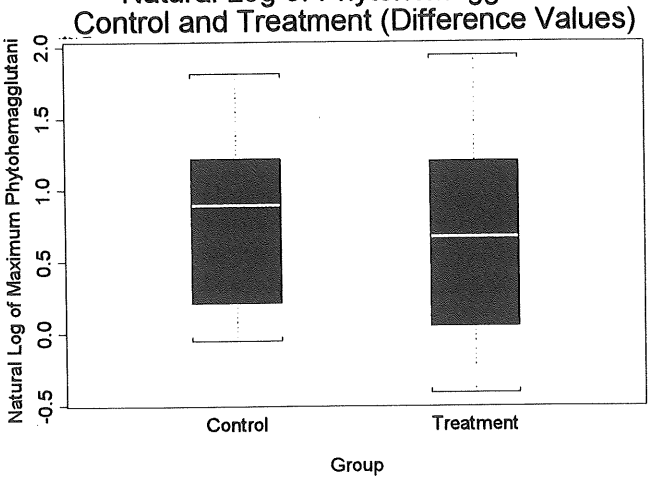
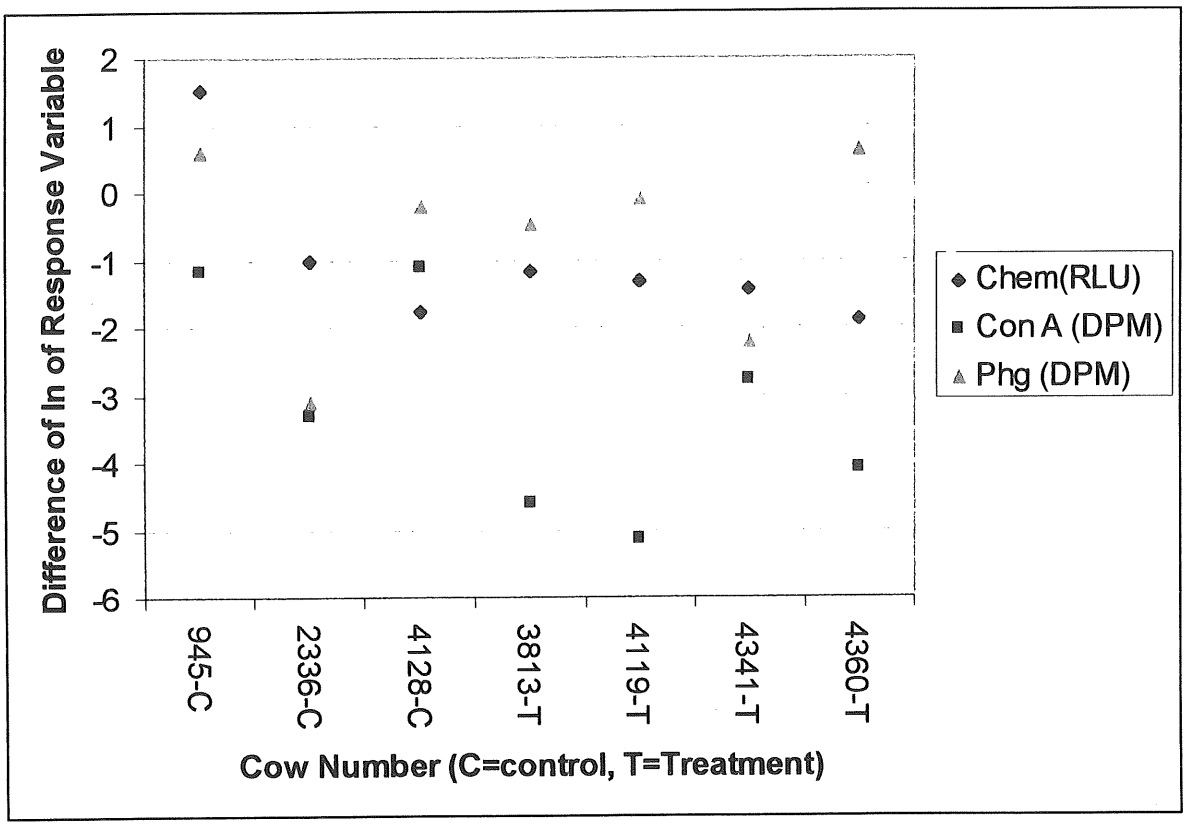


Figure 8. Main Response variables for positive control experiment.



Data Appendix for Part II

Appendix I. Cow information from immune function experiments, Replicates 1, 2 and 3.

Rep.	Cow Number Stall Number Treat or Con	DIM Days In Milk	LAC Lactation Number	DMAVG Average Daily Milk Yield (lbs).	SSCx1000 Somatic Cell Count	DCC Days Carrying Calf
1	4161_2_T	281	2	83	12	84
1	4212_4_C	298	2	81	0	84
1	4106_7_C	137	3	100	92	69
1	4134_8_C	130	3	86	58	63
1	4192_1_T	270	2	63	29	98
1	4066_5_T	257	3	79	29	77
1	3910_6_T	180	4	90	33	70
1	4230_3_C	273	2	78	30	49
2	4052_7_C	205	3	90	113	96
2	4078_8_C	186	3	113	35	102
2	4084_6_T	215	3	80	135	60
2	3861_1_T	175	5	89	72	54
2	4239_4_C	244	2	98	37	88
2	4243_2_T	180	2	65	63	60
2	4246_3_C	187	2	101	28	60
2	4262_5_T	151	2	71	19	39
3	3970_8_C	231	4	70	34	52
3	3987_1_T	243	4	70	141	52
3	3996_4_C	233	4	90	47	165
3	4057_2_T	234	3	114	55	166
3	4105_3_C	242	3	66	68	60
3	4157_5_T	476	2	71	61	123
3	4279_6_T	218	2	98	53	151
3	4286_7_C	190	2	108	19	67
Mean		226.5	2.8	85.6	52.6	82.9
Standard Deviation		69.6	0.9	15.1	36.6	35.9

Appendix II. Cows information used in the positive control experiment.

Cow Number	DIM Days In Milk	LAC Lactation Number	SSCx1000 Somatic Cell Count
3813	502	5	58
2336	285	7	249
4128	256	3	71
4360	121	2	446
4119	85	3	389
945	85	5	20
4341	69	2	14

Appendix III. Immune function data for replicates 1, 2 and 3.

ID CODES

Rep. There were three separate replicates which started on 11/28/98, 01/09/99 and 4/10/99.

stall: Stall number.

cow: This is the cow's number.

Response variables:

- cona: Conconavalin A (DPM)
- phg: Phytohemagglutani (DPM)
- chem: Chemiluminescence (RLU)
- staph: Staphaureus (DPM)
- pwm: Pokeweed (DPM)
- iggserum: Ig G Serum (mg/ml)
- igaserum: Ig A Serum (mg/ml)
- il1serum: Interleuken 1 serum (pg/ml)
- il1vitro: Interleuken 1 in vitro (pg/ml)
- il2serum: Interleukin 2 in serum (pg/ml)
- il2vitro: Interleukin 2 in vitro (pg/ml)
- igvitro: Ig G Production ((micro g)/ml)
- cortisol: Cortisol (ng/ml).

day: Day in Trial of observation (Day 3 and 7 were in Control Weeks).

ln_resp: Natural log of response

trial	cow	variable	trt	day	resp	ln_resp
1	3910	chem	T	3	4961.0	8.51
1	3910	chem	T	7	4932.0	8.50
1	3910	chem	T	10	9100.0	9.12
1	3910	chem	T	14	7119.0	8.87
1	3910	chem	T	17	6383.0	8.76
1	3910	chem	T	21	8039.0	8.99
1	3910	cona	T	3	466.0	6.14
1	3910	cona	T	7	425.0	6.05
1	3910	cona	T	10	9579.0	9.17
1	3910	cona	T	14	101.0	4.62
1	3910	cona	T	17	1449.0	7.28
1	3910	cona	T	21	8366.0	9.03
1	3910	cortisol	T	3	4.8	1.56
1	3910	cortisol	T	7	7.8	2.05
1	3910	cortisol	T	10	4.4	1.47
1	3910	cortisol	T	14	9.4	2.24
1	3910	cortisol	T	17	1.4	0.30
1	3910	cortisol	T	21	4.1	1.40
1	3910	igaserum	T	3	1.8	0.59
1	3910	igaserum	T	7	1.2	0.18
1	3910	igaserum	T	10	1.9	0.64
1	3910	igaserum	T	14	1.9	0.64
1	3910	igaserum	T	17	1.9	0.64
1	3910	igaserum	T	21	1.5	0.41
1	3910	iggserum	T	3	6.4	1.86
1	3910	iggserum	T	7	6.1	1.81
1	3910	iggserum	T	10	6.4	1.86
1	3910	iggserum	T	14	7.5	2.01
1	3910	iggserum	T	17	6.2	1.82
1	3910	iggserum	T	21	6.8	1.92
1	3910	igvitro	T	3	44.0	3.78
1	3910	igvitro	T	7	48.0	3.87
1	3910	igvitro	T	10	38.0	3.64
1	3910	igvitro	T	14	118.0	4.77
1	3910	igvitro	T	17	87.0	4.47
1	3910	igvitro	T	21	136.0	4.91
1	3910	il1serum	T	3	6.0	1.79
1	3910	il1serum	T	7	10.7	2.37
1	3910	il1serum	T	10	8.5	2.14
1	3910	il1serum	T	14	8.5	2.14
1	3910	il1serum	T	17	9.7	2.27
1	3910	il1serum	T	21	7.4	2.00
1	3910	il1vitro	T	3	391.1	5.97
1	3910	il1vitro	T	7	366.6	5.90
1	3910	il1vitro	T	10	321.7	5.77
1	3910	il1vitro	T	14	386.3	5.96
1	3910	il1vitro	T	17	400.3	5.99
1	3910	il1vitro	T	21	334.4	5.81
1	3910	il2serum	T	3	27.0	3.29
1	3910	il2serum	T	7	23.7	3.17
1	3910	il2serum	T	10	26.5	3.28
1	3910	il2serum	T	14	31.4	3.45
1	3910	il2serum	T	17	26.2	3.27
1	3910	il2serum	T	21	23.7	3.17
1	3910	il2vitro	T	3	285.4	5.65
1	3910	il2vitro	T	7	232.8	5.45
1	3910	il2vitro	T	10	259.0	5.56
1	3910	il2vitro	T	14	276.0	5.62
1	3910	il2vitro	T	17	142.5	4.96

1	3910	il2vitro	T	21	149.2	5.01
1	3910	phg	T	3	2820.0	7.94
1	3910	phg	T	7	1025.0	6.93
1	3910	phg	T	10	8010.0	8.99
1	3910	phg	T	14	305.0	5.72
1	3910	phg	T	17	6758.0	8.82
1	3910	phg	T	21	7333.0	8.90
1	3910	pwm	T	3	7909.0	8.98
1	3910	pwm	T	7	2382.0	7.78
1	3910	pwm	T	10	6875.0	8.84
1	3910	pwm	T	14	7005.0	8.85
1	3910	pwm	T	17	9747.0	9.18
1	3910	pwm	T	21	8086.0	9.00
1	3910	staph	T	3	4175.0	8.34
1	3910	staph	T	7	575.0	6.35
1	3910	staph	T	10	3947.0	8.28
1	3910	staph	T	14	3908.0	8.27
1	3910	staph	T	17	2657.0	7.88
1	3910	staph	T	21	1761.0	7.47
1	4066	chem	T	3	7777.0	8.96
1	4066	chem	T	7	21843.0	9.99
1	4066	chem	T	10	26623.0	10.19
1	4066	chem	T	14	43407.0	10.68
1	4066	chem	T	17	25513.0	10.15
1	4066	chem	T	21	9198.0	9.13
1	4066	cona	T	3	605.0	6.41
1	4066	cona	T	7	402.0	6.00
1	4066	cona	T	10	189.0	5.24
1	4066	cona	T	14	997.0	6.90
1	4066	cona	T	17	555.0	6.32
1	4066	cona	T	21	3524.0	8.17
1	4066	cortisol	T	3	9.5	2.25
1	4066	cortisol	T	7	6.0	1.79
1	4066	cortisol	T	10	10.1	2.31
1	4066	cortisol	T	14	2.2	0.79
1	4066	cortisol	T	17	7.5	2.01
1	4066	cortisol	T	21	1.1	0.10
1	4066	igaserum	T	3	1.0	-0.03
1	4066	igaserum	T	7	0.7	-0.30
1	4066	igaserum	T	10	0.6	-0.58
1	4066	igaserum	T	14	0.5	-0.63
1	4066	igaserum	T	17	0.9	-0.09
1	4066	igaserum	T	21	0.9	-0.11
1	4066	iggserum	T	3	12.1	2.49
1	4066	iggserum	T	7	12.6	2.53
1	4066	iggserum	T	10	12.3	2.51
1	4066	iggserum	T	14	10.9	2.39
1	4066	iggserum	T	17	12.2	2.50
1	4066	iggserum	T	21	12.4	2.52
1	4066	igvitro	T	3	47.0	3.85
1	4066	igvitro	T	7	187.0	5.23
1	4066	igvitro	T	10	163.0	5.09
1	4066	igvitro	T	14	93.0	4.53
1	4066	igvitro	T	17	46.0	3.83
1	4066	igvitro	T	21	94.0	4.54
1	4066	il1serum	T	3	13.6	2.61
1	4066	il1serum	T	7	9.4	2.24
1	4066	il1serum	T	10	4.9	1.59
1	4066	il1serum	T	14	10.3	2.34
1	4066	il1serum	T	17	6.4	1.85
1	4066	il1serum	T	21	8.3	2.11
1	4066	il1vitro	T	3	349.4	5.86
1	4066	il1vitro	T	7	339.3	5.83
1	4066	il1vitro	T	10	328.0	5.79
1	4066	il1vitro	T	14	333.5	5.81
1	4066	il1vitro	T	17	343.8	5.84
1	4066	il1vitro	T	21	336.4	5.82
1	4066	il2serum	T	3	22.1	3.10
1	4066	il2serum	T	7	14.3	2.66
1	4066	il2serum	T	10	19.9	2.99
1	4066	il2serum	T	14	19.5	2.97
1	4066	il2serum	T	17	16.5	2.80
1	4066	il2serum	T	21	16.0	2.77
1	4066	il2vitro	T	3	263.9	5.58
1	4066	il2vitro	T	7	315.1	5.75
1	4066	il2vitro	T	10	238.7	5.48
1	4066	il2vitro	T	14	254.4	5.54
1	4066	il2vitro	T	17	243.1	5.49
1	4066	il2vitro	T	21	291.3	5.67
1	4066	phg	T	3	3112.0	8.04
1	4066	phg	T	7	786.0	6.67
1	4066	phg	T	10	483.0	6.18
1	4066	phg	T	14	95.0	4.55
1	4066	phg	T	17	6120.0	8.72
1	4066	phg	T	21	4003.0	8.29
1	4066	pwm	T	3	2823.0	7.95
1	4066	pwm	T	7	3515.0	8.16
1	4066	pwm	T	10	80.0	4.38
1	4066	pwm	T	14	2689.0	7.90
1	4066	pwm	T	17	7138.0	8.87
1	4066	pwm	T	21	4473.0	8.41
1	4066	staph	T	3	2214.0	7.70
1	4066	staph	T	7	1539.0	7.34
1	4066	staph	T	10	39.0	3.66
1	4066	staph	T	14	692.0	6.54
1	4066	staph	T	17	3829.0	8.25
1	4066	staph	T	21	1958.0	7.58
1	4106	chem	C	3	2022.0	7.61
1	4106	chem	C	7	21836.0	9.99
1	4106	chem	C	10	40668.0	10.61
1	4106	chem	C	14	8669.0	9.07
1	4106	chem	C	17	19878.0	9.90
1	4106	chem	C	21	84892.0	11.35
1	4106	cona	C	3	399.0	5.99

1	4106	cona	C	7	158.0	5.06
1	4106	cona	C	10	217.0	5.38
1	4106	cona	C	14	852.0	6.75
1	4106	cona	C	17	941.0	6.85
1	4106	cona	C	21	8499.0	9.05
1	4106	cortisol	C	3	5.9	1.77
1	4106	cortisol	C	7	1.9	0.64
1	4106	cortisol	C	10	0.9	-0.11
1	4106	cortisol	C	14	2.2	0.77
1	4106	cortisol	C	17	2.2	0.79
1	4106	cortisol	C	21	12.8	2.55
1	4106	igaserum	C	3	0.2	-1.47
1	4106	igaserum	C	7	0.3	-1.35
1	4106	igaserum	C	10	0.2	-1.83
1	4106	igaserum	C	14	0.3	-1.35
1	4106	igaserum	C	17	0.3	-1.39
1	4106	igaserum	C	21	0.3	-1.27
1	4106	iggserum	C	3	12.7	2.54
1	4106	iggserum	C	7	11.8	2.47
1	4106	iggserum	C	10	12.2	2.50
1	4106	iggserum	C	14	12.6	2.53
1	4106	iggserum	C	17	13.0	2.56
1	4106	iggserum	C	21	11.7	2.46
1	4106	igvitro	C	3	60.0	4.09
1	4106	igvitro	C	7	49.0	3.89
1	4106	igvitro	C	10	26.0	3.26
1	4106	igvitro	C	14	89.0	4.49
1	4106	igvitro	C	17	119.0	4.78
1	4106	igvitro	C	21	108.0	4.68
1	4106	il1serum	C	3	8.7	2.17
1	4106	il1serum	C	7	7.4	2.00
1	4106	il1serum	C	10	5.0	1.61
1	4106	il1serum	C	14	5.1	1.63
1	4106	il1serum	C	17	8.4	2.13
1	4106	il1serum	C	21	8.2	2.10
1	4106	il1vitro	C	3	389.4	5.96
1	4106	il1vitro	C	7	319.7	5.77
1	4106	il1vitro	C	10	330.6	5.80
1	4106	il1vitro	C	14	426.4	6.06
1	4106	il1vitro	C	17	332.4	5.81
1	4106	il1vitro	C	21	344.5	5.84
1	4106	il2serum	C	3	26.7	3.28
1	4106	il2serum	C	7	24.2	3.19
1	4106	il2serum	C	10	21.6	3.07
1	4106	il2serum	C	14	42.1	3.74
1	4106	il2serum	C	17	22.9	3.13
1	4106	il2serum	C	21	17.7	2.88
1	4106	il2vitro	C	3	165.7	5.11
1	4106	il2vitro	C	7	109.9	4.70
1	4106	il2vitro	C	10	283.8	5.65
1	4106	il2vitro	C	14	147.7	5.00
1	4106	il2vitro	C	17	232.3	5.45
1	4106	il2vitro	C	21	224.1	5.41
1	4106	phg	C	3	2444.0	7.80
1	4106	phg	C	7	1314.0	7.18
1	4106	phg	C	10	78.0	4.36
1	4106	phg	C	14	5887.0	8.68
1	4106	phg	C	17	7932.0	8.98
1	4106	phg	C	21	4555.0	8.42
1	4106	pwm	C	3	5955.0	8.69
1	4106	pwm	C	7	512.0	6.24
1	4106	pwm	C	10	70.0	4.25
1	4106	pwm	C	14	1035.0	6.94
1	4106	pwm	C	17	6858.0	8.83
1	4106	pwm	C	21	8415.0	9.04
1	4106	staph	C	3	2900.0	7.97
1	4106	staph	C	7	118.0	4.77
1	4106	staph	C	10	62.0	4.13
1	4106	staph	C	14	212.0	5.36
1	4106	staph	C	17	2166.0	7.68
1	4106	staph	C	21	1694.0	7.43
1	4134	chem	C	3	1853.0	7.52
1	4134	chem	C	7	1165.0	7.06
1	4134	chem	C	10	9969.0	9.21
1	4134	chem	C	14	8720.0	9.07
1	4134	chem	C	17	6292.0	8.75
1	4134	chem	C	21	9647.0	9.17
1	4134	cona	C	3	1484.0	7.30
1	4134	cona	C	7	361.0	5.89
1	4134	cona	C	10	950.0	6.86
1	4134	cona	C	14	460.0	6.13
1	4134	cona	C	17	3406.0	8.13
1	4134	cona	C	21	6553.0	8.79
1	4134	cortisol	C	3	3.7	1.29
1	4134	cortisol	C	7	4.7	1.55
1	4134	cortisol	C	10	5.1	1.63
1	4134	cortisol	C	14	7.0	1.95
1	4134	cortisol	C	17	5.8	1.75
1	4134	cortisol	C	21	7.6	2.02
1	4134	igaserum	C	3	0.2	-1.61
1	4134	igaserum	C	7	0.2	-1.71
1	4134	igaserum	C	10	0.2	-1.83
1	4134	igaserum	C	14	0.2	-1.71
1	4134	igaserum	C	17	0.3	-1.39
1	4134	igaserum	C	21	0.2	-1.43
1	4134	iggserum	C	3	11.9	2.48
1	4134	iggserum	C	7	12.1	2.49
1	4134	iggserum	C	10	11.7	2.46
1	4134	iggserum	C	14	10.2	2.32
1	4134	iggserum	C	17	10.8	2.38
1	4134	iggserum	C	21	12.5	2.53
1	4134	igvitro	C	3	225.0	5.42
1	4134	igvitro	C	7	176.0	5.17
1	4134	igvitro	C	10	143.0	4.96

1	4134	igvitro	C	14	157.0	5.06
1	4134	igvitro	C	17	140.0	4.94
1	4134	igvitro	C	21	149.0	5.00
1	4134	il1serum	C	3	211.6	5.35
1	4134	il1serum	C	7	142.9	4.96
1	4134	il1serum	C	10	81.7	4.40
1	4134	il1serum	C	14	7.2	1.98
1	4134	il1serum	C	17	103.7	4.64
1	4134	il1serum	C	21	181.9	5.20
1	4134	il1vitro	C	3	321.8	5.77
1	4134	il1vitro	C	7	313.4	5.75
1	4134	il1vitro	C	10	297.0	5.69
1	4134	il1vitro	C	14	358.8	5.88
1	4134	il1vitro	C	17	305.8	5.72
1	4134	il1vitro	C	21	284.4	5.65
1	4134	il2serum	C	3	9.0	2.20
1	4134	il2serum	C	7	8.3	2.12
1	4134	il2serum	C	10	9.0	2.20
1	4134	il2serum	C	14	15.5	2.74
1	4134	il2serum	C	17	9.7	2.27
1	4134	il2serum	C	21	8.1	2.10
1	4134	il2vitro	C	3	269.2	5.60
1	4134	il2vitro	C	7	267.1	5.59
1	4134	il2vitro	C	10	88.0	4.48
1	4134	il2vitro	C	14	126.2	4.84
1	4134	il2vitro	C	17	148.1	5.00
1	4134	il2vitro	C	21	77.4	4.35
1	4134	phg	C	3	4834.0	8.48
1	4134	phg	C	7	1215.0	7.10
1	4134	phg	C	10	9143.0	9.12
1	4134	phg	C	14	3662.0	8.21
1	4134	phg	C	17	9159.0	9.12
1	4134	phg	C	21	7412.0	8.91
1	4134	pwm	C	3	6800.0	8.82
1	4134	pwm	C	7	1894.0	7.55
1	4134	pwm	C	10	6638.0	8.80
1	4134	pwm	C	14	127.0	4.84
1	4134	pwm	C	17	6772.0	8.82
1	4134	pwm	C	21	7870.0	8.97
1	4134	staph	C	3	3952.0	8.28
1	4134	staph	C	7	920.0	6.82
1	4134	staph	C	10	2156.0	7.68
1	4134	staph	C	14	66.0	4.19
1	4134	staph	C	17	2682.0	7.89
1	4134	staph	C	21	2500.0	7.82
1	4161	chem	T	3	6359.0	8.76
1	4161	chem	T	7	8095.0	9.00
1	4161	chem	T	10	23685.0	10.07
1	4161	chem	T	14	8025.0	8.99
1	4161	chem	T	17	16299.0	9.70
1	4161	chem	T	21	4338.0	8.38
1	4161	cona	T	3	260.0	5.56
1	4161	cona	T	7	378.0	5.93
1	4161	cona	T	10	700.0	6.55
1	4161	cona	T	14	212.0	5.36
1	4161	cona	T	17	955.0	6.86
1	4161	cona	T	21	8160.0	9.01
1	4161	cortisol	T	3	3.6	1.28
1	4161	cortisol	T	7	7.3	1.99
1	4161	cortisol	T	10	10.0	2.30
1	4161	cortisol	T	14	3.6	1.28
1	4161	cortisol	T	17	5.6	1.72
1	4161	cortisol	T	21	3.3	1.18
1	4161	igaserum	T	3	1.9	0.64
1	4161	igaserum	T	7	1.8	0.59
1	4161	igaserum	T	10	2.3	0.83
1	4161	igaserum	T	14	0.8	-0.22
1	4161	igaserum	T	17	1.9	0.64
1	4161	igaserum	T	21	1.9	0.64
1	4161	iggserum	T	3	11.8	2.47
1	4161	iggserum	T	7	11.4	2.43
1	4161	iggserum	T	10	10.7	2.37
1	4161	iggserum	T	14	11.0	2.40
1	4161	iggserum	T	17	9.8	2.28
1	4161	iggserum	T	21	10.1	2.31
1	4161	igvitro	T	3	108.0	4.68
1	4161	igvitro	T	7	125.0	4.83
1	4161	igvitro	T	10	87.0	4.47
1	4161	igvitro	T	14	76.0	4.33
1	4161	igvitro	T	17	77.0	4.34
1	4161	igvitro	T	21	43.0	3.76
1	4161	il1serum	T	3	5.2	1.66
1	4161	il1serum	T	7	6.8	1.92
1	4161	il1serum	T	10	7.8	2.05
1	4161	il1serum	T	14	6.8	1.91
1	4161	il1serum	T	17	8.5	2.14
1	4161	il1serum	T	21	9.9	2.29
1	4161	il1vitro	T	3	381.8	5.94
1	4161	il1vitro	T	7	376.1	5.93
1	4161	il1vitro	T	10	396.6	5.98
1	4161	il1vitro	T	14	374.7	5.93
1	4161	il1vitro	T	17	381.9	5.95
1	4161	il1vitro	T	21	378.6	5.94
1	4161	il2serum	T	3	27.4	3.31
1	4161	il2serum	T	7	29.9	3.40
1	4161	il2serum	T	10	27.4	3.31
1	4161	il2serum	T	14	25.2	3.23
1	4161	il2serum	T	17	26.2	3.27
1	4161	il2serum	T	21	26.2	3.27
1	4161	il2vitro	T	3	161.4	5.08
1	4161	il2vitro	T	7	132.9	4.89
1	4161	il2vitro	T	10	138.6	4.93
1	4161	il2vitro	T	14	187.1	5.23
1	4161	il2vitro	T	17	128.2	4.85

1	4161	il2vitro	T	21	239.5	5.48
1	4161	phg	T	3	2884.0	7.97
1	4161	phg	T	7	988.0	6.90
1	4161	phg	T	10	71.0	4.26
1	4161	phg	T	14	165.0	5.11
1	4161	phg	T	17	4752.0	8.47
1	4161	phg	T	21	11710.0	9.37
1	4161	pwm	T	3	5254.0	8.57
1	4161	pwm	T	7	2373.0	7.77
1	4161	pwm	T	10	6972.0	8.85
1	4161	pwm	T	14	847.0	6.74
1	4161	pwm	T	17	6263.0	8.74
1	4161	pwm	T	21	5262.0	8.57
1	4161	staph	T	3	1450.0	7.28
1	4161	staph	T	7	903.0	6.81
1	4161	staph	T	10	2697.0	7.90
1	4161	staph	T	14	122.0	4.80
1	4161	staph	T	17	2733.0	7.91
1	4161	staph	T	21	3662.0	8.21
1	4192	chem	T	3	6045.0	8.71
1	4192	chem	T	7	6362.0	8.76
1	4192	chem	T	10	13451.0	9.51
1	4192	chem	T	14	12016.0	9.39
1	4192	chem	T	17	13788.0	9.53
1	4192	chem	T	21	22905.0	10.04
1	4192	cona	T	3	331.0	5.80
1	4192	cona	T	7	347.0	5.85
1	4192	cona	T	10	832.0	6.72
1	4192	cona	T	14	552.0	6.31
1	4192	cona	T	17	2159.0	7.68
1	4192	cona	T	21	10851.0	9.29
1	4192	cortisol	T	3	2.8	1.02
1	4192	cortisol	T	7	3.0	1.10
1	4192	cortisol	T	10	7.1	1.96
1	4192	cortisol	T	14	2.4	0.88
1	4192	cortisol	T	17	5.2	1.65
1	4192	cortisol	T	21	0.9	-0.11
1	4192	igaserum	T	3	2.2	0.79
1	4192	igaserum	T	7	1.6	0.47
1	4192	igaserum	T	10	1.4	0.34
1	4192	igaserum	T	14	1.1	0.10
1	4192	igaserum	T	17	0.5	-0.69
1	4192	igaserum	T	21	1.3	0.26
1	4192	iggserum	T	3	3.9	1.36
1	4192	iggserum	T	7	3.7	1.31
1	4192	iggserum	T	10	2.6	0.96
1	4192	iggserum	T	14	3.4	1.22
1	4192	iggserum	T	17	2.7	0.99
1	4192	iggserum	T	21	3.6	1.28
1	4192	igvitro	T	3	59.0	4.08
1	4192	igvitro	T	7	221.0	5.40
1	4192	igvitro	T	10	76.0	4.33
1	4192	igvitro	T	14	48.0	3.87
1	4192	igvitro	T	17	50.0	3.91
1	4192	igvitro	T	21	40.0	3.69
1	4192	il1serum	T	3	9.2	2.22
1	4192	il1serum	T	7	5.8	1.75
1	4192	il1serum	T	10	6.2	1.83
1	4192	il1serum	T	14	13.1	2.57
1	4192	il1serum	T	17	11.9	2.48
1	4192	il1serum	T	21	5.7	1.74
1	4192	il1vitro	T	3	368.1	5.91
1	4192	il1vitro	T	7	357.9	5.88
1	4192	il1vitro	T	10	379.4	5.94
1	4192	il1vitro	T	14	361.7	5.89
1	4192	il1vitro	T	17	341.9	5.83
1	4192	il1vitro	T	21	348.9	5.85
1	4192	il2serum	T	3	16.8	2.82
1	4192	il2serum	T	7	19.0	2.94
1	4192	il2serum	T	10	16.0	2.78
1	4192	il2serum	T	14	14.1	2.65
1	4192	il2serum	T	17	13.1	2.57
1	4192	il2serum	T	21	15.0	2.71
1	4192	il2vitro	T	3	238.4	5.47
1	4192	il2vitro	T	7	224.0	5.41
1	4192	il2vitro	T	10	183.2	5.21
1	4192	il2vitro	T	14	126.4	4.84
1	4192	il2vitro	T	17	270.5	5.60
1	4192	il2vitro	T	21	138.3	4.93
1	4192	phg	T	3	3158.0	8.06
1	4192	phg	T	7	1521.0	7.33
1	4192	phg	T	10	6611.0	8.80
1	4192	phg	T	14	3612.0	8.19
1	4192	phg	T	17	7848.0	8.97
1	4192	phg	T	21	9546.0	9.16
1	4192	pwm	T	3	7052.0	8.86
1	4192	pwm	T	7	2222.0	7.71
1	4192	pwm	T	10	609.0	6.41
1	4192	pwm	T	14	998.0	6.91
1	4192	pwm	T	17	7851.0	8.97
1	4192	pwm	T	21	6423.0	8.77
1	4192	staph	T	3	4259.0	8.36
1	4192	staph	T	7	1098.0	7.00
1	4192	staph	T	10	540.0	6.29
1	4192	staph	T	14	105.0	4.65
1	4192	staph	T	17	7264.0	8.89
1	4192	staph	T	21	970.0	6.88
1	4212	chem	C	3	8155.0	9.01
1	4212	chem	C	7	8589.0	9.06
1	4212	chem	C	10	18425.0	9.82
1	4212	chem	C	14	9349.0	9.14
1	4212	chem	C	17	18159.0	9.81
1	4212	chem	C	21	22582.0	10.02
1	4212	cona	C	3	195.0	5.27

1	4212	cona	C	7	176.0	5.17
1	4212	cona	C	10	988.0	6.90
1	4212	cona	C	14	77.0	4.34
1	4212	cona	C	17	632.0	6.45
1	4212	cona	C	21	10253.0	9.24
1	4212	cortisol	C	3	11.1	2.41
1	4212	cortisol	C	7	9.9	2.29
1	4212	cortisol	C	10	10.0	2.30
1	4212	cortisol	C	14	2.2	0.79
1	4212	cortisol	C	17	5.4	1.69
1	4212	cortisol	C	21	5.2	1.64
1	4212	igaserum	C	3	1.5	0.41
1	4212	igaserum	C	7	1.6	0.47
1	4212	igaserum	C	10	1.3	0.26
1	4212	igaserum	C	14	0.5	-0.69
1	4212	igaserum	C	17	0.9	-0.11
1	4212	igaserum	C	21	1.3	0.26
1	4212	iggserum	C	3	11.5	2.44
1	4212	iggserum	C	7	10.7	2.37
1	4212	iggserum	C	10	9.6	2.26
1	4212	iggserum	C	14	10.3	2.33
1	4212	iggserum	C	17	10.6	2.36
1	4212	iggserum	C	21	10.8	2.38
1	4212	igvitro	C	3	134.0	4.90
1	4212	igvitro	C	7	62.0	4.13
1	4212	igvitro	C	10	58.0	4.06
1	4212	igvitro	C	14	41.0	3.71
1	4212	igvitro	C	17	49.0	3.89
1	4212	igvitro	C	21	44.0	3.78
1	4212	il1serum	C	3	11.4	2.44
1	4212	il1serum	C	7	8.8	2.17
1	4212	il1serum	C	10	5.9	1.77
1	4212	il1serum	C	14	4.3	1.46
1	4212	il1serum	C	17	6.4	1.85
1	4212	il1serum	C	21	8.9	2.18
1	4212	il1vitro	C	3	359.8	5.89
1	4212	il1vitro	C	7	321.7	5.77
1	4212	il1vitro	C	10	322.8	5.78
1	4212	il1vitro	C	14	403.6	6.00
1	4212	il1vitro	C	17	325.3	5.78
1	4212	il1vitro	C	21	412.8	6.02
1	4212	il2serum	C	3	15.1	2.72
1	4212	il2serum	C	7	11.6	2.45
1	4212	il2serum	C	10	12.2	2.50
1	4212	il2serum	C	14	16.3	2.79
1	4212	il2serum	C	17	13.9	2.63
1	4212	il2serum	C	21	14.8	2.69
1	4212	il2vitro	C	3	86.4	4.46
1	4212	il2vitro	C	7	85.0	4.44
1	4212	il2vitro	C	10	296.8	5.69
1	4212	il2vitro	C	14	217.8	5.38
1	4212	il2vitro	C	17	426.4	6.06
1	4212	il2vitro	C	21	225.8	5.42
1	4212	phg	C	3	5966.0	8.69
1	4212	phg	C	7	1531.0	7.33
1	4212	phg	C	10	14232.0	9.56
1	4212	phg	C	14	204.0	5.32
1	4212	phg	C	17	4851.0	8.49
1	4212	phg	C	21	8229.0	9.02
1	4212	pwm	C	3	4478.0	8.41
1	4212	pwm	C	7	1183.0	7.08
1	4212	pwm	C	10	54.0	3.99
1	4212	pwm	C	14	80.0	4.38
1	4212	pwm	C	17	6509.0	8.78
1	4212	pwm	C	21	10586.0	9.27
1	4212	staph	C	3	2508.0	7.83
1	4212	staph	C	7	245.0	5.50
1	4212	staph	C	10	67.0	4.20
1	4212	staph	C	14	61.0	4.11
1	4212	staph	C	17	2489.0	7.82
1	4212	staph	C	21	5601.0	8.63
1	4230	chem	C	3	4799.0	8.48
1	4230	chem	C	7	6476.0	8.78
1	4230	chem	C	10	18098.0	9.80
1	4230	chem	C	14	7236.0	8.89
1	4230	chem	C	17	19690.0	9.89
1	4230	chem	C	21	22329.0	10.01
1	4230	cona	C	3	188.0	5.24
1	4230	cona	C	7	263.0	5.57
1	4230	cona	C	10	1127.0	7.03
1	4230	cona	C	14	324.0	5.78
1	4230	cona	C	17	1065.0	6.97
1	4230	cona	C	21	3357.0	8.12
1	4230	cortisol	C	3	7.2	1.97
1	4230	cortisol	C	7	1.9	0.64
1	4230	cortisol	C	10	1.2	0.14
1	4230	cortisol	C	14	3.5	1.24
1	4230	cortisol	C	17	7.5	2.01
1	4230	cortisol	C	21	1.7	0.53
1	4230	igaserum	C	3	0.3	-1.35
1	4230	igaserum	C	7	0.2	-1.90
1	4230	igaserum	C	10	0.2	-1.66
1	4230	igaserum	C	14	0.4	-0.94
1	4230	igaserum	C	17	0.2	-1.77
1	4230	igaserum	C	21	0.2	-1.66
1	4230	iggserum	C	3	5.8	1.76
1	4230	iggserum	C	7	4.6	1.53
1	4230	iggserum	C	10	4.8	1.57
1	4230	iggserum	C	14	1.9	0.64
1	4230	iggserum	C	17	4.2	1.44
1	4230	iggserum	C	21	3.7	1.31
1	4230	igvitro	C	3	129.0	4.86
1	4230	igvitro	C	7	138.0	4.93
1	4230	igvitro	C	10	68.0	4.22

1	4230	igvitro	C	14	92.0	4.52
1	4230	igvitro	C	17	88.0	4.48
1	4230	igvitro	C	21	60.0	4.09
1	4230	il1serum	C	3	8.6	2.15
1	4230	il1serum	C	7	4.3	1.46
1	4230	il1serum	C	10	3.6	1.27
1	4230	il1serum	C	14	4.7	1.54
1	4230	il1serum	C	17	6.9	1.94
1	4230	il1serum	C	21	5.9	1.77
1	4230	il1vitro	C	3	407.2	6.01
1	4230	il1vitro	C	7	355.4	5.87
1	4230	il1vitro	C	10	371.6	5.92
1	4230	il1vitro	C	14	373.9	5.92
1	4230	il1vitro	C	17	361.2	5.89
1	4230	il1vitro	C	21	377.7	5.93
1	4230	il2serum	C	3	26.9	3.29
1	4230	il2serum	C	7	26.9	3.29
1	4230	il2serum	C	10	31.4	3.45
1	4230	il2serum	C	14	30.3	3.41
1	4230	il2serum	C	17	26.0	3.26
1	4230	il2serum	C	21	24.1	3.18
1	4230	il2vitro	C	3	270.8	5.60
1	4230	il2vitro	C	7	215.7	5.37
1	4230	il2vitro	C	10	105.2	4.66
1	4230	il2vitro	C	14	166.2	5.11
1	4230	il2vitro	C	17	283.3	5.65
1	4230	il2vitro	C	21	85.0	4.44
1	4230	phg	C	3	3642.0	8.20
1	4230	phg	C	7	349.0	5.86
1	4230	phg	C	10	62.0	4.13
1	4230	phg	C	14	100.0	4.61
1	4230	phg	C	17	5047.0	8.53
1	4230	phg	C	21	4211.0	8.35
1	4230	pwm	C	3	4838.0	8.48
1	4230	pwm	C	7	2072.0	7.64
1	4230	pwm	C	10	2963.0	7.99
1	4230	pwm	C	14	2373.0	7.77
1	4230	pwm	C	17	8027.0	8.99
1	4230	pwm	C	21	8008.0	8.99
1	4230	staph	C	3	2935.0	7.98
1	4230	staph	C	7	947.0	6.85
1	4230	staph	C	10	1456.0	7.28
1	4230	staph	C	14	535.0	6.28
1	4230	staph	C	17	5392.0	8.59
1	4230	staph	C	21	4617.0	8.44
2	3861	chem	T	3	4519.0	8.42
2	3861	chem	T	7	19962.0	9.90
2	3861	chem	T	10	33440.0	10.42
2	3861	chem	T	14	15034.0	9.62
2	3861	chem	T	17	12553.0	9.44
2	3861	chem	T	21	5717.0	8.65
2	3861	cona	T	3	5513.0	8.61
2	3861	cona	T	7	6558.0	8.79
2	3861	cona	T	10	9984.0	9.21
2	3861	cona	T	14	2011.0	7.61
2	3861	cona	T	17	10636.0	9.27
2	3861	cona	T	21	13458.0	9.51
2	3861	cortisol	T	3	17.7	2.87
2	3861	cortisol	T	7	3.1	1.13
2	3861	cortisol	T	10	10.5	2.35
2	3861	cortisol	T	14	1.1	0.05
2	3861	cortisol	T	17	19.5	2.97
2	3861	cortisol	T	21	14.0	2.64
2	3861	igaserum	T	3	0.7	-0.39
2	3861	igaserum	T	7	0.7	-0.39
2	3861	igaserum	T	10	0.7	-0.43
2	3861	igaserum	T	14	0.6	-0.45
2	3861	igaserum	T	17	0.7	-0.34
2	3861	igaserum	T	21	0.6	-0.51
2	3861	iggserum	T	3	15.4	2.73
2	3861	iggserum	T	7	13.2	2.58
2	3861	iggserum	T	10	16.1	2.78
2	3861	iggserum	T	14	13.5	2.60
2	3861	iggserum	T	17	12.0	2.48
2	3861	iggserum	T	21	15.2	2.72
2	3861	igvitro	T	3	40.0	3.69
2	3861	igvitro	T	7	49.0	3.89
2	3861	igvitro	T	10	30.0	3.40
2	3861	igvitro	T	14	37.0	3.61
2	3861	igvitro	T	17	53.0	3.97
2	3861	igvitro	T	21	39.0	3.66
2	3861	il1serum	T	3	6.2	1.82
2	3861	il1serum	T	7	9.6	2.27
2	3861	il1serum	T	10	49.2	3.90
2	3861	il1serum	T	14	73.9	4.30
2	3861	il1serum	T	17	13.0	2.57
2	3861	il1serum	T	21	69.9	4.25
2	3861	il1vitro	T	3	362.4	5.89
2	3861	il1vitro	T	7	343.0	5.84
2	3861	il1vitro	T	10	344.3	5.84
2	3861	il1vitro	T	14	347.5	5.85
2	3861	il1vitro	T	17	406.9	6.01
2	3861	il1vitro	T	21	360.1	5.89
2	3861	il2serum	T	3	24.1	3.18
2	3861	il2serum	T	7	18.3	2.91
2	3861	il2serum	T	10	12.6	2.53
2	3861	il2serum	T	14	11.3	2.42
2	3861	il2serum	T	17	14.3	2.66
2	3861	il2serum	T	21	10.3	2.33
2	3861	il2vitro	T	3	221.9	5.40
2	3861	il2vitro	T	7	264.4	5.58
2	3861	il2vitro	T	10	171.4	5.14
2	3861	il2vitro	T	14	102.9	4.63
2	3861	il2vitro	T	17	250.5	5.52

2	3861	il2vitro	T	21	134.0	4.90
2	3861	phg	T	3	6178.0	8.73
2	3861	phg	T	7	6890.0	8.84
2	3861	phg	T	10	8829.0	9.09
2	3861	phg	T	14	6502.0	8.78
2	3861	phg	T	17	12894.0	9.46
2	3861	phg	T	21	13835.0	9.53
2	3861	pwm	T	3	11375.0	9.34
2	3861	pwm	T	7	14812.0	9.60
2	3861	pwm	T	10	16023.0	9.68
2	3861	pwm	T	14	8664.0	9.07
2	3861	pwm	T	17	17634.0	9.78
2	3861	pwm	T	21	19356.0	9.87
2	3861	staph	T	3	3369.0	8.12
2	3861	staph	T	7	4288.0	8.36
2	3861	staph	T	10	4634.0	8.44
2	3861	staph	T	14	1288.0	7.16
2	3861	staph	T	17	6815.0	8.83
2	3861	staph	T	21	5437.0	8.60
2	4052	chem	C	3	29018.0	10.28
2	4052	chem	C	7	14702.0	9.60
2	4052	chem	C	10	70098.0	11.16
2	4052	chem	C	14	28327.0	10.25
2	4052	chem	C	17	37604.0	10.53
2	4052	chem	C	21	19694.0	9.89
2	4052	cona	C	3	7673.0	8.95
2	4052	cona	C	7	7908.0	8.98
2	4052	cona	C	10	6734.0	8.81
2	4052	cona	C	14	4274.0	8.36
2	4052	cona	C	17	12213.0	9.41
2	4052	cona	C	21	3748.0	8.23
2	4052	cortisol	C	3	8.8	2.17
2	4052	cortisol	C	7	5.0	1.61
2	4052	cortisol	C	10	14.7	2.69
2	4052	cortisol	C	14	2.3	0.81
2	4052	cortisol	C	17	13.6	2.61
2	4052	cortisol	C	21	1.6	0.44
2	4052	igaserum	C	3	0.3	-1.27
2	4052	igaserum	C	7	0.3	-1.31
2	4052	igaserum	C	10	0.3	-1.24
2	4052	igaserum	C	14	0.2	-1.51
2	4052	igaserum	C	17	0.3	-1.20
2	4052	igaserum	C	21	0.3	-1.39
2	4052	iggserum	C	3	11.5	2.44
2	4052	iggserum	C	7	11.3	2.42
2	4052	iggserum	C	10	11.1	2.41
2	4052	iggserum	C	14	11.2	2.42
2	4052	iggserum	C	17	11.0	2.40
2	4052	iggserum	C	21	11.6	2.45
2	4052	igvitro	C	3	62.0	4.13
2	4052	igvitro	C	7	66.0	4.19
2	4052	igvitro	C	10	52.0	3.95
2	4052	igvitro	C	14	72.0	4.28
2	4052	igvitro	C	17	82.0	4.41
2	4052	igvitro	C	21	73.0	4.29
2	4052	il1serum	C	3	26.2	3.27
2	4052	il1serum	C	7	9.8	2.28
2	4052	il1serum	C	10	17.7	2.87
2	4052	il1serum	C	14	7.5	2.02
2	4052	il1serum	C	17	7.4	2.01
2	4052	il1serum	C	21	19.9	2.99
2	4052	il1vitro	C	3	355.7	5.87
2	4052	il1vitro	C	7	350.5	5.86
2	4052	il1vitro	C	10	338.3	5.82
2	4052	il1vitro	C	14	313.4	5.75
2	4052	il1vitro	C	17	347.1	5.85
2	4052	il1vitro	C	21	343.4	5.84
2	4052	il2serum	C	3	16.6	2.81
2	4052	il2serum	C	7	22.6	3.12
2	4052	il2serum	C	10	17.3	2.85
2	4052	il2serum	C	14	23.1	3.14
2	4052	il2serum	C	17	17.8	2.88
2	4052	il2serum	C	21	15.6	2.75
2	4052	il2vitro	C	3	254.7	5.54
2	4052	il2vitro	C	7	238.7	5.48
2	4052	il2vitro	C	10	172.7	5.15
2	4052	il2vitro	C	14	117.8	4.77
2	4052	il2vitro	C	17	189.7	5.25
2	4052	il2vitro	C	21	217.4	5.38
2	4052	phg	C	3	5857.0	8.68
2	4052	phg	C	7	10111.0	9.22
2	4052	phg	C	10	10893.0	9.30
2	4052	phg	C	14	4527.0	8.42
2	4052	phg	C	17	12941.0	9.47
2	4052	phg	C	21	8172.0	9.01
2	4052	pwm	C	3	10935.0	9.30
2	4052	pwm	C	7	18883.0	9.85
2	4052	pwm	C	10	20309.0	9.92
2	4052	pwm	C	14	14110.0	9.55
2	4052	pwm	C	17	15494.0	9.65
2	4052	pwm	C	21	12915.0	9.47
2	4052	staph	C	3	6048.0	8.71
2	4052	staph	C	7	10060.0	9.22
2	4052	staph	C	10	8175.0	9.01
2	4052	staph	C	14	6269.0	8.74
2	4052	staph	C	17	8087.0	9.00
2	4052	staph	C	21	7509.0	8.92
2	4078	chem	C	3	7000.0	8.85
2	4078	chem	C	7	21506.0	9.98
2	4078	chem	C	10	68673.0	11.14
2	4078	chem	C	14	12070.0	9.40
2	4078	chem	C	17	38427.0	10.56
2	4078	chem	C	21	42885.0	10.67
2	4078	cona	C	3	9132.0	9.12

2	4078	cona	C	7	14348.0	9.57
2	4078	cona	C	10	7107.0	8.87
2	4078	cona	C	14	5323.0	8.58
2	4078	cona	C	17	8355.0	9.03
2	4078	cona	C	21	4901.0	8.50
2	4078	cortisol	C	3	12.0	2.48
2	4078	cortisol	C	7	17.6	2.87
2	4078	cortisol	C	10	7.5	2.01
2	4078	cortisol	C	14	2.5	0.90
2	4078	cortisol	C	17	9.2	2.21
2	4078	cortisol	C	21	3.1	1.13
2	4078	igaserum	C	3	0.3	-1.20
2	4078	igaserum	C	7	0.5	-0.80
2	4078	igaserum	C	10	0.3	-1.08
2	4078	igaserum	C	14	0.4	-0.99
2	4078	igaserum	C	17	0.3	-1.14
2	4078	igaserum	C	21	0.4	-0.97
2	4078	iggserum	C	3	12.3	2.51
2	4078	iggserum	C	7	12.4	2.52
2	4078	iggserum	C	10	12.6	2.53
2	4078	iggserum	C	14	11.3	2.42
2	4078	iggserum	C	17	11.1	2.41
2	4078	iggserum	C	21	11.0	2.40
2	4078	igvitro	C	3	27.0	3.30
2	4078	igvitro	C	7	23.0	3.14
2	4078	igvitro	C	10	17.0	2.83
2	4078	igvitro	C	14	26.0	3.26
2	4078	igvitro	C	17	31.0	3.43
2	4078	igvitro	C	21	25.0	3.22
2	4078	il1serum	C	3	3.6	1.29
2	4078	il1serum	C	7	4.5	1.51
2	4078	il1serum	C	10	5.7	1.74
2	4078	il1serum	C	14	9.5	2.25
2	4078	il1serum	C	17	9.2	2.22
2	4078	il1serum	C	21	12.2	2.50
2	4078	il1vitro	C	3	552.5	6.31
2	4078	il1vitro	C	7	368.3	5.91
2	4078	il1vitro	C	10	342.2	5.84
2	4078	il1vitro	C	14	372.8	5.92
2	4078	il1vitro	C	17	335.9	5.82
2	4078	il1vitro	C	21	324.5	5.78
2	4078	il2serum	C	3	26.2	3.27
2	4078	il2serum	C	7	25.8	3.25
2	4078	il2serum	C	10	20.1	3.00
2	4078	il2serum	C	14	25.7	3.25
2	4078	il2serum	C	17	20.5	3.02
2	4078	il2serum	C	21	19.2	2.96
2	4078	il2vitro	C	3	164.3	5.10
2	4078	il2vitro	C	7	187.9	5.24
2	4078	il2vitro	C	10	140.3	4.94
2	4078	il2vitro	C	14	236.3	5.47
2	4078	il2vitro	C	17	149.8	5.01
2	4078	il2vitro	C	21	191.4	5.25
2	4078	phg	C	3	5344.0	8.58
2	4078	phg	C	7	11942.0	9.39
2	4078	phg	C	10	10576.0	9.27
2	4078	phg	C	14	9144.0	9.12
2	4078	phg	C	17	11072.0	9.31
2	4078	phg	C	21	7567.0	8.93
2	4078	pwm	C	3	13404.0	9.50
2	4078	pwm	C	7	24482.0	10.11
2	4078	pwm	C	10	22105.0	10.00
2	4078	pwm	C	14	12253.0	9.41
2	4078	pwm	C	17	17050.0	9.74
2	4078	pwm	C	21	13485.0	9.51
2	4078	staph	C	3	2985.0	8.00
2	4078	staph	C	7	6546.0	8.79
2	4078	staph	C	10	2255.0	7.72
2	4078	staph	C	14	1196.0	7.09
2	4078	staph	C	17	6438.0	8.77
2	4078	staph	C	21	4337.0	8.37
2	4084	chem	T	3	21727.0	9.99
2	4084	chem	T	7	13174.0	9.49
2	4084	chem	T	10	51741.0	10.85
2	4084	chem	T	14	17193.0	9.75
2	4084	chem	T	17	15392.0	9.64
2	4084	chem	T	21	13783.0	9.53
2	4084	cona	T	3	15935.0	9.68
2	4084	cona	T	7	11367.0	9.34
2	4084	cona	T	10	47458.0	10.77
2	4084	cona	T	14	5670.0	8.64
2	4084	cona	T	17	7269.0	8.89
2	4084	cona	T	21	3605.0	8.19
2	4084	cortisol	T	3	4.9	1.59
2	4084	cortisol	T	7	7.7	2.03
2	4084	cortisol	T	10	15.2	2.72
2	4084	cortisol	T	14	4.6	1.52
2	4084	cortisol	T	17	4.9	1.58
2	4084	cortisol	T	21	7.7	2.03
2	4084	igaserum	T	3	0.7	-0.33
2	4084	igaserum	T	7	0.7	-0.30
2	4084	igaserum	T	10	0.8	-0.29
2	4084	igaserum	T	14	0.8	-0.25
2	4084	igaserum	T	17	0.8	-0.26
2	4084	igaserum	T	21	0.8	-0.24
2	4084	iggserum	T	3	10.4	2.34
2	4084	iggserum	T	7	10.2	2.32
2	4084	iggserum	T	10	10.4	2.34
2	4084	iggserum	T	14	10.1	2.31
2	4084	iggserum	T	17	10.1	2.31
2	4084	iggserum	T	21	11.7	2.46
2	4084	igvitro	T	3	59.0	4.08
2	4084	igvitro	T	7	44.0	3.78
2	4084	igvitro	T	10	39.0	3.66

2	4084	igvitro	T	14	32.0	3.47
2	4084	igvitro	T	17	29.0	3.37
2	4084	igvitro	T	21	36.0	3.58
2	4084	il1serum	T	3	6.3	1.84
2	4084	il1serum	T	7	9.0	2.20
2	4084	il1serum	T	10	11.2	2.42
2	4084	il1serum	T	14	20.5	3.02
2	4084	il1serum	T	17	33.3	3.51
2	4084	il1serum	T	21	17.6	2.87
2	4084	il1vitro	T	3	332.5	5.81
2	4084	il1vitro	T	7	322.1	5.77
2	4084	il1vitro	T	10	346.9	5.85
2	4084	il1vitro	T	14	311.9	5.74
2	4084	il1vitro	T	17	342.8	5.84
2	4084	il1vitro	T	21	340.5	5.83
2	4084	il2serum	T	3	21.9	3.08
2	4084	il2serum	T	7	18.8	2.93
2	4084	il2serum	T	10	18.1	2.90
2	4084	il2serum	T	14	14.0	2.64
2	4084	il2serum	T	17	13.8	2.62
2	4084	il2serum	T	21	15.8	2.76
2	4084	il2vitro	T	3	257.8	5.55
2	4084	il2vitro	T	7	180.7	5.20
2	4084	il2vitro	T	10	114.8	4.74
2	4084	il2vitro	T	14	153.9	5.04
2	4084	il2vitro	T	17	216.8	5.38
2	4084	il2vitro	T	21	157.0	5.06
2	4084	phg	T	3	8248.0	9.02
2	4084	phg	T	7	9655.0	9.18
2	4084	phg	T	10	27880.0	10.24
2	4084	phg	T	14	9383.0	9.15
2	4084	phg	T	17	9027.0	9.11
2	4084	phg	T	21	5890.0	8.68
2	4084	pwm	T	3	15220.0	9.63
2	4084	pwm	T	7	22824.0	10.04
2	4084	pwm	T	10	46719.0	10.75
2	4084	pwm	T	14	18579.0	9.83
2	4084	pwm	T	17	17182.0	9.75
2	4084	pwm	T	21	13521.0	9.51
2	4084	staph	T	3	5274.0	8.57
2	4084	staph	T	7	7810.0	8.96
2	4084	staph	T	10	11157.0	9.32
2	4084	staph	T	14	4336.0	8.37
2	4084	staph	T	17	3847.0	8.26
2	4084	staph	T	21	3364.0	8.12
2	4239	chem	C	3	14272.0	9.57
2	4239	chem	C	7	20413.0	9.92
2	4239	chem	C	10	61180.0	11.02
2	4239	chem	C	14	9796.0	9.19
2	4239	chem	C	17	18703.0	9.84
2	4239	chem	C	21	9599.0	9.17
2	4239	cona	C	3	6602.0	8.80
2	4239	cona	C	7	22202.0	10.01
2	4239	cona	C	10	18564.0	9.83
2	4239	cona	C	14	11247.0	9.33
2	4239	cona	C	17	20354.0	9.92
2	4239	cona	C	21	8790.0	9.08
2	4239	cortisol	C	3	2.9	1.06
2	4239	cortisol	C	7	1.8	0.56
2	4239	cortisol	C	10	4.4	1.48
2	4239	cortisol	C	14	6.0	1.78
2	4239	cortisol	C	17	6.0	1.78
2	4239	cortisol	C	21	0.9	-0.11
2	4239	igaserum	C	3	0.7	-0.39
2	4239	igaserum	C	7	0.6	-0.45
2	4239	igaserum	C	10	0.6	-0.48
2	4239	igaserum	C	14	0.6	-0.48
2	4239	igaserum	C	17	0.7	-0.40
2	4239	igaserum	C	21	0.6	-0.45
2	4239	iggserum	C	3	10.0	2.30
2	4239	iggserum	C	7	10.4	2.34
2	4239	iggserum	C	10	13.7	2.62
2	4239	iggserum	C	14	10.1	2.31
2	4239	iggserum	C	17	10.1	2.31
2	4239	iggserum	C	21	10.0	2.30
2	4239	igvitro	C	3	156.0	5.05
2	4239	igvitro	C	7	236.0	5.46
2	4239	igvitro	C	10	168.0	5.12
2	4239	igvitro	C	14	105.0	4.65
2	4239	igvitro	C	17	121.0	4.80
2	4239	igvitro	C	21	149.0	5.00
2	4239	il1serum	C	3	22.3	3.10
2	4239	il1serum	C	7	14.0	2.64
2	4239	il1serum	C	10	36.3	3.59
2	4239	il1serum	C	14	33.2	3.50
2	4239	il1serum	C	17	28.9	3.37
2	4239	il1serum	C	21	10.8	2.38
2	4239	il1vitro	C	3	306.7	5.73
2	4239	il1vitro	C	7	312.6	5.74
2	4239	il1vitro	C	10	350.3	5.86
2	4239	il1vitro	C	14	296.5	5.69
2	4239	il1vitro	C	17	320.7	5.77
2	4239	il1vitro	C	21	323.1	5.78
2	4239	il2serum	C	3	16.2	2.79
2	4239	il2serum	C	7	14.7	2.69
2	4239	il2serum	C	10	15.6	2.75
2	4239	il2serum	C	14	11.9	2.48
2	4239	il2serum	C	17	14.6	2.68
2	4239	il2serum	C	21	14.1	2.65
2	4239	il2vitro	C	3	175.6	5.17
2	4239	il2vitro	C	7	190.0	5.25
2	4239	il2vitro	C	10	158.6	5.07
2	4239	il2vitro	C	14	230.1	5.44
2	4239	il2vitro	C	17	207.7	5.34

2	4239	il2vitro	C	21	145.0	4.98
2	4239	phg	C	3	8822.0	9.09
2	4239	phg	C	7	16536.0	9.71
2	4239	phg	C	10	17010.0	9.74
2	4239	phg	C	14	10848.0	9.29
2	4239	phg	C	17	16117.0	9.69
2	4239	phg	C	21	11683.0	9.37
2	4239	pwm	C	3	13984.0	9.55
2	4239	pwm	C	7	23291.0	10.06
2	4239	pwm	C	10	23034.0	10.04
2	4239	pwm	C	14	14078.0	9.55
2	4239	pwm	C	17	28155.0	10.25
2	4239	pwm	C	21	15118.0	9.62
2	4239	staph	C	3	5108.0	8.54
2	4239	staph	C	7	10912.0	9.30
2	4239	staph	C	10	7306.0	8.90
2	4239	staph	C	14	4514.0	8.41
2	4239	staph	C	17	7200.0	8.88
2	4239	staph	C	21	7116.0	8.87
2	4243	chem	T	3	23713.0	10.07
2	4243	chem	T	7	43609.0	10.68
2	4243	chem	T	10	94827.0	11.46
2	4243	chem	T	14	24517.0	10.11
2	4243	chem	T	17	26063.0	10.17
2	4243	chem	T	21	15292.0	9.64
2	4243	cona	T	3	22038.0	10.00
2	4243	cona	T	7	26920.0	10.20
2	4243	cona	T	10	44871.0	10.71
2	4243	cona	T	14	18498.0	9.83
2	4243	cona	T	17	14519.0	9.58
2	4243	cona	T	21	9684.0	9.18
2	4243	cortisol	T	3	2.4	0.88
2	4243	cortisol	T	7	1.2	0.18
2	4243	cortisol	T	10	11.0	2.39
2	4243	cortisol	T	14	1.9	0.62
2	4243	cortisol	T	17	0.7	-0.36
2	4243	cortisol	T	21	4.1	1.40
2	4243	igaserum	T	3	0.6	-0.49
2	4243	igaserum	T	7	0.7	-0.36
2	4243	igaserum	T	10	0.8	-0.22
2	4243	igaserum	T	14	0.7	-0.33
2	4243	igaserum	T	17	0.7	-0.30
2	4243	igaserum	T	21	0.7	-0.34
2	4243	iggserum	T	3	13.5	2.60
2	4243	iggserum	T	7	10.5	2.35
2	4243	iggserum	T	10	15.0	2.71
2	4243	iggserum	T	14	11.4	2.43
2	4243	iggserum	T	17	10.2	2.32
2	4243	iggserum	T	21	8.1	2.09
2	4243	igvitro	T	3	141.0	4.95
2	4243	igvitro	T	7	122.0	4.80
2	4243	igvitro	T	10	99.0	4.60
2	4243	igvitro	T	14	141.0	4.95
2	4243	igvitro	T	17	128.0	4.85
2	4243	igvitro	T	21	130.0	4.87
2	4243	il1serum	T	3	2.8	1.03
2	4243	il1serum	T	7	6.2	1.82
2	4243	il1serum	T	10	24.8	3.21
2	4243	il1serum	T	14	16.2	2.79
2	4243	il1serum	T	17	11.3	2.43
2	4243	il1serum	T	21	10.0	2.30
2	4243	il1vitro	T	3	371.5	5.92
2	4243	il1vitro	T	7	355.8	5.87
2	4243	il1vitro	T	10	359.3	5.88
2	4243	il1vitro	T	14	335.3	5.81
2	4243	il1vitro	T	17	367.3	5.91
2	4243	il1vitro	T	21	362.1	5.89
2	4243	il2serum	T	3	24.3	3.19
2	4243	il2serum	T	7	20.9	3.04
2	4243	il2serum	T	10	21.0	3.04
2	4243	il2serum	T	14	14.7	2.68
2	4243	il2serum	T	17	25.8	3.25
2	4243	il2serum	T	21	23.4	3.15
2	4243	il2vitro	T	3	309.5	5.74
2	4243	il2vitro	T	7	177.1	5.18
2	4243	il2vitro	T	10	259.5	5.56
2	4243	il2vitro	T	14	130.1	4.87
2	4243	il2vitro	T	17	146.0	4.98
2	4243	il2vitro	T	21	258.7	5.56
2	4243	phg	T	3	20944.0	9.95
2	4243	phg	T	7	23420.0	10.06
2	4243	phg	T	10	36166.0	10.50
2	4243	phg	T	14	21263.0	9.96
2	4243	phg	T	17	20480.0	9.93
2	4243	phg	T	21	17443.0	9.77
2	4243	pwm	T	3	9360.0	9.14
2	4243	pwm	T	7	24022.0	10.09
2	4243	pwm	T	10	23893.0	10.08
2	4243	pwm	T	14	17361.0	9.76
2	4243	pwm	T	17	22608.0	10.03
2	4243	pwm	T	21	16373.0	9.70
2	4243	staph	T	3	2524.0	7.83
2	4243	staph	T	7	7388.0	8.91
2	4243	staph	T	10	4573.0	8.43
2	4243	staph	T	14	3519.0	8.17
2	4243	staph	T	17	5791.0	8.66
2	4243	staph	T	21	5430.0	8.60
2	4246	chem	C	3	6056.0	8.71
2	4246	chem	C	7	8017.0	8.99
2	4246	chem	C	10	34536.0	10.45
2	4246	chem	C	14	4859.0	8.49
2	4246	chem	C	17	21245.0	9.96
2	4246	chem	C	21	4667.0	8.45
2	4246	cona	C	3	3340.0	8.11

2	4246	cona	C	7	14532.0	9.58
2	4246	cona	C	10	8959.0	9.10
2	4246	cona	C	14	7088.0	8.87
2	4246	cona	C	17	8886.0	9.09
2	4246	cona	C	21	3795.0	8.24
2	4246	cortisol	C	3	3.3	1.19
2	4246	cortisol	C	7	9.4	2.24
2	4246	cortisol	C	10	21.0	3.04
2	4246	cortisol	C	14	7.2	1.97
2	4246	cortisol	C	17	8.8	2.17
2	4246	cortisol	C	21	5.1	1.62
2	4246	igaserum	C	3	0.3	-1.14
2	4246	igaserum	C	7	0.3	-1.27
2	4246	igaserum	C	10	0.4	-0.99
2	4246	igaserum	C	14	0.3	-1.17
2	4246	igaserum	C	17	0.4	-0.99
2	4246	igaserum	C	21	0.4	-1.02
2	4246	iggserum	C	3	11.7	2.46
2	4246	iggserum	C	7	11.5	2.44
2	4246	iggserum	C	10	10.8	2.38
2	4246	iggserum	C	14	10.9	2.39
2	4246	iggserum	C	17	10.2	2.32
2	4246	iggserum	C	21	10.0	2.30
2	4246	igvitro	C	3	198.0	5.29
2	4246	igvitro	C	7	251.0	5.53
2	4246	igvitro	C	10	159.0	5.07
2	4246	igvitro	C	14	186.0	5.23
2	4246	igvitro	C	17	154.0	5.04
2	4246	igvitro	C	21	144.0	4.97
2	4246	il1serum	C	3	31.6	3.45
2	4246	il1serum	C	7	84.9	4.44
2	4246	il1serum	C	10	103.9	4.64
2	4246	il1serum	C	14	63.7	4.15
2	4246	il1serum	C	17	59.7	4.09
2	4246	il1serum	C	21	23.4	3.15
2	4246	il1vitro	C	3	370.2	5.91
2	4246	il1vitro	C	7	322.2	5.78
2	4246	il1vitro	C	10	322.8	5.78
2	4246	il1vitro	C	14	324.7	5.78
2	4246	il1vitro	C	17	362.4	5.89
2	4246	il1vitro	C	21	359.4	5.88
2	4246	il2serum	C	3	23.0	3.13
2	4246	il2serum	C	7	16.8	2.82
2	4246	il2serum	C	10	16.1	2.78
2	4246	il2serum	C	14	16.6	2.81
2	4246	il2serum	C	17	16.2	2.79
2	4246	il2serum	C	21	20.8	3.03
2	4246	il2vitro	C	3	162.9	5.09
2	4246	il2vitro	C	7	130.0	4.87
2	4246	il2vitro	C	10	130.7	4.87
2	4246	il2vitro	C	14	154.4	5.04
2	4246	il2vitro	C	17	162.5	5.09
2	4246	il2vitro	C	21	153.7	5.04
2	4246	phg	C	3	5333.0	8.58
2	4246	phg	C	7	14966.0	9.61
2	4246	phg	C	10	11608.0	9.36
2	4246	phg	C	14	15219.0	9.63
2	4246	phg	C	17	12048.0	9.40
2	4246	phg	C	21	12815.0	9.46
2	4246	pwm	C	3	12750.0	9.45
2	4246	pwm	C	7	18968.0	9.85
2	4246	pwm	C	10	19514.0	9.88
2	4246	pwm	C	14	14093.0	9.55
2	4246	pwm	C	17	14574.0	9.59
2	4246	pwm	C	21	10541.0	9.26
2	4246	staph	C	3	6232.0	8.74
2	4246	staph	C	7	9213.0	9.13
2	4246	staph	C	10	7146.0	8.87
2	4246	staph	C	14	7348.0	8.90
2	4246	staph	C	17	4075.0	8.31
2	4246	staph	C	21	6955.0	8.85
2	4262	chem	T	3	14570.0	9.59
2	4262	chem	T	7	21288.0	9.97
2	4262	chem	T	10	42151.0	10.65
2	4262	chem	T	14	16520.0	9.71
2	4262	chem	T	17	18657.0	9.83
2	4262	chem	T	21	15798.0	9.67
2	4262	cona	T	3	8485.0	9.05
2	4262	cona	T	7	14806.0	9.60
2	4262	cona	T	10	16034.0	9.68
2	4262	cona	T	14	9840.0	9.19
2	4262	cona	T	17	4173.0	8.34
2	4262	cona	T	21	3828.0	8.25
2	4262	cortisol	T	3	3.3	1.19
2	4262	cortisol	T	7	1.4	0.34
2	4262	cortisol	T	10	9.5	2.25
2	4262	cortisol	T	14	0.6	-0.60
2	4262	cortisol	T	17	7.4	1.99
2	4262	cortisol	T	21	0.9	-0.16
2	4262	igaserum	T	3	0.7	-0.37
2	4262	igaserum	T	7	0.6	-0.45
2	4262	igaserum	T	10	0.7	-0.39
2	4262	igaserum	T	14	0.7	-0.37
2	4262	igaserum	T	17	0.6	-0.45
2	4262	igaserum	T	21	0.7	-0.42
2	4262	iggserum	T	3	11.3	2.42
2	4262	iggserum	T	7	10.6	2.36
2	4262	iggserum	T	10	11.3	2.42
2	4262	iggserum	T	14	10.2	2.32
2	4262	iggserum	T	17	10.1	2.31
2	4262	iggserum	T	21	10.0	2.30
2	4262	igvitro	T	3	49.0	3.89
2	4262	igvitro	T	7	56.0	4.03
2	4262	igvitro	T	10	81.0	4.39

2	4262	igvitro	T	14	46.0	3.83
2	4262	igvitro	T	17	62.0	4.13
2	4262	igvitro	T	21	35.0	3.56
2	4262	il1serum	T	3	4.2	1.44
2	4262	il1serum	T	7	3.8	1.34
2	4262	il1serum	T	10	7.7	2.04
2	4262	il1serum	T	14	5.1	1.62
2	4262	il1serum	T	17	9.1	2.20
2	4262	il1serum	T	21	11.8	2.47
2	4262	il1vitro	T	3	376.3	5.93
2	4262	il1vitro	T	7	344.4	5.84
2	4262	il1vitro	T	10	406.0	6.01
2	4262	il1vitro	T	14	350.4	5.86
2	4262	il1vitro	T	17	357.6	5.88
2	4262	il1vitro	T	21	352.3	5.86
2	4262	il2serum	T	3	31.6	3.45
2	4262	il2serum	T	7	29.5	3.38
2	4262	il2serum	T	10	29.9	3.40
2	4262	il2serum	T	14	23.9	3.18
2	4262	il2serum	T	17	22.2	3.10
2	4262	il2serum	T	21	27.3	3.31
2	4262	il2vitro	T	3	230.3	5.44
2	4262	il2vitro	T	7	232.3	5.45
2	4262	il2vitro	T	10	169.5	5.13
2	4262	il2vitro	T	14	246.0	5.51
2	4262	il2vitro	T	17	92.9	4.53
2	4262	il2vitro	T	21	83.2	4.42
2	4262	phg	T	3	7693.0	8.95
2	4262	phg	T	7	13262.0	9.49
2	4262	phg	T	10	10679.0	9.28
2	4262	phg	T	14	10429.0	9.25
2	4262	phg	T	17	10616.0	9.27
2	4262	phg	T	21	9225.0	9.13
2	4262	pwm	T	3	17537.0	9.77
2	4262	pwm	T	7	27594.0	10.23
2	4262	pwm	T	10	44699.0	10.71
2	4262	pwm	T	14	22968.0	10.04
2	4262	pwm	T	17	18760.0	9.84
2	4262	pwm	T	21	15221.0	9.63
2	4262	staph	T	3	7846.0	8.97
2	4262	staph	T	7	15660.0	9.66
2	4262	staph	T	10	22859.0	10.04
2	4262	staph	T	14	8785.0	9.08
2	4262	staph	T	17	10406.0	9.25
2	4262	staph	T	21	9201.0	9.13
3	3970	chem	C	3	3529.0	8.17
3	3970	chem	C	7	7146.0	8.87
3	3970	chem	C	10	5745.0	8.66
3	3970	chem	C	14	12807.0	9.46
3	3970	chem	C	17	10041.0	9.21
3	3970	chem	C	21	7485.0	8.92
3	3970	cona	C	3	563.0	6.33
3	3970	cona	C	7	7784.0	8.96
3	3970	cona	C	10	5372.0	8.59
3	3970	cona	C	14	5190.0	8.55
3	3970	cona	C	17	2575.0	7.85
3	3970	cona	C	21	18714.0	9.84
3	3970	cortisol	C	3	1.0	0.00
3	3970	cortisol	C	7	3.0	1.08
3	3970	cortisol	C	10	3.5	1.25
3	3970	cortisol	C	14	0.9	-0.16
3	3970	cortisol	C	17	0.4	-0.92
3	3970	cortisol	C	21	1.2	0.14
3	3970	igaserum	C	3	0.3	-1.27
3	3970	igaserum	C	7	0.3	-1.27
3	3970	igaserum	C	10	0.3	-1.24
3	3970	igaserum	C	14	0.3	-1.24
3	3970	igaserum	C	17	0.3	-1.31
3	3970	igaserum	C	21	0.3	-1.35
3	3970	iggserum	C	3	9.9	2.29
3	3970	iggserum	C	7	8.8	2.17
3	3970	iggserum	C	10	10.6	2.36
3	3970	iggserum	C	14	9.6	2.26
3	3970	iggserum	C	17	12.1	2.49
3	3970	iggserum	C	21	11.4	2.43
3	3970	igvitro	C	3	140.0	4.94
3	3970	igvitro	C	7	126.0	4.84
3	3970	igvitro	C	10	105.0	4.65
3	3970	igvitro	C	14	123.0	4.81
3	3970	igvitro	C	17	127.0	4.84
3	3970	igvitro	C	21	129.0	4.86
3	3970	il1serum	C	3	22.7	3.12
3	3970	il1serum	C	7	11.8	2.47
3	3970	il1serum	C	10	16.6	2.81
3	3970	il1serum	C	14	11.6	2.45
3	3970	il1serum	C	17	13.2	2.58
3	3970	il1serum	C	21	7.5	2.01
3	3970	il1vitro	C	3	301.5	5.71
3	3970	il1vitro	C	7	314.7	5.75
3	3970	il1vitro	C	10	310.2	5.74
3	3970	il1vitro	C	14	297.5	5.70
3	3970	il1vitro	C	17	296.6	5.69
3	3970	il1vitro	C	21	282.8	5.64
3	3970	il2serum	C	3	12.2	2.50
3	3970	il2serum	C	7	13.5	2.60
3	3970	il2serum	C	10	11.7	2.46
3	3970	il2serum	C	14	13.8	2.62
3	3970	il2serum	C	17	12.9	2.56
3	3970	il2serum	C	21	15.9	2.76
3	3970	il2vitro	C	3	109.1	4.69
3	3970	il2vitro	C	7	73.4	4.30
3	3970	il2vitro	C	10	73.2	4.29
3	3970	il2vitro	C	14	92.2	4.52
3	3970	il2vitro	C	17	75.6	4.33

3	3970	il2vitro	C	21	73.1	4.29
3	3970	phg	C	3	1197.0	7.09
3	3970	phg	C	7	6807.0	8.83
3	3970	phg	C	10	5680.0	8.64
3	3970	phg	C	14	7692.0	8.95
3	3970	phg	C	17	5826.0	8.67
3	3970	phg	C	21	13848.0	9.54
3	3970	pwm	C	3	3034.0	8.02
3	3970	pwm	C	7	15297.0	9.64
3	3970	pwm	C	10	17562.0	9.77
3	3970	pwm	C	14	15381.0	9.64
3	3970	pwm	C	17	12789.0	9.46
3	3970	pwm	C	21	29282.0	10.28
3	3970	staph	C	3	1056.0	6.96
3	3970	staph	C	7	5250.0	8.57
3	3970	staph	C	10	2384.0	7.78
3	3970	staph	C	14	4732.0	8.46
3	3970	staph	C	17	3645.0	8.20
3	3970	staph	C	21	6957.0	8.85
3	3987	chem	T	3	9981.0	9.21
3	3987	chem	T	7	10881.0	9.29
3	3987	chem	T	10	9637.0	9.17
3	3987	chem	T	14	15846.0	9.67
3	3987	chem	T	17	9818.0	9.19
3	3987	chem	T	21	6940.0	8.85
3	3987	cona	T	3	1622.0	7.39
3	3987	cona	T	7	14518.0	9.58
3	3987	cona	T	10	13735.0	9.53
3	3987	cona	T	14	13869.0	9.54
3	3987	cona	T	17	7019.0	8.86
3	3987	cona	T	21	17008.0	9.74
3	3987	cortisol	T	3	10.8	2.38
3	3987	cortisol	T	7	6.2	1.82
3	3987	cortisol	T	10	3.9	1.36
3	3987	cortisol	T	14	1.6	0.47
3	3987	cortisol	T	17	3.7	1.31
3	3987	cortisol	T	21	2.2	0.77
3	3987	igaserum	T	3	0.8	-0.22
3	3987	igaserum	T	7	0.4	-0.82
3	3987	igaserum	T	10	0.8	-0.19
3	3987	igaserum	T	14	0.9	-0.13
3	3987	igaserum	T	17	0.9	-0.16
3	3987	igaserum	T	21	0.8	-0.20
3	3987	iggserum	T	3	12.3	2.51
3	3987	iggserum	T	7	11.9	2.48
3	3987	iggserum	T	10	11.6	2.45
3	3987	iggserum	T	14	12.1	2.49
3	3987	iggserum	T	17	11.5	2.44
3	3987	iggserum	T	21	12.7	2.54
3	3987	igvitro	T	3	50.0	3.91
3	3987	igvitro	T	7	22.0	3.09
3	3987	igvitro	T	10	26.0	3.26
3	3987	igvitro	T	14	25.0	3.22
3	3987	igvitro	T	17	26.0	3.26
3	3987	igvitro	T	21	27.0	3.30
3	3987	il1serum	T	3	42.8	3.76
3	3987	il1serum	T	7	37.3	3.62
3	3987	il1serum	T	10	52.8	3.97
3	3987	il1serum	T	14	21.8	3.08
3	3987	il1serum	T	17	60.7	4.11
3	3987	il1serum	T	21	85.6	4.45
3	3987	il1vitro	T	3	319.9	5.77
3	3987	il1vitro	T	7	314.7	5.75
3	3987	il1vitro	T	10	298.7	5.70
3	3987	il1vitro	T	14	303.8	5.72
3	3987	il1vitro	T	17	309.8	5.74
3	3987	il1vitro	T	21	284.7	5.65
3	3987	il2serum	T	3	8.4	2.13
3	3987	il2serum	T	7	7.6	2.03
3	3987	il2serum	T	10	7.7	2.04
3	3987	il2serum	T	14	8.8	2.17
3	3987	il2serum	T	17	7.8	2.05
3	3987	il2serum	T	21	7.7	2.04
3	3987	il2vitro	T	3	288.0	5.66
3	3987	il2vitro	T	7	74.4	4.31
3	3987	il2vitro	T	10	94.1	4.54
3	3987	il2vitro	T	14	74.1	4.30
3	3987	il2vitro	T	17	75.2	4.32
3	3987	il2vitro	T	21	78.9	4.37
3	3987	phg	T	3	2548.0	7.84
3	3987	phg	T	7	19784.0	9.89
3	3987	phg	T	10	23075.0	10.05
3	3987	phg	T	14	12518.0	9.43
3	3987	phg	T	17	13969.0	9.54
3	3987	phg	T	21	12164.0	9.41
3	3987	pwm	T	3	2827.0	7.95
3	3987	pwm	T	7	27985.0	10.24
3	3987	pwm	T	10	33988.0	10.43
3	3987	pwm	T	14	18774.0	9.84
3	3987	pwm	T	17	17736.0	9.78
3	3987	pwm	T	21	30461.0	10.32
3	3987	staph	T	3	1969.0	7.59
3	3987	staph	T	7	9693.0	9.18
3	3987	staph	T	10	10181.0	9.23
3	3987	staph	T	14	3772.0	8.24
3	3987	staph	T	17	5626.0	8.64
3	3987	staph	T	21	7042.0	8.86
3	3996	chem	C	3	8583.0	9.06
3	3996	chem	C	7	4495.0	8.41
3	3996	chem	C	10	4373.0	8.38
3	3996	chem	C	14	6881.0	8.84
3	3996	chem	C	17	4458.0	8.40
3	3996	chem	C	21	5397.0	8.59
3	3996	cona	C	3	992.0	6.90

3	3996	cona	C	7	22576.0	10.02
3	3996	cona	C	10	15689.0	9.66
3	3996	cona	C	14	19770.0	9.89
3	3996	cona	C	17	11937.0	9.39
3	3996	cona	C	21	16669.0	9.72
3	3996	cortisol	C	3	7.2	1.97
3	3996	cortisol	C	7	7.9	2.06
3	3996	cortisol	C	10	10.3	2.33
3	3996	cortisol	C	14	1.3	0.26
3	3996	cortisol	C	17	13.9	2.63
3	3996	cortisol	C	21	8.6	2.15
3	3996	igaserum	C	3	0.3	-1.27
3	3996	igaserum	C	7	0.3	-1.24
3	3996	igaserum	C	10	0.3	-1.24
3	3996	igaserum	C	14	0.3	-1.24
3	3996	igaserum	C	17	0.3	-1.20
3	3996	igaserum	C	21	0.3	-1.31
3	3996	iggserum	C	3	11.8	2.47
3	3996	iggserum	C	7	11.8	2.47
3	3996	iggserum	C	10	11.5	2.44
3	3996	iggserum	C	14	11.7	2.46
3	3996	iggserum	C	17	11.6	2.45
3	3996	iggserum	C	21	12.0	2.48
3	3996	igvitro	C	3	107.0	4.67
3	3996	igvitro	C	7	76.0	4.33
3	3996	igvitro	C	10	74.0	4.30
3	3996	igvitro	C	14	103.0	4.63
3	3996	igvitro	C	17	63.0	4.14
3	3996	igvitro	C	21	93.0	4.53
3	3996	il1serum	C	3	13.4	2.60
3	3996	il1serum	C	7	36.3	3.59
3	3996	il1serum	C	10	23.2	3.15
3	3996	il1serum	C	14	37.5	3.62
3	3996	il1serum	C	17	20.0	3.00
3	3996	il1serum	C	21	36.9	3.61
3	3996	il1vitro	C	3	337.0	5.82
3	3996	il1vitro	C	7	338.7	5.82
3	3996	il1vitro	C	10	358.9	5.88
3	3996	il1vitro	C	14	315.3	5.75
3	3996	il1vitro	C	17	320.1	5.77
3	3996	il1vitro	C	21	312.7	5.75
3	3996	il2serum	C	3	11.2	2.41
3	3996	il2serum	C	7	10.1	2.32
3	3996	il2serum	C	10	11.5	2.44
3	3996	il2serum	C	14	10.1	2.31
3	3996	il2serum	C	17	12.2	2.50
3	3996	il2serum	C	21	12.4	2.52
3	3996	il2vitro	C	3	73.4	4.30
3	3996	il2vitro	C	7	116.0	4.75
3	3996	il2vitro	C	10	73.4	4.30
3	3996	il2vitro	C	14	73.7	4.30
3	3996	il2vitro	C	17	75.2	4.32
3	3996	il2vitro	C	21	84.8	4.44
3	3996	phg	C	3	5113.0	8.54
3	3996	phg	C	7	21353.0	9.97
3	3996	phg	C	10	18251.0	9.81
3	3996	phg	C	14	20398.0	9.92
3	3996	phg	C	17	16805.0	9.73
3	3996	phg	C	21	19773.0	9.89
3	3996	pwm	C	3	6533.0	8.78
3	3996	pwm	C	7	37575.0	10.53
3	3996	pwm	C	10	24003.0	10.09
3	3996	pwm	C	14	34377.0	10.45
3	3996	pwm	C	17	24314.0	10.10
3	3996	pwm	C	21	31267.0	10.35
3	3996	staph	C	3	2332.0	7.75
3	3996	staph	C	7	11164.0	9.32
3	3996	staph	C	10	8050.0	8.99
3	3996	staph	C	14	5921.0	8.69
3	3996	staph	C	17	7388.0	8.91
3	3996	staph	C	21	8047.0	8.99
3	4057	chem	T	3	7084.0	8.87
3	4057	chem	T	7	4818.0	8.48
3	4057	chem	T	10	6170.0	8.73
3	4057	chem	T	14	14913.0	9.61
3	4057	chem	T	17	3256.0	8.09
3	4057	chem	T	21	6240.0	8.74
3	4057	cona	T	3	1736.0	7.46
3	4057	cona	T	7	8029.0	8.99
3	4057	cona	T	10	4498.0	8.41
3	4057	cona	T	14	7717.0	8.95
3	4057	cona	T	17	5966.0	8.69
3	4057	cona	T	21	3057.0	8.03
3	4057	cortisol	T	3	2.8	1.01
3	4057	cortisol	T	7	4.7	1.54
3	4057	cortisol	T	10	3.1	1.12
3	4057	cortisol	T	14	4.7	1.55
3	4057	cortisol	T	17	1.8	0.56
3	4057	cortisol	T	21	3.7	1.29
3	4057	igaserum	T	3	0.9	-0.11
3	4057	igaserum	T	7	0.6	-0.54
3	4057	igaserum	T	10	0.6	-0.49
3	4057	igaserum	T	14	0.9	-0.16
3	4057	igaserum	T	17	0.8	-0.27
3	4057	igaserum	T	21	0.7	-0.34
3	4057	iggserum	T	3	12.6	2.53
3	4057	iggserum	T	7	12.2	2.50
3	4057	iggserum	T	10	12.2	2.50
3	4057	iggserum	T	14	12.0	2.48
3	4057	iggserum	T	17	12.1	2.49
3	4057	iggserum	T	21	12.6	2.53
3	4057	igvitro	T	3	59.0	4.08
3	4057	igvitro	T	7	66.0	4.19
3	4057	igvitro	T	10	37.0	3.61

3	4057	igvitro	T	14	70.0	4.25
3	4057	igvitro	T	17	53.0	3.97
3	4057	igvitro	T	21	56.0	4.03
3	4057	il1serum	T	3	210.9	5.35
3	4057	il1serum	T	7	227.4	5.43
3	4057	il1serum	T	10	204.9	5.32
3	4057	il1serum	T	14	184.9	5.22
3	4057	il1serum	T	17	210.7	5.35
3	4057	il1serum	T	21	150.2	5.01
3	4057	il1vitro	T	3	296.2	5.69
3	4057	il1vitro	T	7	298.7	5.70
3	4057	il1vitro	T	10	323.2	5.78
3	4057	il1vitro	T	14	352.9	5.87
3	4057	il1vitro	T	17	315.8	5.76
3	4057	il1vitro	T	21	347.0	5.85
3	4057	il2serum	T	3	7.5	2.01
3	4057	il2serum	T	7	7.5	2.01
3	4057	il2serum	T	10	7.5	2.02
3	4057	il2serum	T	14	7.6	2.02
3	4057	il2serum	T	17	7.5	2.01
3	4057	il2serum	T	21	7.6	2.03
3	4057	il2vitro	T	3	73.5	4.30
3	4057	il2vitro	T	7	73.5	4.30
3	4057	il2vitro	T	10	73.5	4.30
3	4057	il2vitro	T	14	153.2	5.03
3	4057	il2vitro	T	17	73.2	4.29
3	4057	il2vitro	T	21	74.4	4.31
3	4057	phg	T	3	3115.0	8.04
3	4057	phg	T	7	11443.0	9.35
3	4057	phg	T	10	11999.0	9.39
3	4057	phg	T	14	11104.0	9.32
3	4057	phg	T	17	11258.0	9.33
3	4057	phg	T	21	7217.0	8.88
3	4057	pwm	T	3	5851.0	8.67
3	4057	pwm	T	7	24149.0	10.09
3	4057	pwm	T	10	21529.0	9.98
3	4057	pwm	T	14	18700.0	9.84
3	4057	pwm	T	17	15789.0	9.67
3	4057	pwm	T	21	13945.0	9.54
3	4057	staph	T	3	2328.0	7.75
3	4057	staph	T	7	6572.0	8.79
3	4057	staph	T	10	5406.0	8.60
3	4057	staph	T	14	3318.0	8.11
3	4057	staph	T	17	4421.0	8.39
3	4057	staph	T	21	743.0	6.61
3	4105	chem	C	3	5469.0	8.61
3	4105	chem	C	7	6539.0	8.79
3	4105	chem	C	10	3925.0	8.28
3	4105	chem	C	14	6599.0	8.79
3	4105	chem	C	17	2249.0	7.72
3	4105	chem	C	21	3096.0	8.04
3	4105	cona	C	3	1050.0	6.96
3	4105	cona	C	7	24520.0	10.11
3	4105	cona	C	10	13349.0	9.50
3	4105	cona	C	14	17456.0	9.77
3	4105	cona	C	17	9812.0	9.19
3	4105	cona	C	21	8614.0	9.06
3	4105	cortisol	C	3	5.8	1.75
3	4105	cortisol	C	7	5.1	1.63
3	4105	cortisol	C	10	4.5	1.49
3	4105	cortisol	C	14	2.1	0.74
3	4105	cortisol	C	17	2.0	0.69
3	4105	cortisol	C	21	4.2	1.44
3	4105	igaserum	C	3	0.3	-1.14
3	4105	igaserum	C	7	0.6	-0.54
3	4105	igaserum	C	10	0.5	-0.73
3	4105	igaserum	C	14	0.3	-1.27
3	4105	igaserum	C	17	0.3	-1.24
3	4105	igaserum	C	21	0.3	-1.11
3	4105	iggserum	C	3	10.5	2.35
3	4105	iggserum	C	7	10.9	2.39
3	4105	iggserum	C	10	10.6	2.36
3	4105	iggserum	C	14	10.5	2.35
3	4105	iggserum	C	17	10.7	2.37
3	4105	iggserum	C	21	10.9	2.39
3	4105	igvitro	C	3	19.0	2.94
3	4105	igvitro	C	7	20.0	3.00
3	4105	igvitro	C	10	24.0	3.18
3	4105	igvitro	C	14	16.0	2.77
3	4105	igvitro	C	17	20.0	3.00
3	4105	igvitro	C	21	21.0	3.04
3	4105	il1serum	C	3	111.1	4.71
3	4105	il1serum	C	7	225.1	5.42
3	4105	il1serum	C	10	169.3	5.13
3	4105	il1serum	C	14	199.5	5.30
3	4105	il1serum	C	17	179.6	5.19
3	4105	il1serum	C	21	215.4	5.37
3	4105	il1vitro	C	3	300.1	5.70
3	4105	il1vitro	C	7	293.2	5.68
3	4105	il1vitro	C	10	313.4	5.75
3	4105	il1vitro	C	14	298.4	5.70
3	4105	il1vitro	C	17	309.2	5.73
3	4105	il1vitro	C	21	288.1	5.66
3	4105	il2serum	C	3	7.5	2.02
3	4105	il2serum	C	7	7.5	2.01
3	4105	il2serum	C	10	7.5	2.01
3	4105	il2serum	C	14	7.8	2.05
3	4105	il2serum	C	17	7.7	2.04
3	4105	il2serum	C	21	7.5	2.02
3	4105	il2vitro	C	3	114.9	4.74
3	4105	il2vitro	C	7	99.1	4.60
3	4105	il2vitro	C	10	114.6	4.74
3	4105	il2vitro	C	14	125.1	4.83
3	4105	il2vitro	C	17	131.2	4.88

3	4105	il2vitro	C	21	141.4	4.95
3	4105	phg	C	3	2460.0	7.81
3	4105	phg	C	7	33897.0	10.43
3	4105	phg	C	10	22171.0	10.01
3	4105	phg	C	14	19506.0	9.88
3	4105	phg	C	17	20745.0	9.94
3	4105	phg	C	21	21513.0	9.98
3	4105	pwm	C	3	4267.0	8.36
3	4105	pwm	C	7	54194.0	10.90
3	4105	pwm	C	10	26316.0	10.18
3	4105	pwm	C	14	31651.0	10.36
3	4105	pwm	C	17	16325.0	9.70
3	4105	pwm	C	21	28192.0	10.25
3	4105	staph	C	3	1085.0	6.99
3	4105	staph	C	7	12068.0	9.40
3	4105	staph	C	10	5168.0	8.55
3	4105	staph	C	14	4794.0	8.48
3	4105	staph	C	17	6114.0	8.72
3	4105	staph	C	21	5743.0	8.66
3	4157	chem	T	3	3598.0	8.19
3	4157	chem	T	7	7243.0	8.89
3	4157	chem	T	10	7215.0	8.88
3	4157	chem	T	14	9372.0	9.15
3	4157	chem	T	17	7220.0	8.88
3	4157	chem	T	21	10340.0	9.24
3	4157	cona	T	3	1601.0	7.38
3	4157	cona	T	7	19465.0	9.88
3	4157	cona	T	10	12742.0	9.45
3	4157	cona	T	14	18728.0	9.84
3	4157	cona	T	17	11055.0	9.31
3	4157	cona	T	21	20927.0	9.95
3	4157	cortisol	T	3	2.0	0.69
3	4157	cortisol	T	7	4.1	1.41
3	4157	cortisol	T	10	7.0	1.94
3	4157	cortisol	T	14	1.5	0.37
3	4157	cortisol	T	17	7.1	1.96
3	4157	cortisol	T	21	4.7	1.54
3	4157	igaserum	T	3	0.5	-0.67
3	4157	igaserum	T	7	0.3	-1.20
3	4157	igaserum	T	10	0.4	-0.84
3	4157	igaserum	T	14	0.4	-0.82
3	4157	igaserum	T	17	0.4	-0.92
3	4157	igaserum	T	21	0.4	-0.89
3	4157	iggserum	T	3	10.0	2.30
3	4157	iggserum	T	7	10.5	2.35
3	4157	iggserum	T	10	10.2	2.32
3	4157	iggserum	T	14	10.1	2.31
3	4157	iggserum	T	17	11.3	2.42
3	4157	iggserum	T	21	12.5	2.53
3	4157	igvitro	T	3	119.0	4.78
3	4157	igvitro	T	7	112.0	4.72
3	4157	igvitro	T	10	108.0	4.68
3	4157	igvitro	T	14	105.0	4.65
3	4157	igvitro	T	17	116.0	4.75
3	4157	igvitro	T	21	96.0	4.56
3	4157	il1serum	T	3	14.4	2.67
3	4157	il1serum	T	7	31.4	3.45
3	4157	il1serum	T	10	39.4	3.67
3	4157	il1serum	T	14	25.0	3.22
3	4157	il1serum	T	17	17.1	2.84
3	4157	il1serum	T	21	31.2	3.44
3	4157	il1vitro	T	3	317.7	5.76
3	4157	il1vitro	T	7	304.6	5.72
3	4157	il1vitro	T	10	301.6	5.71
3	4157	il1vitro	T	14	303.3	5.71
3	4157	il1vitro	T	17	281.4	5.64
3	4157	il1vitro	T	21	292.9	5.68
3	4157	il2serum	T	3	11.5	2.44
3	4157	il2serum	T	7	10.5	2.35
3	4157	il2serum	T	10	8.3	2.11
3	4157	il2serum	T	14	9.7	2.27
3	4157	il2serum	T	17	10.2	2.33
3	4157	il2serum	T	21	10.4	2.35
3	4157	il2vitro	T	3	126.9	4.84
3	4157	il2vitro	T	7	157.9	5.06
3	4157	il2vitro	T	10	81.4	4.40
3	4157	il2vitro	T	14	86.4	4.46
3	4157	il2vitro	T	17	73.7	4.30
3	4157	il2vitro	T	21	118.9	4.78
3	4157	phg	T	3	3427.0	8.14
3	4157	phg	T	7	18164.0	9.81
3	4157	phg	T	10	13128.0	9.48
3	4157	phg	T	14	16099.0	9.69
3	4157	phg	T	17	19998.0	9.90
3	4157	phg	T	21	19724.0	9.89
3	4157	pwm	T	3	4294.0	8.36
3	4157	pwm	T	7	19896.0	9.90
3	4157	pwm	T	10	13941.0	9.54
3	4157	pwm	T	14	16689.0	9.72
3	4157	pwm	T	17	26086.0	10.17
3	4157	pwm	T	21	22043.0	10.00
3	4157	staph	T	3	2613.0	7.87
3	4157	staph	T	7	8580.0	9.06
3	4157	staph	T	10	4844.0	8.49
3	4157	staph	T	14	3730.0	8.22
3	4157	staph	T	17	8448.0	9.04
3	4157	staph	T	21	7058.0	8.86
3	4279	chem	T	3	4147.0	8.33
3	4279	chem	T	7	5820.0	8.67
3	4279	chem	T	10	5569.0	8.62
3	4279	chem	T	14	6706.0	8.81
3	4279	chem	T	17	2614.0	7.87
3	4279	chem	T	21	14498.0	9.58
3	4279	cona	T	3	2648.0	7.88

3	4279	cona	T	7	25365.0	10.14
3	4279	cona	T	10	25865.0	10.16
3	4279	cona	T	14	13876.0	9.54
3	4279	cona	T	17	10780.0	9.29
3	4279	cona	T	21	17308.0	9.76
3	4279	cortisol	T	3	3.3	1.19
3	4279	cortisol	T	7	6.1	1.81
3	4279	cortisol	T	10	6.3	1.84
3	4279	cortisol	T	14	3.2	1.15
3	4279	cortisol	T	17	6.9	1.93
3	4279	cortisol	T	21	2.5	0.90
3	4279	igaserum	T	3	0.3	-1.11
3	4279	igaserum	T	7	0.4	-0.97
3	4279	igaserum	T	10	0.4	-0.82
3	4279	igaserum	T	14	0.3	-1.24
3	4279	igaserum	T	17	0.3	-1.17
3	4279	igaserum	T	21	0.4	-1.02
3	4279	iggserum	T	3	11.3	2.42
3	4279	iggserum	T	7	11.5	2.44
3	4279	iggserum	T	10	11.0	2.40
3	4279	iggserum	T	14	11.2	2.42
3	4279	iggserum	T	17	12.8	2.55
3	4279	iggserum	T	21	10.5	2.35
3	4279	igvitro	T	3	126.0	4.84
3	4279	igvitro	T	7	106.0	4.66
3	4279	igvitro	T	10	152.0	5.02
3	4279	igvitro	T	14	113.0	4.73
3	4279	igvitro	T	17	127.0	4.84
3	4279	igvitro	T	21	125.0	4.83
3	4279	il1serum	T	3	6.1	1.81
3	4279	il1serum	T	7	10.0	2.30
3	4279	il1serum	T	10	11.3	2.43
3	4279	il1serum	T	14	6.8	1.92
3	4279	il1serum	T	17	28.2	3.34
3	4279	il1serum	T	21	6.2	1.82
3	4279	il1vitro	T	3	334.9	5.81
3	4279	il1vitro	T	7	329.9	5.80
3	4279	il1vitro	T	10	314.9	5.75
3	4279	il1vitro	T	14	331.1	5.80
3	4279	il1vitro	T	17	320.0	5.77
3	4279	il1vitro	T	21	301.5	5.71
3	4279	il2serum	T	3	13.0	2.57
3	4279	il2serum	T	7	16.5	2.80
3	4279	il2serum	T	10	16.2	2.79
3	4279	il2serum	T	14	25.5	3.24
3	4279	il2serum	T	17	8.5	2.13
3	4279	il2serum	T	21	12.9	2.56
3	4279	il2vitro	T	3	115.3	4.75
3	4279	il2vitro	T	7	74.6	4.31
3	4279	il2vitro	T	10	82.1	4.41
3	4279	il2vitro	T	14	256.0	5.55
3	4279	il2vitro	T	17	99.2	4.60
3	4279	il2vitro	T	21	94.5	4.55
3	4279	phg	T	3	5678.0	8.64
3	4279	phg	T	7	20131.0	9.91
3	4279	phg	T	10	19823.0	9.89
3	4279	phg	T	14	15423.0	9.64
3	4279	phg	T	17	15878.0	9.67
3	4279	phg	T	21	19196.0	9.86
3	4279	pwm	T	3	6616.0	8.80
3	4279	pwm	T	7	41260.0	10.63
3	4279	pwm	T	10	29813.0	10.30
3	4279	pwm	T	14	27375.0	10.22
3	4279	pwm	T	17	23734.0	10.07
3	4279	pwm	T	21	32430.0	10.39
3	4279	staph	T	3	4174.0	8.34
3	4279	staph	T	7	16125.0	9.69
3	4279	staph	T	10	9448.0	9.15
3	4279	staph	T	14	8107.0	9.00
3	4279	staph	T	17	9317.0	9.14
3	4279	staph	T	21	12550.0	9.44
3	4286	chem	C	3	19272.0	9.87
3	4286	chem	C	7	19272.0	9.87
3	4286	chem	C	10	8249.0	9.02
3	4286	chem	C	14	4962.0	8.51
3	4286	chem	C	17	6974.0	8.85
3	4286	chem	C	21	8309.0	9.03
3	4286	cona	C	3	5786.0	8.66
3	4286	cona	C	7	1940.0	7.57
3	4286	cona	C	10	25066.0	10.13
3	4286	cona	C	14	24124.0	10.09
3	4286	cona	C	17	11810.0	9.38
3	4286	cona	C	21	12060.0	9.40
3	4286	cortisol	C	3	1.9	0.64
3	4286	cortisol	C	7	33.2	3.50
3	4286	cortisol	C	10	4.2	1.42
3	4286	cortisol	C	14	11.2	2.42
3	4286	cortisol	C	17	8.7	2.16
3	4286	cortisol	C	21	2.8	1.03
3	4286	igaserum	C	3	0.3	-1.31
3	4286	igaserum	C	7	0.3	-1.35
3	4286	igaserum	C	10	0.3	-1.24
3	4286	igaserum	C	14	0.3	-1.24
3	4286	igaserum	C	17	0.2	-1.47
3	4286	igaserum	C	21	0.3	-1.24
3	4286	iggserum	C	3	7.9	2.07
3	4286	iggserum	C	7	7.1	1.96
3	4286	iggserum	C	10	7.2	1.97
3	4286	iggserum	C	14	7.3	1.99
3	4286	iggserum	C	17	7.5	2.01
3	4286	iggserum	C	21	7.4	2.00
3	4286	igvitro	C	3	152.0	5.02
3	4286	igvitro	C	7	167.0	5.12
3	4286	igvitro	C	10	128.0	4.85

3	4286	igvitro	C	14	129.0	4.86
3	4286	igvitro	C	17	138.0	4.93
3	4286	igvitro	C	21	125.0	4.83
3	4286	il1serum	C	3	159.3	5.07
3	4286	il1serum	C	7	7.5	2.01
3	4286	il1serum	C	10	202.7	5.31
3	4286	il1serum	C	14	64.0	4.16
3	4286	il1serum	C	17	27.0	3.30
3	4286	il1serum	C	21	12.7	2.54
3	4286	il1vitro	C	3	482.0	6.18
3	4286	il1vitro	C	7	304.0	5.72
3	4286	il1vitro	C	10	286.1	5.66
3	4286	il1vitro	C	14	289.4	5.67
3	4286	il1vitro	C	17	290.6	5.67
3	4286	il1vitro	C	21	273.9	5.61
3	4286	il2serum	C	3	7.5	2.01
3	4286	il2serum	C	7	9.3	2.23
3	4286	il2serum	C	10	7.5	2.01
3	4286	il2serum	C	14	7.5	2.02
3	4286	il2serum	C	17	8.1	2.10
3	4286	il2serum	C	21	9.4	2.24
3	4286	il2vitro	C	3	73.5	4.30
3	4286	il2vitro	C	7	93.1	4.53
3	4286	il2vitro	C	10	109.1	4.69
3	4286	il2vitro	C	14	76.9	4.34
3	4286	il2vitro	C	17	121.4	4.80
3	4286	il2vitro	C	21	113.8	4.73
3	4286	phg	C	3	7540.0	8.93
3	4286	phg	C	7	4822.0	8.48
3	4286	phg	C	10	23118.0	10.05
3	4286	phg	C	14	18618.0	9.83
3	4286	phg	C	17	15679.0	9.66
3	4286	phg	C	21	36809.0	10.51
3	4286	pwm	C	3	7768.0	8.96
3	4286	pwm	C	7	9267.0	9.13
3	4286	pwm	C	10	24232.0	10.10
3	4286	pwm	C	14	26390.0	10.18
3	4286	pwm	C	17	23114.0	10.05
3	4286	pwm	C	21	34399.0	10.45
3	4286	staph	C	3	5475.0	8.61
3	4286	staph	C	7	1565.0	7.36
3	4286	staph	C	10	16547.0	9.71
3	4286	staph	C	14	9117.0	9.12
3	4286	staph	C	17	11564.0	9.36
3	4286	staph	C	21	12494.0	9.43

Appendix IV. Cow and stall monitoring data for replicates 1, 2 and 3.

ID CODES
Rep: There were three replicates that started on 11/28/98, 01/09/99 and 4/10/99.
Date: Day of observation.
Stall: Stall number.
cow.num: [ie. 4192_1_T] This is the cows number (4192), the stall it was in (1), and if it received treatment (T) or Control (C).
amtemp: This is the cow temperature in the morning in degree Celsius.
amvolts: This was the measured voltage in the morning from front to back of stall.
pmvolts: This was the measured voltage in the evening from font to back of stall with a 1k shunt resistor.

amwater: Gallons of water drank by the cow in a 24 hour period.
milk: Milk production in pounds for a 24 hour period.

Rep	date	stall	cow.num	amtemp	amvolts	pmvolts	amwater	milk
1	11/28/98	1	4192_1_T	38.7	0	0	0	69
1	11/28/98	2	4161_2_T	38.5	0	0	0	86
1	11/28/98	3	4230_3_C	38.5	0	0	0	78
1	11/28/98	4	4212_4_C	38.8	0	0	0	75
1	11/28/98	5	4066_5_T	38.8	0	0	0	83
1	11/28/98	6	3910_6_T	38.8	0	0	0	87
1	11/28/98	7	4106_7_C	39.1	0	0	0	116
1	11/28/98	8	4134_8_C	38.8	0	0	0	91
1	11/29/98	1	4192_1_T	38.6	0	0	15.7	65
1	11/29/98	2	4161_2_T	38.4	0	0	21.8	76
1	11/29/98	3	4230_3_C	38.5	0	0	27	82
1	11/29/98	4	4212_4_C	39.7	0	0	23.5	65
1	11/29/98	5	4066_5_T	38.5	0	0	24.6	78
1	11/29/98	6	3910_6_T	38.5	0	0	22.1	82
1	11/29/98	7	4106_7_C	38.7	0	0	27	113
1	11/29/98	8	4134_8_C	38.8	0	0	17	93
1	11/30/98	1	4192_1_T	38.7	0	0	14.3	61
1	11/30/98	2	4161_2_T	38.8	0	0	18.2	95
1	11/30/98	3	4230_3_C	38.4	0	0	23	93
1	11/30/98	4	4212_4_C	38.4	0	0	16.5	89
1	11/30/98	5	4066_5_T	38.6	0	0	15.4	76
1	11/30/98	6	3910_6_T	38.9	0	0	27.9	89
1	11/30/98	7	4106_7_C	38.9	0	0	23	125
1	11/30/98	8	4134_8_C	38.7	0	0	23	103
1	12/01/98	1	4192_1_T	38	0	0	20	62
1	12/01/98	2	4161_2_T	38.5	0	0	30	84
1	12/01/98	3	4230_3_C	38.6	0	0	20	81
1	12/01/98	4	4212_4_C	38.5	0	0	20	68
1	12/01/98	5	4066_5_T	38.6	0	0	30	73
1	12/01/98	6	3910_6_T	38.6	0	0	20	91
1	12/01/98	7	4106_7_C	38.8	0	0	20	113
1	12/01/98	8	4134_8_C	38.8	0	0	20	85
1	12/02/98	1	4192_1_T	38.7	0	0	23	73
1	12/02/98	2	4161_2_T	38.6	0	0	25.5	86
1	12/02/98	3	4230_3_C	38.7	0	0	25	84
1	12/02/98	4	4212_4_C	38.8	0	0	18	76
1	12/02/98	5	4066_5_T	38.7	0	0	28	82

1	12/02/98	6	3910_6_T	38.2	0	0	31.5	94
1	12/02/98	7	4106_7_C	38.8	0	0	32	117
1	12/02/98	8	4134_8_C	38.8	0	0	24	86
1	12/03/98	1	4192_1_T	38.8	0	0	14	63
1	12/03/98	2	4161_2_T	38.8	0	0	21.5	74
1	12/03/98	3	4230_3_C	38.5	0	0	26	79
1	12/03/98	4	4212_4_C	39.5	0	0	17	68
1	12/03/98	5	4066_5_T	39.4	0	0	31	77
1	12/03/98	6	3910_6_T	39.4	0	0	20.5	86
1	12/03/98	7	4106_7_C	38.8	0	0	21	111
1	12/03/98	8	4134_8_C	38.7	0	0	22.5	86
1	12/04/98	1	4192_1_T	37.3	0	1.2	19	63
1	12/04/98	2	4161_2_T	38.9	0	0.58	21.5	74
1	12/04/98	3	4230_3_C	38.2	0	0	24	77
1	12/04/98	4	4212_4_C	38.5	0	0	17	63
1	12/04/98	5	4066_5_T	38.6	0	1.15	11.5	69
1	12/04/98	6	3910_6_T	38.8	0	1.21	23.5	84
1	12/04/98	7	4106_7_C	38.8	0	0	23	107
1	12/04/98	8	4134_8_C	38.2	0	0	24.5	84
1	12/05/98	1	4192_1_T	38.4	1.12	0.7	21.2	62
1	12/05/98	2	4161_2_T	38.7	1.29	0.88	23.6	67
1	12/05/98	3	4230_3_C	38.4	0	0	21.5	72
1	12/05/98	4	4212_4_C	38	0	0	19	64
1	12/05/98	5	4066_5_T	38.8	1.15	1.13	20.5	66
1	12/05/98	6	3910_6_T	39.2	0.86	0.99	24.7	80
1	12/05/98	7	4106_7_C	38.8	0	0	20.2	106
1	12/05/98	8	4134_8_C	38.9	0	0	22.8	82
1	12/06/98	1	4192_1_T	38.6	1.28	1.6	22.8	54
1	12/06/98	2	4161_2_T	38.8	1.74	0.44	28	70
1	12/06/98	3	4230_3_C	38.8	0	0	26	79
1	12/06/98	4	4212_4_C	38.7	0	0	20.2	67
1	12/06/98	5	4066_5_T	38.9	1.15	1.1	26.2	70
1	12/06/98	6	3910_6_T	38.8	1.02	1	28.8	86
1	12/06/98	7	4106_7_C	38.8	0	0	25.3	103
1	12/06/98	8	4134_8_C	38.7	0	0	28.1	79
1	12/07/98	1	4192_1_T	38.4	1.41	1.35	21.5	64
1	12/07/98	2	4161_2_T	38.8	0.85	1.11	16.6	70
1	12/07/98	3	4230_3_C	38.6	0	0	19.3	74
1	12/07/98	4	4212_4_C	38.3	0	0	17.9	67
1	12/07/98	5	4066_5_T	39.1	1.04	1.02	23.8	76
1	12/07/98	6	3910_6_T	37.7	1.13	1.02	17	80
1	12/07/98	7	4106_7_C	38.7	0	0	24.5	102
1	12/07/98	8	4134_8_C	38.5	0	0	22.4	81
1	12/08/98	1	4192_1_T	38	1.46	0.94	17	66
1	12/08/98	2	4161_2_T	38.5	0.9	0.79	20.3	75
1	12/08/98	3	4230_3_C	38.5	0	0	24.2	79
1	12/08/98	4	4212_4_C	39.1	0	0	17.9	71
1	12/08/98	5	4066_5_T	38.7	1.04	1.05	21.5	83
1	12/08/98	6	3910_6_T	38.1	1	0.99	20	91
1	12/08/98	7	4106_7_C	38.5	0	0	19	102
1	12/08/98	8	4134_8_C	38.6	0	0	22.2	86
1	12/09/98	1	4192_1_T	38.3	1	1.14	20	62
1	12/09/98	2	4161_2_T	38.5	1	0.73	20	73
1	12/09/98	3	4230_3_C	38.6	0	0	21.75	78
1	12/09/98	4	4212_4_C	38.6	0	0	15.5	69
1	12/09/98	5	4066_5_T	38.5	1	1.05	22.5	88

1	12/09/98	6	3910_6_T	38.8	1	1.04	20	91
1	12/09/98	7	4106_7_C	38.4	0	0	20.75	105
1	12/09/98	8	4134_8_C	38.5	0	0	20.75	81
1	12/10/98	1	4192_1_T	38	1	1.02	16.5	61
1	12/10/98	2	4161_2_T	38.6	0.8	1.64	19.25	68
1	12/10/98	3	4230_3_C	38.6	0	0	22.25	74
1	12/10/98	4	4212_4_C	38.6	0	0	15.5	71
1	12/10/98	5	4066_5_T	38.7	1	0.86	20.25	72
1	12/10/98	6	3910_6_T	38.9	1.1	1.14	22.25	90
1	12/10/98	7	4106_7_C	38.8	0	0	20.25	105
1	12/10/98	8	4134_8_C	38.6	0	0	20.75	78
1	12/11/98	1	4192_1_T	38.5	1.1	1.16	22.3	60
1	12/11/98	2	4161_2_T	38.9	0.3	1.24	22.25	71
1	12/11/98	3	4230_3_C	38.6	0	0	23.5	75
1	12/11/98	4	4212_4_C	38.4	0	0	17	63
1	12/11/98	5	4066_5_T	38.8	1	1.05	21.75	71
1	12/11/98	6	3910_6_T	38.5	1.2	0.72	20.25	90
1	12/11/98	7	4106_7_C	38.7	0	0	19	107
1	12/11/98	8	4134_8_C	38.2	0	0	23	87
1	12/12/98	1	4192_1_T	38.4	1.13	1.12	15	57
1	12/12/98	2	4161_2_T	38.6	0.45	1.14	20.4	72
1	12/12/98	3	4230_3_C	38.5	0	0	24	75
1	12/12/98	4	4212_4_C	39	0	0	18.7	72
1	12/12/98	5	4066_5_T	38.9	1.04	1	19.5	66
1	12/12/98	6	3910_6_T	38.5	1.25	1	27	87
1	12/12/98	7	4106_7_C	39	0	0	19.7	102
1	12/12/98	8	4134_8_C	39	0	0	20.2	77
1	12/13/98	1	4192_1_T	38.8	0.95	0.945	19.1	64
1	12/13/98	2	4161_2_T	38.4	1.24	1.03	21.1	66
1	12/13/98	3	4230_3_C	38.3	0	0	21.2	70
1	12/13/98	4	4212_4_C	38.8	0	0	16.3	67
1	12/13/98	5	4066_5_T	38.7	1.05	1	20.9	90
1	12/13/98	6	3910_6_T	38.8	1.03	0.61	21.7	89
1	12/13/98	7	4106_7_C	38.8	0	0	21.3	98
1	12/13/98	8	4134_8_C	38.8	0	0	20.8	77
1	12/14/98	1	4192_1_T	38.2	0.9	1.13	15.6	61
1	12/14/98	2	4161_2_T	38.6	0.96	0.58	20.5	70
1	12/14/98	3	4230_3_C	38.6	0	0	20.3	68
1	12/14/98	4	4212_4_C	38.6	0	0	13.5	62
1	12/14/98	5	4066_5_T	38.6	1.04	1.05	22.1	68
1	12/14/98	6	3910_6_T	38.5	0.81	1.07	24.1	88
1	12/14/98	7	4106_7_C	38.4	0	0	17	104
1	12/14/98	8	4134_8_C	38.5	0	0	22	82
1	12/15/98	1	4192_1_T	38.4	1.02	0.85	17.3	61
1	12/15/98	2	4161_2_T	38.6	0.95	1.1	18.5	70
1	12/15/98	3	4230_3_C	38.2	0	0	22.3	68
1	12/15/98	4	4212_4_C	38.6	0	0	19	62
1	12/15/98	5	4066_5_T	38.5	1.03	1.04	16.5	68
1	12/15/98	6	3910_6_T	38.2	0.9	0.98	20.7	88
1	12/15/98	7	4106_7_C	38.6	0	0	17	104
1	12/15/98	8	4134_8_C	38.4	0	0	19	81
1	12/16/98	1	4192_1_T	38	1.42	1.02	21.2	65
1	12/16/98	2	4161_2_T	38.5	0.98	0.71	22.5	73
1	12/16/98	3	4230_3_C	38.6	0	0	23.2	75
1	12/16/98	4	4212_4_C	38.2	0	0	16.3	75
1	12/16/98	5	4066_5_T	38.6	1.05	1.05	21.5	67

1	12/16/98	6	3910_6_T	38.8	1.05	0.95	26.5	88
1	12/16/98	7	4106_7_C	38.6	0	0	19.5	94
1	12/16/98	8	4134_8_C	38.7	0	0	21	84
1	12/17/98	1	4192_1_T	38.3	1.08	0.83	18	68
1	12/17/98	2	4161_2_T	38.6	1.23	0.71	19	72
1	12/17/98	3	4230_3_C	38.4	0	0	20.8	75
1	12/17/98	4	4212_4_C	38.8	0	0	18	66
1	12/17/98	5	4066_5_T	38.7	1.02	0.94	23.3	69
1	12/17/98	6	3910_6_T	36.2	0.91	0.8	17.8	92
1	12/17/98	7	4106_7_C	38.5	0	0	22	76
1	12/17/98	8	4134_8_C	38.5	0	0	16.5	71
1	12/18/98	1	4192_1_T	38.3	0.98	0	20	63
1	12/18/98	2	4161_2_T	38	0.6	0	20.5	70
1	12/18/98	3	4230_3_C	38.4	0	0	21.2	72
1	12/18/98	4	4212_4_C	38.2	0	0	17.2	68
1	12/18/98	5	4066_5_T	38.7	0.97	0	21.2	70
1	12/18/98	6	3910_6_T	39	1.14	0	19.7	87
1	12/18/98	7	4106_7_C	38.3	0	0	14.3	70
1	12/18/98	8	4134_8_C	38.8	0	0	25	75
2	01/09/99	1	3861_1_T	0	0	0	0	109
2	01/09/99	2	4243_2_T	38.9	0	0	0	79
2	01/09/99	3	4246_3_C	38.8	0	0	0	112
2	01/09/99	4	4239_4_C	38.7	0	0	0	110
2	01/09/99	5	4262_5_T	38.7	0	0	0	67
2	01/09/99	6	4084_6_T	38.5	0	0	0	88
2	01/09/99	7	4052_7_C	38.9	0	0	0	97
2	01/09/99	8	4078_8_C	38.6	0	0	0	119
2	01/10/99	1	3861_1_T	0	0	0	0	107
2	01/10/99	2	4243_2_T	38.5	0	0	17.3	70
2	01/10/99	3	4246_3_C	38.8	0	0	26.7	105
2	01/10/99	4	4239_4_C	38.7	0	0	26.7	105
2	01/10/99	5	4262_5_T	38.5	0	0	16.6	60
2	01/10/99	6	4084_6_T	38.8	0	0	23.1	80
2	01/10/99	7	4052_7_C	38.8	0	0	20.6	96
2	01/10/99	8	4078_8_C	38.5	0	0	25.3	115
2	01/11/99	1	3861_1_T	0	0	0	0	114
2	01/11/99	2	4243_2_T	38.5	0	0	20.2	39
2	01/11/99	3	4246_3_C	38.5	0	0	26	108
2	01/11/99	4	4239_4_C	38.5	0	0	27.3	106
2	01/11/99	5	4262_5_T	38.7	0	0	17.8	61
2	01/11/99	6	4084_6_T	38.8	0	0	21.6	79
2	01/11/99	7	4052_7_C	38.6	0	0	25.3	102
2	01/11/99	8	4078_8_C	38.6	0	0	27.15	120
2	01/12/99	1	3861_1_T	38.7	0	0	25.3	98
2	01/12/99	2	4243_2_T	38.5	0	0	20.6	72
2	01/12/99	3	4246_3_C	37.9	0	0	27	103
2	01/12/99	4	4239_4_C	38.5	0	0	28	101
2	01/12/99	5	4262_5_T	38.5	0	0	18	60
2	01/12/99	6	4084_6_T	38.6	0	0	22	78
2	01/12/99	7	4052_7_C	38.8	0	0	24.5	88
2	01/12/99	8	4078_8_C	38.6	0	0	26.75	119
2	01/13/99	1	3861_1_T	38.8	0	0	22.7	114
2	01/13/99	2	4243_2_T	38.4	0	0	16.2	75
2	01/13/99	3	4246_3_C	38.6	0	0	28.5	108
2	01/13/99	4	4239_4_C	38.5	0	0	32.5	104
2	01/13/99	5	4262_5_T	38.4	0	0	20	62

2	01/13/99	6	4084_6_T	38.5	0	0	25	85
2	01/13/99	7	4052_7_C	38.7	0	0	26.3	99
2	01/13/99	8	4078_8_C	38.2	0	0	27.3	115
2	01/14/99	1	3861_1_T	38.2	0	0	24.9	104
2	01/14/99	2	4243_2_T	38.8	0	0	19	73
2	01/14/99	3	4246_3_C	38.3	0	0	28	107
2	01/14/99	4	4239_4_C	38.6	0	0	25.5	101
2	01/14/99	5	4262_5_T	38.5	0	0	21.3	64
2	01/14/99	6	4084_6_T	38.6	0	0	23.5	77
2	01/14/99	7	4052_7_C	38.6	0	0	22.2	93
2	01/14/99	8	4078_8_C	38.6	0	0	27.7	113
2	01/15/99	1	3861_1_T	38.5	0	0	23.9	103
2	01/15/99	2	4243_2_T	38.8	0	0	20	68
2	01/15/99	3	4246_3_C	38.3	0	0	25	98
2	01/15/99	4	4239_4_C	38.3	0	0	30.7	82
2	01/15/99	5	4262_5_T	38.3	0	0	16.2	57
2	01/15/99	6	4084_6_T	38.3	0	0	20	85
2	01/15/99	7	4052_7_C	38.7	0	0	24.3	86
2	01/15/99	8	4078_8_C	38.7	0	0	28.8	97
2	01/16/99	1	3861_1_T	38.8	1.008	0.986	27	100
2	01/16/99	2	4243_2_T	38.7	1.193	0.997	19.8	64
2	01/16/99	3	4246_3_C	38.7	0	0	24.5	99
2	01/16/99	4	4239_4_C	38.9	0	0	27.3	83
2	01/16/99	5	4262_5_T	38.5	1.001	0.78	20.3	61
2	01/16/99	6	4084_6_T	38.8	1.131	1.045	21.7	70
2	01/16/99	7	4052_7_C	38.8	0	0	23	92
2	01/16/99	8	4078_8_C	38.9	0	0	28.2	97
2	01/17/99	1	3861_1_T	38.8	0.927	0.915	23.8	94
2	01/17/99	2	4243_2_T	38.8	0.998	0.975	17.2	62
2	01/17/99	3	4246_3_C	38.5	0	0	26	93
2	01/17/99	4	4239_4_C	38.9	0	0	26.4	73
2	01/17/99	5	4262_5_T	38.7	1.053	0.349	20.2	62
2	01/17/99	6	4084_6_T	38.5	1.112	0.778	23.6	66
2	01/17/99	7	4052_7_C	38.8	0	0	27.5	89
2	01/17/99	8	4078_8_C	38.8	0	0	28.4	98
2	01/18/99	1	3861_1_T	38.8	1.173	1.05	23.5	94
2	01/18/99	2	4243_2_T	38.4	0.993	0.956	14.5	69
2	01/18/99	3	4246_3_C	38.7	0	0	26.8	105
2	01/18/99	4	4239_4_C	38.8	0	0	24.8	83
2	01/18/99	5	4262_5_T	38.1	0.617	0.583	19.7	66
2	01/18/99	6	4084_6_T	38.8	1.148	0.879	23.2	75
2	01/18/99	7	4052_7_C	38.9	0	0	27.1	95
2	01/18/99	8	4078_8_C	38.6	0	0	25	106
2	01/19/99	1	3861_1_T	38.5	1.09	0.974	22.15	90
2	01/19/99	2	4243_2_T	38.6	0.92	0.91	18.8	51
2	01/19/99	3	4246_3_C	38.5	0	0	26.2	97
2	01/19/99	4	4239_4_C	38.5	0	0	27	80
2	01/19/99	5	4262_5_T	38.4	1.05	0.869	19.3	65
2	01/19/99	6	4084_6_T	37.8	1.06	0.995	20	67
2	01/19/99	7	4052_7_C	38.1	0	0	22.6	91
2	01/19/99	8	4078_8_C	38.5	0	0	26.6	113
2	01/20/99	1	3861_1_T	38	0.56	0.582	27.75	91
2	01/20/99	2	4243_2_T	38.4	0.73	0.892	21.7	66
2	01/20/99	3	4246_3_C	38.7	0	0	31.8	107
2	01/20/99	4	4239_4_C	38.3	0	0	34.5	88
2	01/20/99	5	4262_5_T	38.4	0.15	0.945	24.3	72

2	01/20/99	6	4084_6_T	38.6	0.89	0.856	23.25	69
2	01/20/99	7	4052_7_C	38.7	0	0	29	61
2	01/20/99	8	4078_8_C	38.7	0	0	32	113
2	01/21/99	1	3861_1_T	38.8	1.26	1.111	22	94
2	01/21/99	2	4243_2_T	38.4	0.74	1.39	20.5	65
2	01/21/99	3	4246_3_C	38.5	0	0	25.7	100
2	01/21/99	4	4239_4_C	38.7	0	0	26	92
2	01/21/99	5	4262_5_T	38.5	0.33	0.582	21	72
2	01/21/99	6	4084_6_T	38.3	0.73	0.706	25.75	71
2	01/21/99	7	4052_7_C	38.8	0	0	29	94
2	01/21/99	8	4078_8_C	38.5	0	0	26.3	115
2	01/22/99	1	3861_1_T	38.3	1.05	1.115	22.3	84
2	01/22/99	2	4243_2_T	38.6	1.2	0.908	20.3	63
2	01/22/99	3	4246_3_C	38.8	0	0	25.5	101
2	01/22/99	4	4239_4_C	39.2	0	0	27.5	87
2	01/22/99	5	4262_5_T	38.6	1.04	0.498	20	69
2	01/22/99	6	4084_6_T	38.9	0.92	1	23.5	71
2	01/22/99	7	4052_7_C	38.9	0	0	24	101
2	01/22/99	8	4078_8_C	38.7	0	0	31	112
2	01/23/99	1	3861_1_T	38.8	0.885	1.169	21.8	75
2	01/23/99	2	4243_2_T	38.7	1.279	1.134	19.5	81
2	01/23/99	3	4246_3_C	38.3	0	0	28.3	102
2	01/23/99	4	4239_4_C	38.6	0	0	32.2	87
2	01/23/99	5	4262_5_T	38.5	0.623	0.237	23.7	74
2	01/23/99	6	4084_6_T	38.4	1.237	1.241	23.6	74
2	01/23/99	7	4052_7_C	38.6	0	0	33	93
2	01/23/99	8	4078_8_C	38.4	0	0	27.2	114
2	01/24/99	1	3861_1_T	38.8	1.063	0.709	22.5	92
2	01/24/99	2	4243_2_T	38.6	1.069	0.977	21.7	65
2	01/24/99	3	4246_3_C	38.8	0	0	27.8	100
2	01/24/99	4	4239_4_C	38.7	0	0	31.1	88
2	01/24/99	5	4262_5_T	38.4	1.044	0.439	21.5	70
2	01/24/99	6	4084_6_T	38.4	1.239	1.068	22.1	67
2	01/24/99	7	4052_7_C	38.8	0	0	25.3	93
2	01/24/99	8	4078_8_C	38.7	0	0	25.6	112
2	01/25/99	1	3861_1_T	38.7	0.96	0.958	20.4	84
2	01/25/99	2	4243_2_T	38.6	0.67	1.177	18.5	63
2	01/25/99	3	4246_3_C	38.1	0	0	27.65	102
2	01/25/99	4	4239_4_C	38.8	0	0	29.7	89
2	01/25/99	5	4262_5_T	38.5	0.48	0.524	21.5	69
2	01/25/99	6	4084_6_T	38	0.82	0.707	22.8	69
2	01/25/99	7	4052_7_C	38.9	0	0	24.2	96
2	01/25/99	8	4078_8_C	38.8	0	0	29.2	106
2	01/26/99	1	3861_1_T	38.8	0.58	1.004	21	71
2	01/26/99	2	4243_2_T	38.7	0.97	0.916	15.5	59
2	01/26/99	3	4246_3_C	38.5	0	0	27.75	97
2	01/26/99	4	4239_4_C	38.6	0	0	29.5	81
2	01/26/99	5	4262_5_T	38.4	0.33	0.46	21.5	63
2	01/26/99	6	4084_6_T	39	1.08	1.151	24.5	63
2	01/26/99	7	4052_7_C	38.6	0	0	25.3	82
2	01/26/99	8	4078_8_C	38.7	0	0	26.2	99
2	01/27/99	1	3861_1_T	38.5	0.76	0.69	21	67
2	01/27/99	2	4243_2_T	38.7	0.97	0.992	24	59
2	01/27/99	3	4246_3_C	38.2	0	0	29.3	90
2	01/27/99	4	4239_4_C	38.4	0	0	28.5	86
2	01/27/99	5	4262_5_T	38.5	0.33	0.476	24	64

2	01/27/99	6	4084_6_T	37.8	1.17	0.27	25	64
2	01/27/99	7	4052_7_C	38.7	0	0	28.2	90
2	01/27/99	8	4078_8_C	38.8	0	0	25	94
2	01/28/99	1	3861_1_T	37.8	0.95	1.202	18	60
2	01/28/99	2	4243_2_T	38.6	1.06	1.162	22.3	58
2	01/28/99	3	4246_3_C	38	0	0	36	90
2	01/28/99	4	4239_4_C	35.5	0	0	27	75
2	01/28/99	5	4262_5_T	38.8	0.29	0.587	20.3	66
2	01/28/99	6	4084_6_T	38.2	1.1	1.18	20.5	60
2	01/28/99	7	4052_7_C	38.3	0	0	25.3	82
2	01/28/99	8	4078_8_C	38.7	0	0	27	93
2	01/29/99	1	3861_1_T	38.5	0.75	0	18.8	66
2	01/29/99	2	4243_2_T	38.1	0.93	0	16.2	25
2	01/29/99	3	4246_3_C	38.2	0	0	17.2	45
2	01/29/99	4	4239_4_C	38.5	0	0	29	44
2	01/29/99	5	4262_5_T	38.5	0.55	0	22.2	31
2	01/29/99	6	4084_6_T	38.8	0.55	0	22	30
2	01/29/99	7	4052_7_C	38.6	0	0	29.5	47
2	01/29/99	8	4078_8_C	38.4	0	0	27.8	45
3	4/10/99	1	3987_1_T	38.7	0	0	0	51
3	4/10/99	2	4057_2_T	38.9	0	0	0	110
3	4/10/99	3	4105_3_C	38.4	0	0	0	67
3	4/10/99	4	3996_4_C	38.6	0	0	0	71
3	4/10/99	5	4157_5_T	38.5	0	0	0	69
3	4/10/99	6	4279_6_T	38.9	0	0	0	79
3	4/10/99	7	4286_7_C	38.7	0	0	0	104
3	4/10/99	8	3970_8_C	38.7	0	0	0	73
3	4/11/99	1	3987_1_T	38.6	0	0	17.7	59
3	4/11/99	2	4057_2_T	38.8	0	0	31.4	109
3	4/11/99	3	4105_3_C	38.8	0	0	21.5	72
3	4/11/99	4	3996_4_C	38.7	0	0	23.8	75
3	4/11/99	5	4157_5_T	38.8	0	0	23.6	79
3	4/11/99	6	4279_6_T	38.8	0	0	28.2	89
3	4/11/99	7	4286_7_C	38.8	0	0	28.2	120
3	4/11/99	8	3970_8_C	38.3	0	0	17.6	91
3	4/12/99	1	3987_1_T	38.7	0	0	21	58
3	4/12/99	2	4057_2_T	38.4	0	0	28.3	113
3	4/12/99	3	4105_3_C	38.7	0	0	22.3	72
3	4/12/99	4	3996_4_C	38.8	0	0	25.7	72
3	4/12/99	5	4157_5_T	38.6	0	0	20.5	78
3	4/12/99	6	4279_6_T	38.5	0	0	24	82
3	4/12/99	7	4286_7_C	38.7	0	0	29.4	114
3	4/12/99	8	3970_8_C	38.5	0	0	22	86
3	4/13/99	1	3987_1_T	39.1	0	0	15.5	56
3	4/13/99	2	4057_2_T	38.3	0	0	24	111
3	4/13/99	3	4105_3_C	38.4	0	0	22.2	66
3	4/13/99	4	3996_4_C	38.8	0	0	19	66
3	4/13/99	5	4157_5_T	38.8	0	0	15	75
3	4/13/99	6	4279_6_T	38.7	0	0	25	91
3	4/13/99	7	4286_7_C	38.2	0	0	18	106
3	4/13/99	8	3970_8_C	38	0	0	26.5	88
3	4/14/99	1	3987_1_T	38.8	0	0	16	57
3	4/14/99	2	4057_2_T	38.9	0	0	32	112
3	4/14/99	3	4105_3_C	38.5	0	0	19.6	63
3	4/14/99	4	3996_4_C	38.6	0	0	19	63
3	4/14/99	5	4157_5_T	38.5	0	0	23.3	73

3	4/14/99	6	4279_6_T	38.5	0	0	25.5	84
3	4/14/99	7	4286_7_C	38	0	0	20.5	104
3	4/14/99	8	3970_8_C	38.5	0	0	22.8	85
3	4/15/99	1	3987_1_T	38.7	0	0	18.5	55
3	4/15/99	2	4057_2_T	38.8	0	0	30	100
3	4/15/99	3	4105_3_C	38.4	0	0	19.45	62
3	4/15/99	4	3996_4_C	38.2	0	0	23.7	73
3	4/15/99	5	4157_5_T	38.5	0	0	25	65
3	4/15/99	6	4279_6_T	38.5	0	0	29	86
3	4/15/99	7	4286_7_C	38.3	0	0	22	68
3	4/15/99	8	3970_8_C	38.4	0	0	24.5	81
3	4/16/99	1	3987_1_T	38.6	0	0	22.5	57
3	4/16/99	2	4057_2_T	38.7	0	0	28.5	106
3	4/16/99	3	4105_3_C	37.8	0	0	21.25	66
3	4/16/99	4	3996_4_C	38.7	0	0	29.3	66
3	4/16/99	5	4157_5_T	38.5	0	0	24	65
3	4/16/99	6	4279_6_T	38.7	0	0	28.5	82
3	4/16/99	7	4286_7_C	39.5	0	0	29.5	84
3	4/16/99	8	3970_8_C	38.5	0	0	26.5	94
3	4/17/99	1	3987_1_T	38.6	0.99	1.004	23.7	60
3	4/17/99	2	4057_2_T	38.7	1.041	1.021	31.2	111
3	4/17/99	3	4105_3_C	38.5	0	0	23.9	60
3	4/17/99	4	3996_4_C	38.6	0	0	27.5	68
3	4/17/99	5	4157_5_T	38.7	0.994	1.001	27.2	67
3	4/17/99	6	4279_6_T	38.4	0.98	0.996	30	86
3	4/17/99	7	4286_7_C	38.3	0	0	24	69
3	4/17/99	8	3970_8_C	38.4	0	0	29.4	81
3	4/18/99	1	3987_1_T	38.8	0.997	0.927	22.2	54
3	4/18/99	2	4057_2_T	39.1	1.032	1.025	29.8	104
3	4/18/99	3	4105_3_C	38.8	0	0	19.6	59
3	4/18/99	4	3996_4_C	39.1	0	0	23.3	68
3	4/18/99	5	4157_5_T	39	1.032	0.994	15.8	61
3	4/18/99	6	4279_6_T	38.8	0.998	0.971	24.8	83
3	4/18/99	7	4286_7_C	39	0	0	23	83
3	4/18/99	8	3970_8_C	38.9	0	0	23.9	82
3	4/19/99	1	3987_1_T	38.3	0.988	0.991	23.4	52
3	4/19/99	2	4057_2_T	38.3	1.013	1.05	24	83
3	4/19/99	3	4105_3_C	38.8	0	0	20.5	59
3	4/19/99	4	3996_4_C	38.5	0	0	30.5	61
3	4/19/99	5	4157_5_T	38.5	0.99	1.017	27.2	65
3	4/19/99	6	4279_6_T	38.8	0.998	1.005	26.7	85
3	4/19/99	7	4286_7_C	38.8	0	0	28.3	84
3	4/19/99	8	3970_8_C	38.1	0	0	28.2	81
3	4/20/99	1	3987_1_T	38.2	0.975	0.982	22.2	52
3	4/20/99	2	4057_2_T	38.8	1.025	1.046	24.5	88
3	4/20/99	3	4105_3_C	38.4	0	0	22	52
3	4/20/99	4	3996_4_C	38.7	0	0	26.5	64
3	4/20/99	5	4157_5_T	38.8	0.977	1.002	25.5	63
3	4/20/99	6	4279_6_T	38.9	0.995	0.997	25.5	83
3	4/20/99	7	4286_7_C	37.6	0	0	27.5	78
3	4/20/99	8	3970_8_C	38.4	0	0	21.7	82
3	4/21/99	1	3987_1_T	38.9	0.969	0.965	23	50
3	4/21/99	2	4057_2_T	38.8	0.97	1.035	31.5	90
3	4/21/99	3	4105_3_C	38.8	0	0	19	60
3	4/21/99	4	3996_4_C	38.6	0	0	27	64
3	4/21/99	5	4157_5_T	38.8	0.954	0.971	26.5	61

3	4/21/99	6	4279_6_T	38.3	1	0.99	25	81
3	4/21/99	7	4286_7_C	38.8	0	0	27.7	101
3	4/21/99	8	3970_8_C	38.1	0	0	25	87
3	4/22/99	1	3987_1_T	38.8	0.974	0.957	25	57
3	4/22/99	2	4057_2_T	38.7	1.008	1.017	30.3	99
3	4/22/99	3	4105_3_C	38.5	0	0	20.8	56
3	4/22/99	4	3996_4_C	38.9	0	0	26.7	67
3	4/22/99	5	4157_5_T	38.6	0.982	0.982	21	71
3	4/22/99	6	4279_6_T	39	0.982	0.994	29.3	91
3	4/22/99	7	4286_7_C	38.5	0	0	31.5	104
3	4/22/99	8	3970_8_C	38.2	0	0	25.3	81
3	4/23/99	1	3987_1_T	38.7	1	1.005	22	56
3	4/23/99	2	4057_2_T	38.5	1.024	1.05	25.7	87
3	4/23/99	3	4105_3_C	38.5	0	0	21.7	53
3	4/23/99	4	3996_4_C	38.7	0	0	28.3	60
3	4/23/99	5	4157_5_T	38.7	0.989	1.006	23.5	65
3	4/23/99	6	4279_6_T	39	0.989	1.007	23.7	89
3	4/23/99	7	4286_7_C	38.1	0	0	30.3	95
3	4/23/99	8	3970_8_C	37.1	0	0	24.5	81
3	4/24/99	1	3987_1_T	38.8	1.015	0.998	18.1	48
3	4/24/99	2	4057_2_T	38.4	1.046	1.053	27	91
3	4/24/99	3	4105_3_C	38.6	0	0	17.2	46
3	4/24/99	4	3996_4_C	38.9	0	0	20	61
3	4/24/99	5	4157_5_T	38.4	1.005	0.991	20.5	67
3	4/24/99	6	4279_6_T	38.8	1.002	0.991	23.2	83
3	4/24/99	7	4286_7_C	38.8	0	0	22.7	108
3	4/24/99	8	3970_8_C	38.7	0	0	23.2	79
3	4/25/99	1	3987_1_T	38.5	1.002	0.997	21.2	55
3	4/25/99	2	4057_2_T	38.7	1.05	1.037	24.5	88
3	4/25/99	3	4105_3_C	38.6	0	0	19	50
3	4/25/99	4	3996_4_C	38.9	0	0	26.7	60
3	4/25/99	5	4157_5_T	38.4	1	0.991	21.5	63
3	4/25/99	6	4279_6_T	38.8	0.996	0.991	23.8	80
3	4/25/99	7	4286_7_C	39	0	0	20.2	100
3	4/25/99	8	3970_8_C	38.5	0	0	23	77
3	4/26/99	1	3987_1_T	38.6	1	1.003	22.7	52
3	4/26/99	2	4057_2_T	38.2	1.038	1.056	26.3	92
3	4/26/99	3	4105_3_C	38.7	0	0	19.3	52
3	4/26/99	4	3996_4_C	38.7	0	0	26.8	62
3	4/26/99	5	4157_5_T	38.5	0.998	1.009	26.5	64
3	4/26/99	6	4279_6_T	38.8	0.94	1.003	28.3	85
3	4/26/99	7	4286_7_C	38.5	0	0	27.1	100
3	4/26/99	8	3970_8_C	38.4	0	0	26.5	78
3	4/27/99	1	3987_1_T	38.5	0.908	0.93	25.5	52
3	4/27/99	2	4057_2_T	38.7	1.02	1.041	32.7	90
3	4/27/99	3	4105_3_C	38.5	0	0	21.5	53
3	4/27/99	4	3996_4_C	38.8	0	0	26.5	61
3	4/27/99	5	4157_5_T	38.6	0.732	1	23.8	62
3	4/27/99	6	4279_6_T	38.5	0.991	0.999	28.7	88
3	4/27/99	7	4286_7_C	38.5	0	0	28.7	102
3	4/27/99	8	3970_8_C	38.6	0	0	27.5	82
3	4/28/99	1	3987_1_T	38.8	0.989	1.006	20	51
3	4/28/99	2	4057_2_T	38.8	0.956	1.04	27	78
3	4/28/99	3	4105_3_C	38.5	0	0	20	47
3	4/28/99	4	3996_4_C	38.8	0	0	24.2	53
3	4/28/99	5	4157_5_T	38.8	0.989	1	19.7	63

4360	T	il1vitro	319.9	198.4
3813	T	il1vitro	317.9	190.3
2336	C	il1serum	16.06	9.34
945	C	il1serum	5.23	8.61
4128	C	il1serum	6.67	19.74
4341	T	il1serum	10.75	24.73
4119	T	il1serum	7.97	4.89
4360	T	il1serum	6.50	3.69
3813	T	il1serum	4.18	5.55
2336	C	iggserum	10.9	12
945	C	iggserum	10.8	7.8

4128	C	iggserum	11.2	10.8
4341	T	iggserum	11.5	13.6
4119	T	iggserum	10.3	12.3
4360	T	iggserum	11.6	7.2
3813	T	iggserum	13.2	10.6
2336	C	igaserum	1.64	2.86
945	C	igaserum	0.98	1.08
4128	C	igaserum	2.54	2.78
4341	T	igaserum	1.56	3.74
4119	T	igaserum	0.94	2.67
4360	T	igaserum	2.38	0.86
3813	T	igaserum	3.22	3.1

Appendix VI. Cow and stall observation data for positive control experiment.

date	stall	cow.num	amtemp	amwater	milk
05/08/99	2	4341_2_T	38.4	0	119
05/08/99	3	2336_3_C	38.6	0	77
05/08/99	4	4119_4_T	38.8	0	97
05/08/99	5	945_5_C	38.4	0	99
05/08/99	6	4360_6_T	38.8	0	92
05/08/99	7	4128_7_C	38.5	0	76
05/08/99	8	3813_8_T	38.4	0	87
05/09/99	2	4341_2_T	39	21	114
05/09/99	3	2336_3_C	38.5	30.2	83
05/09/99	4	4119_4_T	38.6	28.8	88
05/09/99	5	945_5_C	38.4	31.6	97
05/09/99	6	4360_6_T	38.7	27.6	83
05/09/99	7	4128_7_C	38.5	18.1	59
05/09/99	8	3813_8_T	38.5	19.8	76
05/10/99	2	4341_2_T	38.3	22.5	92
05/10/99	3	2336_3_C	38	32.3	70
05/10/99	4	4119_4_T	38.3	25.6	67
05/10/99	5	945_5_C	38.3	20	102
05/10/99	6	4360_6_T	38.3	18.5	71
05/10/99	7	4128_7_C	38.4	18.7	66
05/10/99	8	3813_8_T	38.4	14	61
05/11/99	2	4341_2_T	38.3	29.5	77
05/11/99	3	2336_3_C	38.2	39	72
05/11/99	4	4119_4_T	38.5	25.2	54
05/11/99	5	945_5_C	38.5	30.5	96
05/11/99	6	4360_6_T	38.7	24.2	56
05/11/99	7	4128_7_C	38.3	22.3	64
05/11/99	8	3813_8_T	38.3	25.3	42
05/12/99	2	4341_2_T	38	22	74
05/12/99	3	2336_3_C	38.2	30.5	66
05/12/99	4	4119_4_T	38.4	14.5	48
05/12/99	5	945_5_C	38.3	24.5	104
05/12/99	6	4360_6_T	38.5	14.3	46
05/12/99	7	4128_7_C	38.7	12.2	65
05/12/99	8	3813_8_T	38.5	10.7	23
05/13/99	2	4341_2_T	38.5	20.3	87
05/13/99	3	2336_3_C	38	34.5	65
05/13/99	4	4119_4_T	38.8	17	52
05/13/99	5	945_5_C	38.7	22.3	98
05/13/99	6	4360_6_T	38.8	16	57
05/13/99	7	4128_7_C	38.3	15.3	74
05/13/99	8	3813_8_T	39	9.8	15
05/14/99	2	4341_2_T	38.9	18.2	81
05/14/99	3	2336_3_C	38.5	23.8	65
05/14/99	4	4119_4_T	38.5	16.3	53
05/14/99	5	945_5_C	38.5	24.5	103
05/14/99	6	4360_6_T	38.1	19.2	56
05/14/99	7	4128_7_C	37.8	16.2	70
05/14/99	8	3813_8_T	38.4	4.7	6

Riley Hendrickson

om: Anderson, Larry E [larry.anderson@pnl.gov]
ent: Thursday, July 01, 1999 4:23 PM
To: 'Hendrickson, Riley'
Cc: Anderson, Larry E
Subject: Final report

Dear Riley:

The final report on Parts I and II of the study conducted in Dr Douglas Reinemann's laboratory at the University of Wisconsin-Madison has been reviewed. It presents the results of experiments to compare behavioral and physiological responses in cows subjected to a 60 Hz current. Also described was a second study investigating the effect of current on mild delivery and efficiency of milking.

The report was clear and consise with an excellent description of the rationale for selecting parameters of interest; experimental design used in the study; preliminary tests used to establish baseline values and the description of results. Furthermore, the analysis of those results, although brief, were straightforward and consistent with the data collected. A few specific points of clarification are noted below:

1] Statistical methods applied are not described adequately in the materials and methods sections of the reports. A brief section on the statistical treatment of the data would be valuable.

2] Indication is made that the cortisol assay procedure resulted in over 90% of the cortisol from the serum. However, there is no indication or data included demonstrate that such recovery was actually achieved. Was information tained as the the variability from assay to assay or sample to sample. If information is available on the precision and reproducibility for each test (eg., were samples spiked to develop a standard concentration curve to provide controls within the assay) it should be included in the report.

3] Additional environmental information should be included (eg., lighting cycle, time of year, temperature and relative humidity). This kind of information may be important if any attempts at replication of the results are conducted.

4] No indication is given that this was a "blind" study. Was the exposure condition known to behavioral observers, for instance. Also were the assays and milk production data determined with the analyses blind to exposure condition?

Overall, the conclusions seem to be strongly supported by the experimental results - that exposure to 60 Hz currents are more readily observable via behavioral changes than through measurements in physiological (cortisol) indicators. Also, that adverse responses in milking parameters were not observed when cows are exposed to 60 Hz currents (1 mA) during milking.

Larry

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June 26, 1999

Riley Hendrickson
The Bakken Library and Museum
3537 Zenith Ave. S.
Minneapolis, MN 55416

Dear Riley:

I have reviewed the June, 1999, "Dairy Cow Response to Electrical Environment, Final Report, Part I. Comparison of Behavioral to Physiological Responses and Part II. Comparison of Treatments Applied during Milking" that was submitted to the MN Public Utilities Commission by Dr. Douglas Reinemann and coworkers.

Based upon what was submitted, the following are my comments:

1) Satisfactory progress continues to be made in achieving the four major objectives that were outlined in the contract with the MN PUC for this research.

2) I believe that the investigators should be complimented on the care used in planning and conducting the studies. Use of controls, random selection of subjects, appropriate statistical analysis of data and attention to validation of equipment and assays were included and were important to obtaining reliable results.

3) Results of Part I of the report indicate that behavioral changes are more sensitive indicators of response to electric current than blood cortisol levels.

a) While plasma concentration of cortisol may not rise following a relatively short term exposure of dairy cows to an electrical environment, it is only one indicator of stress. Responses to stress are very complex. Studies in the future should be more adequately funded and should continue to look at the impact of chronic stress that may occur from a wide variety of sources, including nonelectrical stressors, such as poor nutrition and metabolic diseases. Behavioral, endocrine and immune system studies combined with performance criteria such as fertility, reproduction, weight of newborns, dry matter intake, feed conversion, body condition, weight

gain, and milk production are required to fully assess potential harmful impacts of chronic stress in cattle.

b) Animal scientists and veterinarians have for many decades devoted their
research efforts to finding ways to make animals more comfortable, more healthy and more productive. They have had a major role in improving the efficiency of food animal production. In the Final Report of the Science Advisors to the PUC, July 31, 1998, page 35, reference was made to two 1998 publications regarding measures of responses of pigs to acute stress. Authors of these articles are well established experts in their field of research. Hicks et al. reported: "Because of the lack of agreement on the appropriate or 'best' measures for stress, a battery of physiological, behavioral, endocrine, and immune traits were measured." "During acute stress, behavioral changes seem to be the most consistent and reliable indicators."

c) Behavioral changes or an elevation in endocrine concentrations in blood
or plasma do not necessarily accompany or cause impaired performance, the most important concern in food animal production and, perhaps, the best indicator of an unhealthy environment for cows. For example, Turner et al. reported: "Our results suggest that repeated acute activation of the hypothalamo-pituitary adrenal axis prior to and during estrus does not affect the factors that control estrus and ovulation in gilts." "The negative handling treatment (shocking the gilts with an electric prodder) resulted in substantial elevations in plasma concentrations of cortisol for periods of at least 3-4 h and induced a higher level of fear of humans than in control gilts. Nonetheless, none of the parameters of reproduction or sexual behavior were affected by negative handling."

d) Behavioral or endocrine changes may provide new information on mechanisms of physiological responses but not all changes are undesirable or indicative of an impairment in performance. The finding that the hoof trimming treatment caused an elevation of plasma cortisol does not indicate that the procedure had lasting harmful impacts on production or health or that the hoof trimming procedure should be discontinued.

e) On page 9, paragraph 2, lines 9 and 10, it is stated that: "Information on the cows used for this study is given in the Appendix." I could not find that information in my copy.

4) Results of Part II of the report indicate that one mA, rms of 60 Hz electrical current applied from front to back hooves during milking did not significantly alter milk yield, average milk flow rate, maximum milk flow rate, cow activity, and strip yield.

a) It appears that milking unit pulsation failure and aged liners (not uncommon problems on dairy farms) had a measurable effect on milking patterns but that a 5 minute exposure to an electric current of 1 mA from front to rear hooves during milking did not affect milking patterns or cow activity. This controlled study in which cows were randomly selected for assignment to groups, in which known and measurable milking machine problems were introduced and in which the same operator milked all the cows during the study is important. Clearly, this type of experiment could not be conducted satisfactorily on privately-owned farms and is an example of carefully planned and conducted experimentation in seeking unbiased results.

b) I believe that in the discussion on page 12 some comment by the authors
regarding the following may be desirable:

1. "A malfunctioning pulsator is a problem commonly encountered in the
field and was expected to produce mild discomfort to the cows." See page 10, paragraph 5, lines 5 to 7." "Pulsation failure produced a significant decrease in cow activity." See page 12, paragraph 2, lines 2 and 3. A reader might speculate: a) that pulsation failure in this experiment did not cause discomfort but had another physiological effect, b) that pulsator failure caused discomfort but the cows responded by moving less than without the pulsator failure, or c) that stopping or reducing milking machine pulsation is a suitable method for reducing cow activity during milking? What is the best interpretation of this finding?

2. "This reduction in tension (artificially aging a liner) was expected to reduce the massage applied to the cows' teats during milking, thus causing mild discomfort to the cows." See page 11, paragraph 1, lines 3 to 5. "Aged liners produced a significant effect on milk yield (2.2 kg. increase)..." To the reader without background information, this may sound as if artificially aging liners would be a method for increasing milk yield. An explanation of the potential long term effects of aged liners on udder health and milk production over the entire lactation is indicated. Also, an explanation is needed for why milk yield over the 3 milkings was increased by aged liners.

5) A report on Part III, Immune Function Response to Sub-acute Voltages, has not been submitted and, therefore, critical review of data, results and conclusions is not possible at this time. Procedures for conducting the trials and for analysis of the immune response appeared to be carefully set forth. Appropriate control animals/stalls and sensitivity and specificity of the immune assays had been identified. Randomized stall assignment and stall maintenance were properly outlined. The researchers indicated that

they were seeking approval for use of a positive control procedure for immune suppression. However, they did not specify what that procedure might be.

I look forward to reviewing Part III of this interesting research and I am encouraged by the carefully planned and executed studies that have already been reported. I believe that this research provides valuable new information. I don't expect that all the questions that have been, are being or will be asked by concerned individuals will be answered by this recently completed research.

Please contact me if you need further comment or action from me.

Sincerely yours,

Harold Dziuk, D.V.M., M.S., Ph.D.

Riley Hendrickson

From: Harold Dziuk [hdziuk@bigfork.net]
Sent: Friday, July 09, 1999 6:34 AM
To: hendrick@thebakken.org

Harold Dziuk
51301 Pine Point Road
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Phone: 218-743-6102
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July 8, 1999

Riley Hendrickson
The Bakken Library and Museum
3537 Zenith Ave. S.
Minneapolis, MN 55416

Dear Riley:

I have reviewed the June, 1999, "Dairy Cow Response to Electrical Environment, Final Report, Part III. Immune Function Response To Low-Level Electrical Current Exposure" that was submitted to the MN Public Utilities Commission by Dr. Douglas Reinemann and coworkers.

Based upon what was submitted, the following are my comments:

1) The four major objectives that were outlined in the contract with the MN PUC for this research have been satisfactorily completed.

2) Repeating what I wrote after review of Parts I and II of the Final Report, I believe that the investigators should be complimented on the care used in planning, conducting and reporting the studies in Part III. Use of controls, random selection of subjects, appropriate statistical analysis of data and attention to validation of equipment and assays were included and were important to obtaining reliable results.

3) Results of Part III of the Report indicate that for dairy cows 1 mA of 60 Hz electrical current for two weeks had no significant effect on immune function responses, standing and lying behavior, or time required to enter stalls. I concur with the conclusions drawn by the authors.

4) Procedures for conducting the trials and for analysis of the immune responses were carefully set forth and completed. Appropriate control animals/stalls and sensitivity and specificity of the immune assays were identified. Randomized stall assignment and stall maintenance were properly outlined. The use of dexamethasone injections over a 4-day period provided positive and informative control values to determine if the immune response tests would detect the expected immunosuppression.

5) I believe that the research that has been completed by the authors and summarized in the Final Report is very valuable in understanding dairy cow responses to electrical environments. Also, I believe that the results they obtained can be relied upon and should be considered carefully by those who make recommendations for dairy cow herd management in the future.

6) Information from this last study that is outlined in the Final Report, review of the literature, on-farm visits, information provided at public hearings, surveys of dairy farmers, and measurements of electrical events on farms coupled with assessment of electrical wiring and herd health management all indicate that earth currents do not significantly contribute to herd health and production problems in dairy herds.

Please contact me if you need further comment or action from me.

Sincerely yours,

Review of "Final Report" by Dr. Reinemann et al. on "Dairy Cow Response to Electrical Environment" (Research in 1998/99 sponsored by Minnesota PUC).

Part I. Comparison of Behavioral to Physiological Responses

The conclusion that "cows respond at lower current levels to 1-front to 2-rear hoof pathway than to muzzle to 4-hooves" is interesting. Of course, this experiment neither provided, nor was it designed to provide any information about possible effects of long-term exposure to small currents, since the "behavioral response" was only tested during 5-minute observation periods. The experiments tested only, as indicated in the "Conclusions" (page 9) immediate "perception or annoyance" to the sudden application of a current.

Apparently two types of exposure were used:
(1) Constant current for 1 minute, and
(2) Pulsed 60 Hz (0.5 seconds on and 2 seconds off for 1 minute);
The authors state (page 7) that "there appeared to be little difference between constant and pulsed exposure methods", but data to show this cannot be found in the report. Did the "flinch" response just occur when the current was first turned on , so that what came after the switching event made no or little difference?

On page 6 the report states that "the current delivered to cows was controlled by adjusting the source resistance and was measured as the voltage across a 1000 ohm resistor in series with the cow circuit and confirmed using a precision current clamp". **Where** was the "current clamp" (current clamp-on meter) placed? Did it actually measure current through the cows' leg(s)?

Also on page 6 the report states "stalls were routinely checked for any current leakage paths using a standard cow-contact measurement device (copper plates placed 1-m apart and connected with shunt resistors ranging from 500 to 10000 ohms)". It would be interesting to see the results of these measurements to confirm that the entire applied current was actually flowing through the animal.

Part II. Comparison of Treatments Applied during Milking.

Referring to the circuit on Fig.9 of the report, how was it verified that the current (measured by the voltage across the 1000 ohm resistor) was actually flowing through the cow, and particularly along the front to rear hooves path? What was the magnitude (if measurable) of the leakage current bypassing the cow?

What measurements (if any) were made to verify that no current was flowing from any part of the milking equipment through either control or exposed animals?

Under "Results and Discussion" (page 12) I note the statement "there was no statistically significant **main** (my emphasis) effect for current exposure for any of the response variables for either experiment". What is meant by "main effect" and what were the statistically significant effects of the other, non-"main" variables? Do the authors identify as not "main" the statistically significant effects of interaction between current exposure and pulsation failure in experiment I, and with aged liner in experiment II?

Part III. Immune Function Response to Low-Level Electrical Current Exposure

The conclusion of this report "Collectively, these results suggest that exposure to 1 mA of 60 Hz electrical current for two weeks had no significant effect on immune function of dairy cattle" is **not** justified. This comment is based, in part, on discussions with my immunologist colleague, Dr. S. Mehta.

On page 6 the authors of the report state correctly that "Phytohemagglutinin and Concanavalin-A activate largely T lymphocytes, pokeweed mitogen (activates) T and B lymphocytes and *S.aureus* (activates) B lymphocytes". Therefore one cannot expect that the *S.aureus* assay of lymphocytes should be "consistent with other observations" as stated in the "Conclusion". There is no reason that it should be.

The authors' suggest (on page 13) that the statistically significant response of B-cells indicated by the *S. aureus* assay can possibly be discounted ("probable type I error"), because the difference in response was caused by an increase in the control cows, while the treatment cows showed no change. However, is it not likely that some physiological changes take place in a pregnant animal during a two week period and that such changes were, in this case, inhibited by the current exposure ? Possibly normal growth of B-cells in the exposed animals may have been inhibited by the 1 mA exposure. The result does suggest that the difference in B-cell response between control and exposed animals cannot be dismissed and deserves further investigation.

I also note that the increase of Il-1 cytokine in serum from exposed cows comes close to statistical significance (using $p< 0.05$) with $p< 0.071$. This is at least interesting, because the exposure periods were only 2 weeks and a significant effect on cytokine secretion may very well require longer exposure.

I further note from the discussion on pages 12/13 that "One of the control cows in this experiment showed a change in immune function within 4 days in response to a mastitis infection". Shouldn't the data from this animal have been excluded from the comparison between exposed and controls? (It appears that it was not excluded since $n = 12$ for both control and exposed animals on Table II).

I note (page 3) that the animals in the exposed-control experiments were pregnant while (page 10) the positive controls were not. Furthermore, the exposed-control experiments were for two weeks exposure - a period during which some physiological changes might be expected in a pregnant animal - while the positive control experiment lasted only seven days (pages 34 and 10). Didn't these differences between the exposed-control experiments and the positive control experiment make the validity of any comparison rather questionable ?

In summary, one can say at best (or worst, depending on one's point of view) that the results of this study showed a statistically significant effect of 1 mA current exposure only on B-cell response and indicate the need for further research. Probably a longer period of exposure and more precise (continuous) monitoring of current flow through the animals would be desirable.

Charles Polk, July 12,1999