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**OFFICE WORKER EXPOSURE TO
EXTREMELY LOW FREQUENCY MAGNETIC FIELDS**

by
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**Office Worker Exposure to Extremely Low Frequency
Magnetic Fields**

Conducted at Los Alamos National Laboratory
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ABSTRACT

A study of office worker exposure to extremely low frequency magnetic fields (ELF MF) was conducted at Los Alamos National Laboratory. The main purpose of this study was to quantitatively assess ELF MF exposures. A secondary objective was to determine whether or not exposures to ELF MF can be reduced by implementing administrative controls and educating workers on the sources of such fields. EMDEX dosimeters were used to determine full shift personal exposures for 12 volunteers from two personnel sections and one training section. In addition, using the EMDEX meter in survey mode, office area evaluations were conducted. Administrative controls and training were implemented in an attempt to reduce exposures. Post control monitoring was conducted to determine if a reduction in ELF MF occurred among the workers.

On average, baseline office worker exposures to ELF MF were 2.3 mG, ranging from 0.6 to 9.7 mG. The post control exposures averaged 1.1 mG with a range from 0.5 to 2.2 mG. A reduction of 53% overall was seen after implementation of administrative controls and training. The office area survey indicated that many sources of ELF MF influence exposure and that magnetic field strengths vary not only from one type of equipment to another, but also vary between two similar pieces of equipment.

I. INTRODUCTION

Potential adverse health effects associated with exposure to extremely low frequency (ELF) electric and magnetic fields are the focus of growing concern. Research areas include human epidemiology and basic biology (in vivo and in vitro).

Epidemiologic studies, both residential and occupational, have suggested that adverse health effects, namely cancer, may be associated with exposure to ELF magnetic fields (MF)¹⁻⁹.

Laboratory studies, animal and cellular, show that exposure to ELF MF can cause biologic damage, but the interaction mechanisms and health implications are not fully understood¹⁰⁻¹⁵.

Although historically office workers have been considered to be at low risk of occupational hazards, recently there have been attempts to associate adverse health effects, such as adverse reproductive outcomes, with work in an office. Recent reviews generally conclude that ELF MF from VDT's are not a cause of these adverse health effects¹⁶. These studies have been conducted, for the most part, without adequate ELF MF exposure data. Assessments of MF exposure sources and levels in an office setting are needed to better determine the contribution of VDT's to the total exposure picture. In addition, office workers have also been utilized as a comparison group in epidemiologic studies of electrical workers. Having a better understanding of office worker MF exposure is needed in order to evaluate the utility of using these workers as a comparison group.

In light of the current scientific uncertainty about the health effects of exposure to ELF MF, management of field exposure is being considered¹⁷. Field management can consist of cancellation and shielding, as well as administrative efforts, such as work practices and training. Administrative efforts can reduce exposures through maximizing distance and minimizing time near ELF sources. This approach can also be referred to as prudent avoidance¹⁸. The first two management techniques are usually quite costly¹⁷, yet the third is by design, less expensive. In a recent position paper, the AIHA takes the position that when health effect data are conflicting, such as with ELF MF, good industrial hygiene practice dictates a cautious approach be taken¹⁹. What is meant by a cautious approach is quite subjective. The AIHA does go on to suggest that, while health effects are being investigated industrial hygienists should characterize exposures and train workers on potential effects of ELF MF exposures, exposure guidelines, and protection methods. In order to characterize exposures, a better understanding ELF MF in diverse settings is needed.

In an attempt to characterize office exposures and determine the possibilities for reductions in worker exposures, a study was conducted at Los Alamos National Laboratory (LANL). The purpose of this study was to quantitatively assess ELF MF exposures, and determine whether or not exposures to ELF MF can be reduced by implementing administrative controls and educating workers on the sources of such fields. The study population was drawn from

volunteers from three locations at LANL. Because of the recent office worker concern about exposures to ELF fields, office settings were chosen for this study. In addition, office worker exposure characterization is needed because there is little information in the literature concerning typical office exposures to ELF MF.

II. BACKGROUND

General

Extremely low frequency electric and magnetic fields are ubiquitous in our modern environment. These fields are produced by both natural sources, such as the earth's magnetic field, and man-made sources, predominantly electrical power transmission and use. ELF fields, including those originating from alternating currents range from 1 to 300 Hz. An electric field is produced around any charged conductor. Electric fields represent the difference in charge between the conductor and other charges and are measured in volts per meter (V/m). Because electric fields interact with and are affected by any conductor, such as the human body, the act of measuring them causes inaccuracies in their assessment²⁰.

Magnetic fields are produced by the movement of electrical charge in a conductor. Magnetic fields can be quantified based on the magnetic field strength (H), or the magnetic flux density (B). Flux density has the units of tesla(T) or gauss(G) where 1

milligauss(10^{-3} G) equals 0.1 microtestla(10^{-7} T). Field strength has the units of ampere/meter(A/m). These two properties can be related by the formula:

$$B/H = 4\pi \times 10^{-7} \text{ (Tm/A)}$$

in nonmagnetic material. For the purpose of this paper, magnetic flux density will be reported in terms milligauss (mG).

Early research on the effects of exposure to ELF electric and magnetic fields placed emphasis on the electric fields because of the perceivable effects from these fields and the elevated levels near electric transmission facilities^{20,21}. Current research is now focusing on magnetic fields because they are difficult to shield, leading to greater exposure, and laboratory and epidemiologic data have suggested possible adverse health effects from the these fields^{1,20}.

Occupational ELF exposure assessments have typically focused on electrical workers. Although they are not considered as electrical workers, office workers are exposed to a variety of electrical equipment. Much attention has been focused on computer work stations and video display terminals (VDT's) as a source of ELF exposure. In addition to VDT's, there are many sources of ELF in an office setting such as electrical distribution, printers, copiers, electric heaters, lighting, and numerous appliances to name a few. The potential for significant exposure from these types of equipment is dependant on the field strength and the duration and distance of the exposure.

Prior to a report in 1979 by Wertheimer and Leeper³, ELF

fields were thought to be benign. The Wertheimer and Leeper report concluded that there was an association between childhood cancers and homes which they classified as being located near High Current Configuration distribution lines. This reported association initiated much concern and lead to follow up epidemiologic and laboratory studies concerning the possible health effects related to ELF field exposure. Some of the subsequent epidemiologic studies have supported the association, but the laboratory studies have been slow to determine the biologic mechanisms of action.

Most of the occupational studies have used job classification, electrical worker or not, as a surrogate for ELF exposure. Throughout the studies using this classification, consistent associations have been shown between electrical work and increased risk of leukemia and brain cancer^{2,6-9}. In addition to these cancers, several occupational studies have shown an increased risk of male breast cancer associated with occupational exposure to ELF fields^{4,22,23}. Although many studies have shown some association between cancers and ELF field exposures, there are many methodological concerns making interpretation difficult. The major concerns are lack of exposure assessments, confounding factors, and selection and information biases²⁴.

Reviews of the epidemiology studies tend to support the fact that there is a statistical correlation between exposures to ELF fields and cancer. In a review of recent epidemiologic studies, Bates concluded that evidence strongly suggests that ELF fields

are a cause of cancer¹. When looking at the consistency of these studies Bates shows that twenty-two of the twenty-five occupational exposure studies demonstrated elevated risk for leukemia and brain or nervous system cancers. In a review of residential and occupational studies Savitz² concludes that the data tends to show an association between electric and magnetic fields, or a surrogate measure of the fields, and cancer. In his review of twenty-two occupational studies, Savitz notes consistent patterns of positive association between leukemia, brain cancer, and male breast cancer and electric and magnetic fields.

In addition to epidemiologic studies, laboratory studies of the effects of ELF field exposure have been conducted. Recent cellular level experiments have shown that ELF fields can produce effects in cells^{10-15,24}. These effects are thought to be mediated primarily through field interaction with the cell membrane and not through direct interaction with DNA, resulting in the conclusion that the fields most likely do not initiate cancer but could promote it^{11,15,24}. The observed cellular effects from ELF fields include increased cell proliferation, increased surface transferrin receptors, increased resistance to natural-killer-cell activities, and increased expression of tumor cell antigens^{11,15}. Animal studies have supported the theory that ELF fields act as cancer promoters by showing increased numbers and earlier appearance of tumors after initiation by a known carcinogen¹². Further supporting the promotion theory, studies

have shown that ELF can suppress pineal melatonin secretion thereby potentially disturbing the immune system¹². Similar to epidemiologic studies, laboratory studies are limited due to drawbacks including lack of reproducibility and methodological problems such as limited population size and possibly confounding factors.

Reduction Techniques

Common engineering methods for magnetic field reduction include cancellation and shielding. In addition, it is thought that administrative controls and training can be used to reduce exposures to ELF MF¹⁸. Magnetic field cancellation is accomplished by configuring conductor phases so that the magnetic field produced by each phase cancels the opposite field created by other phases. Current knowledge of phase positioning allows for significant reduction in ELF MF levels¹⁷. This cancellation is effective for a variety of electric current usage, from high voltage transmission lines to electric blankets. Although retrofitting all transmission lines and appliances would be cost prohibitive, cancellation may be effectively used in new designs and replacements.

Shielding of magnetic fields is quite complicated. ELF MF, at levels encountered in the environment, are not perturbed by non-ferromagnetic materials, or most ferromagnetic materials. However, there are materials available which can offer

significant shielding for these fields, usually specially designed, highly conductive copper products¹⁷. The effect of this shielding is greatest when the source is completely enclosed. As with cancellation, retrofitting all existing sources with shielding would be cost prohibitive, but shielding may be effectively used in new designs and replacements.

Alternative reduction techniques include administrative controls, work practices, and training. Examples include reducing field exposure through rearranging work areas and educating workers to minimize time spent in areas of elevated fields and maximize the distance from elevated field sources during normal work routines. This reduction approach, sometimes referred to as prudent avoidance, promotes the reduction of ELF MF, as much as possible, at modest costs¹⁸. Determining what constitutes modest costs is dependant on the amount of reduction, the possible health and legal implications, and the source of funding for the modifications. For example, it may be too costly for power companies to reroute existing lines, but they could route new lines away from the public and use cancellation and shielding techniques in their new designs. In terms of personal non-occupational exposures, it is not necessary for individuals to stop using all electrical appliances, but they could avoid exposures through maximizing distance and minimize time near sources. In terms of occupational exposures, workers need not stop all work with electrical equipment, but they could minimize time near elevated fields and maximize distance from these fields.

In the case of office workers, a survey of equipment in proximity to work areas can be performed to indicate areas of elevated magnetic fields. Equipment which causes elevated exposures can then be relocated away from workers, or workers can be relocated away from the sources. Offices may be rearranged such that employees are not situated near machinery, such as copiers or heating appliances, or distribution systems that feed this equipment. In addition, appliances such as portable heaters, fans, and coffee makers may also be located away from work stations. When rearranging an area, caution should be taken to avoid creating a situation where fields from one area unnecessarily increase nearby worker ELF MF exposure. Equipment which produces lower fields can be used to replace items that wear out, when the difference in cost is reasonable.

Training should also be included in any ELF field exposure reduction program. Training can include information on recognition of ELF MF sources, the possible health effects related to ELF MF, possible reduction methods including decreasing field strength with increasing distance from sources and decreasing time near sources, and creating an environment in which field exposures are as low as practical. Workers can be instructed to routinely turn equipment off when it is not needed.

Administrative controls and training can be inexpensive and utilize resources which already exist. Without producing a burden on the company, these controls can be implemented as an interim measure in situations where the harmful effects of an

environmental agent such as ELF MF are not fully understood.

III. METHODS

Population

A total of 12 volunteers from three office locations at Los Alamos National Laboratories participated in this study. The participants consisted of 4 word processors from the training section, 5 computer information specialists from the personnel section, and 3 records keepers from a separate location in the personnel section. This evaluation was conducted in four separate phases; baseline monitoring, office area evaluations, implementation of administrative controls and worker training, and post intervention monitoring.

At the start of the study, the participants were not informed of the purpose of the study. This was done in order to reduce bias in the baseline monitoring.

Exposure Assessment

ELF cumulative magnetic field average exposure estimates were determined for each of the participants, one baseline and one after administrative controls and training. Since magnetic field exposures vary depending on daily activity, participant's daily exposure records encompassed monitoring on three separate

days for both baseline and post control exposure estimates. An attempt was made to select all monitoring periods in a random manner. For both the baseline post control monitoring, the three monitoring periods were conducted on nonconsecutive days and not on the same day each week.

Monitoring was conducted using EMDEX II personal exposure meters. The EMDEX II meters were worn in a waist pouch located at the participants lower back. Each meter was set to record magnetic fields in the frequency range of 40 to 1000 Hz. The data acquisition was set for three second intervals. Each EMDEX II meter stored in memory the magnetic field strength data which was down loaded to a PC at the end of each shift.

The participants were instructed to wear the meter for the entire shift. In order to associate field strength with daily tasks the participants were requested to fill out a Personnel Monitoring Log. This log indicated activities undertaken by the participant during the monitoring period.

After each participant completed baseline monitoring, an Office Area Survey was conducted using the EMDEX II set in the survey mode. The purpose of this survey was to evaluate magnetic field strength associated with areas and equipment where the employee routinely worked. Magnetic field strengths were recorded in the office of each participant. In addition to areas within the office, specific information was gathered concerning the VDT and its usage, features and appliances used on a daily basis, and work locations outside of the office. Magnetic fields

from the VDT were measured in five locations; in front of the screen at distances of 30 cm and 50 cm, to the left and right of the unit at 30 cm, and to the rear of the unit at 30 cm. Two additional measures were recorded in front of the screen at distances of 30 cm and 50 cm with the VDT turned off. Fields were also measured at working distance from the VDT for each participant. In addition, information was gathered concerning the number of hours worked on the computer each day and the number of hours per day that the VDT was on but not being used.

Finally, post control exposure levels were determined for each worker. This monitoring was conducted identical to baseline monitoring while observing the administrative controls and training prescribed. These exposures were then compared to the baseline data in order to determine if there was a change in exposures due to implementation of the administrative controls and training.

Administrative Controls and Training

After the baseline monitoring and the office area surveys were completed administrative controls were implemented. These measures included individually training the participants and rearranging office areas where called for.

The main portion of the training incorporated explaining the possible health effects of ELF MF, teaching the participants how to recognize sources of magnetic fields, where elevated magnetic

fields are located, and how to maximize distance and minimize time near magnetic fields. In addition, the participants were instructed to turn off VDT's and printers when this equipment was not in use. As an educational tool, the results of the baseline monitoring and the office area surveys were reviewed. Exposures were explained by comparing the personal monitoring log and the field strength versus time graph, and by explaining field strengths in working areas using the office area survey. The EMDEX II meter, operated in the survey mode, was used to visually show field strengths and fundamentals of increasing the distance to reduce exposures.

When feasible, office areas were rearranged. The areas were rearranged such that the exposure sources from one office do not unnecessarily expose other populated areas or common areas. In addition, when elevated field strengths were encountered in an area, usually due to the electrical distribution system, rearranging was accomplished such that work stations were as far as practical from the source of the elevated field. A common example of office rearrangement would be to organize the desks such that VDT's, especially from the sides and rear, are not close to neighboring work stations. In the study, the offices in one location were rearranged to reduce exposures from an outside electrical distribution transformer.

Data Evaluation

Paired T tests using matched baseline and post control data were used to test the hypothesis that the baseline exposure data were statistically equivalent to the post control exposure data. In accordance with common practice, P value > 0.05 was taken as an indicator of non-significance. Any decrease is likely to be due to reduction in exposure to ELF MF associated with the administrative controls and training. The data were also compared by determining the ratio of post exposures to baseline exposures. This ratio indicates a relative reduction in exposures due to administrative controls and training. Analyses were conducted comparing participants without regard to location and by location.

Although statistical power was lost in the evaluation, the average ELF MF exposure from the three monitoring periods was used as the daily exposure level. This was done because the three monitoring periods were not independent and could not be treated as such for analysis. In addition, exposure levels were compared by location, using the average of all exposures in that location as the location exposure level.

IV. RESULTS

Personal Exposure Estimates

Table 1 contains the ELF MF exposures to office workers in this study. The baseline exposures ranged from 0.6 to 9.7 mG

Table 1

**Baseline and Post Control Office Worker
ELF MF Exposures in mG**

Employee	Location	Day	Baseline	Mean (SD)	Post Controls	Mean (SD)
1	1	1	8.32	8.73 (0.85)	1.43	1.42 (0.01)
		2	8.17		1.41	
		3	9.71		1.42	
2	1	1	2.98	2.39 (0.66)	1.43	1.63 (0.18)
		2	1.67		1.76	
		3	2.53		1.71	
3	1	1	5.20	6.04 (0.94)	1.30	1.36 (0.06)
		2	5.86		1.36	
		3	7.06		1.43	
4	2	1	0.98	1.39 (0.43)	1.37	1.10 (0.23)
		2	1.84		0.97	
		3	1.35		0.97	
5	2	1	1.85	1.45 (0.71)	0.55	0.64 (0.09)
		2	1.86		0.73	
		3	0.63		0.64	
6	2	1	1.07	0.82 (0.22)	0.52	0.60 (0.16)
		2	0.70		0.78	
		3	0.68		0.50	
7	2	1	0.81	0.91 (0.22)	0.80	0.87 (0.08)
		2	0.76		0.85	
		3	1.16		0.95	
12	2	1	1.05	1.08 (0.05)	0.82	0.77 (0.13)
		2	1.14		0.87	
		3	1.06		0.63	
8	3	1	1.93	1.87 (0.30)	0.97	0.98 (0.13)
		2	2.14		1.12	
		3	1.54		0.86	
9	3	1	1.35	1.25 (0.44)	2.23	1.63 (0.52)
		2	1.64		1.33	
		3	0.77		1.34	
10	3	1	0.67	0.99 (0.36)	1.18	1.03 (0.13)
		2	0.93		0.96	
		3	1.38		0.95	
11	3	1	0.88	0.96 (0.08)	1.32	1.19 (0.15)
		2	0.95		1.21	
		3	1.04		1.03	

Location 1 = Training Section (Word Processors)

Location 2 = Personnel Section (Information Specialists)

Location 3 = Personnel Section (Records Keepers)

with mean of 2.3 mG. The exposures post controls ranged from 0.5 to 2.2 mG with a mean of 1.1 mG. Employee 1 from location 1 received the highest average baseline exposure (8.7 mG).

Employees 2 and 9 from locations 1 and 3 respectively received the highest average post control exposure (1.6 mG). Standard deviations of all mean exposures were below 1.0 mG with the lowest for post control monitoring on employee 1 (0.01 mG).

Figure 1 compares the baseline and post control exposures by location. Location 1 was reduced from a baseline of 5.7 mG (SD 3.1 mG) to a post control of 1.5 mG (SD 0.1 mG). Location 2 was reduced from a baseline of 1.1 mG (SD 0.3 mG) to a post control of 0.8 mG (SD 0.2 mG). Location 3 was reduced from a baseline of 1.3 mG (SD 0.4 mG) to a post control of 1.2 mG (SD 0.3 mG). The average exposure by location ranged from 1.1 to 5.7 mG baseline and 0.8 to 1.5 mG post control.

Paired T tests, used to compare the differences of the baseline and post control average exposure, indicates that the post control exposures were significantly reduced from the baseline exposures ($p = 0.003$). The overall difference (base - post) is 1.22 mG. **Table 2** shows the mean differences by location. The mean difference was 4.3 mG for location 1 (statistically significant: $P = 0.0025$), 0.3 mG for location for location 2 (statistically significant: $P = 0.016$), and 0.1 mG for location 3 (not statistically significant $P = 0.74$).

The ratio of post control to baseline average exposures, contained in **Table 3**, was used to determine a relative reduction

Figure 1 Average Office Worker ELF MF Exposures by Location - Bseline and Post Control

TABLE 2

Statistical Analysis of
Difference in ELF MF Exposures
(Baseline-Post Control)

Location	Number	Mean Difference	T Stat	Prob>T
1	3	4.25	4.32	0.0025
2	5	0.33	2.75	0.0155
3	4	0.06	0.33	0.7453
Overall	12	1.22	3.16	0.0032

Table 3

ELF MF Average Exposures - Baseline and Post Control

Employee	Location	Baseline Avg	Post Controls Avg	Ratio Post/Base	% Reduction
1	1	8.73	1.42	0.16	84
2	1	2.39	1.63	0.68	32
3	1	6.04	1.36	0.23	77
4	2	1.39	1.1	0.79	21
5	2	1.45	0.64	0.44	56
6	2	0.82	0.6	0.73	27
7	2	0.91	0.87	0.96	4
12	2	1.08	0.77	0.71	29
8	3	1.87	0.98	0.52	48
9	3	1.25	1.63	1.30	-30
10	3	0.94	1.03	1.10	-10
11	3	0.96	1.19	1.24	-24
Overall		2.32	1.1	0.47	53
By Location					
	1	5.72	1.47	0.26	74
	2	1.13	0.8	0.71	29
	3	1.27	1.21	0.95	5

in exposures. The percentage change from baseline ranged from an increase of 30% to a reduction of 84% by employee. The exposures were reduced by 74% at location 1, 29% at location 2, and 5% at location 3. The overall percentage reduction was 53%.

Area Survey Data

Information was gathered concerning the magnetic field levels and related information in and around the participants' offices using the Office Area Survey. **Table 4** shows data gathered from the survey. Data from Location 1 was collected after the area was rearranged. Data from employee 1 is not available due to that employee being transferred. From the survey, VDT's and printers were determined to be a major source of ELF MF exposures in an office setting. Three different brands of computer VDT's were used by the participants. The magnetic fields, measured at a distance of 30 cm, varied between brands among the VDT's surveyed in this study. The lowest was the Macintosh RGB (0.1 mG at 30 cm), followed by the IBM PS/2 (1.4 mG at 30 cm), and finally the NEC 3D (4.5 mG at 30 cm). The mean magnetic field at a distance of 30 cm from the VDT was 4.2 mG and 1.7 mG at a distance of 50 cm from the VDT. The average participant reported 5.4 hours of VDT work at a distance of 49 cm. The mean magnetic field measured at the approximate working distance of each participant (centered above the working position of the chair without the operator present) was 1.4 mG.

Table 4

ELF MF Office Area Survey Data

Emp	Location	VDT on at 30 cm*	VDT off at 30 cm*	VDT on at 50 cm*	VDT off at 50 cm*	On Chair at Desk*	Working Distance from Computer (cm)	Hours/Day at Computer
1	1	Data Not Available						
2**	1	3.7	3.7	5.0	3.4	2.7	35	6.0
3**	1	1.7	1.6	1.6	1.6	1.5	35	6.0
4	2	4.5	0.4	1.8	0.5	2.0	50	8.0
5	2	3.5	0.6	1.4	0.4	0.3	36	4.0
6	2	2.1	1.8	1.1	0.8	0.4	71	3.5
7	2	4.1	0.5	2.1	0.6	1.8	50	7.5
12	2	1.2	0.6	0.6	0.6	0.7	53	7.0
8	3	5.3	0.5	2.1	0.4	1.7	50	4.0
9	3	5.7	0.3	2.2	0.3	2.5	50	4.0
10	3	1.3	0.5	0.6	0.4	0.7	58	4.0
11	3	1.3	0.3	0.6	0.3	0.7	50	5.0
Overall		4.2	1.0	1.7	0.8	1.4	49	5.4

* Readings measured in milligauss (mG)

**Data from #'s 2,&3 were recorded after the office was rearranged

V. DISCUSSION

The magnetic field levels encountered in this study are several orders of magnitude lower than the ACGIH TLV (at 60 Hz magnetic field TLV is 10 gauss). The first objective of the study, characterization of office worker exposure to ELF MF, shows that baseline occupational exposures of this group of office workers was 2.3 mG. These are similar to levels recorded by Breysse¹⁶ and Braken²⁰ who measured office worker exposures to be 3.2 and 3.1 mG respectively. Although the exposure levels are low compared to ACGIH guidelines, current scientific evidence suggests that these levels may result in adverse health effects. Without a firm understanding of the possible effects of ELF magnetic fields, reductions in the fields should be considered to protect workers or for additional margins of safety. Accordingly, the second purpose of this study was to determine whether or not exposures to ELF magnetic fields can be reduced by implementing administrative controls and educating workers.

The results indicate that, overall, administrative controls and training successfully reduced exposures to ELF magnetic fields, with an overall reduction of 53%. When the analysis is conducted by location, there is a variation in the effectiveness of the administrative controls. Location 1 showed the most dramatic reduction, with exposures reduced by 74%. This is due to the fact that the office was rearranged to reduce exposures. This was the only area in which the offices were rearranged to

reduce the exposures.

In location 1, above average exposures were found to be related to a transformer located outside of the building adjacent to the participants offices. This location was set up in a large open space with each office enclosed by cubicle partitions. The participants of the study working at this location were situated adjacent to the wall closest to the transformer. It was possible, in this situation, to relocate the employees to cubicles across the room from the elevated exposure area. The only expense encountered in this change was the time taken to relocate the offices. This type of resolution is not always possible, but with creativity, many exposure situations such as this can be lowered.

The exposures to the participants in location 2 were reduced 29% on average. The administrative controls in this location consisted only of training. It should be recognized that behavioral modification is often most effective right after training. Therefore, this level of compliance with administrative controls might not be seen several weeks after the training. In addition, the participants were wearing a meter which might have reminded them to observe the training suggestions, which also might increase the level to which exposures were reduced.

The exposures to participants in location 3 were reduced, on average, 5%. In fact, this reduction was accounted for by only one of the four participants in this location. The other three

participants' exposures increased slightly during the study period. Through interviews with the participants at this location after the study was completed, it was determined that a possible explanation for the increase was a dramatic increase in workload concurrent to implementation the administrative controls. The participants reported working longer hours at their VDT's, printers, copiers, and other equipment in the office. The one employee whose exposure was reduced during the study was the supervisor, who was not required to change work routines similar to the others.

The analysis of the Office Area Survey data show the complexity in exposures to ELF magnetic fields. Magnetic field strengths vary not only from one type of equipment to another, but also vary between two similar pieces of equipment. The average exposures from VDT's (1.7 mG at 50 cm) are similar to measures by Abdollaahzadeh²⁵ (1.3 mG at 46 cm). A single exposure source, such as an electrical transformer, can overshadow exposures from other sources.

VI. SUMMARY

The possible adverse health effects caused by exposures to ELF magnetic fields is the subject of scientific uncertainty. Many epidemiologic and laboratory studies have been and are being conducted to gain more information in this area. In the face of uncertainty, one possible strategy is to attempt to use

techniques available to reduce exposures in a reasonable manner to levels as low as feasible. This study shows that it is possible to reduce exposures to office workers from ELF magnetic fields through the use of administrative controls and training, referred to here as prudent avoidance.

Additional studies of this type need to be conducted to verify that the results are repeatable. These studies should be conducted over an extended period of time to see if reductions are maintained or return to previous levels.

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Appendix I

The following is the raw data collected at LANL during the ELF study concerning ELF MF exposures to office workers.

Data File: TEST60.MAT
Data Set Label: IS-11 Write/Edit
Data Set Number: 0

1 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.45 mG	21.85 mG	8.32 mG	5.00 mG	6.05 mG
Fundamental Result	0.05 mG	20.65 mG	7.43 mG	4.59 mG	5.35 mG
Harmonic Result	0.15 mG	7.85 mG	3.61 mG	2.09 mG	3.05 mG

Data File: TEST58.MAT
Data Set Label: IS-11 WRITE/EDIT
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.35 mG	18.05 mG	8.17 mG	4.60 mG	5.95 mG
Fundamental Result	0.05 mG	17.35 mG	7.65 mG	4.39 mG	5.65 mG
Harmonic Result	0.15 mG	6.45 mG	2.72 mG	1.44 mG	2.05 mG

Data File: TEST55.MAT
Data Set Label: IS-11 WRITE/EDIT
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.95 mG	38.9 mG	9.71 mG	4.41 mG	9.55 mG
Fundamental Result	0.05 mG	37.5 mG	9.22 mG	4.25 mG	9.05 mG
Harmonic Result	0.25 mG	9.85 mG	2.90 mG	1.27 mG	2.85 mG

***** DESCRIPTIVE STATISTICS *****

Data File: B:TEST203.MAT
 Data Set Label: HS-8 Writer Editor
 Data Set Number: 0

#1 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.75 mG	8.95 mG	1.43 mG	0.82 mG	1.25 mG
Fundamental Result	0.05 mG	8.85 mG	1.29 mG	0.82 mG	1.05 mG
Harmonic Result	0.15 mG	4.35 mG	0.51 mG	0.15 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST208.MAT
 Data Set Label: S-8 Writer Editor
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.55 mG	11.85 mG	1.41 mG	1.00 mG	1.05 mG
Fundamental Result	0.05 mG	11.25 mG	1.26 mG	0.93 mG	0.95 mG
Harmonic Result	0.15 mG	7.15 mG	0.52 mG	0.39 mG	0.45 mG

Data File: TEST54.MAT

Data Set Label:

HS-3 WRITE/EDIT

#2 Baseline

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.55 mG	10.65 mG	2.98 mG	0.85 mG	2.95 mG
Fundamental Result	0.45 mG	10.25 mG	2.57 mG	0.90 mG	2.55 mG
Harmonic Result	0.25 mG	3.75 mG	1.41 mG	0.23 mG	1.45 mG

Data File: TEST61.MAT

Data Set Label:

HS-3 Write/Edit

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.75 mG	5.05 mG	1.67 mG	0.51 mG	1.55 mG
Fundamental Result	0.05 mG	4.55 mG	1.23 mG	0.51 mG	1.25 mG
Harmonic Result	0.15 mG	2.35 mG	1.06 mG	0.28 mG	0.95 mG

Data File: TEST63.MAT

Data Set Label:

HS-3 WRITE/EDIT

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	1.45 mG	8.85 mG	2.53 mG	0.51 mG	2.45 mG
Fundamental Result	0.85 mG	8.65 mG	2.04 mG	0.55 mG	1.95 mG
Harmonic Result	0.25 mG	2.15 mG	1.40 mG	0.26 mG	1.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST204.MAT
Data Set Label: US-8 Writer Ed
Data Set Number: 0

#2 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.45 mG	25.3 mG	1.43 mG	0.73 mG	1.45 mG
Fundamental Result	0.05 mG	25.1 mG	1.32 mG	0.72 mG	1.35 mG
Harmonic Result	0.15 mG	3.05 mG	0.35 mG	0.15 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST209.MAT
Data Set Label: US-8 Writer Ed
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.45 mG	8.15 mG	1.76 mG	0.67 mG	1.65 mG
Fundamental Result	0.05 mG	7.85 mG	1.65 mG	0.67 mG	1.55 mG
Harmonic Result	0.15 mG	3.35 mG	0.34 mG	0.16 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST215.MAT
Data Set Label: HS-8 Writer Ed
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.55 mG	10.15 mG	1.71 mG	0.46 mG	1.75 mG
Fundamental Result	0.05 mG	10.05 mG	1.61 mG	0.46 mG	1.65 mG
Harmonic Result	0.15 mG	2.45 mG	0.31 mG	0.12 mG	0.25 mG

Data File: TEST52.MAT
Data Set Label:
Data Set Number: 0

HS-3 WORD PRO

3 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.55 mG	26.3 mG	5.20 mG	2.71 mG	4.75 mG
Fundamental Result	0.05 mG	25.7 mG	4.69 mG	2.55 mG	4.35 mG
Harmonic Result	0.15 mG	7.85 mG	2.12 mG	1.02 mG	1.95 mG

Data File: TEST64.MAT
Data Set Label:
Data Set Number: 0

HS-3 Word Pro

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.55 mG	27.1 mG	5.86 mG	2.86 mG	5.25 mG
Fundamental Result	0.05 mG	26.9 mG	5.28 mG	2.70 mG	4.55 mG
Harmonic Result	0.25 mG	7.45 mG	2.44 mG	1.07 mG	2.45 mG

Data File: TEST66.MAT
Data Set Label:
Data Set Number: 0

HS-3 WORD PRO

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.45 mG	18.45 mG	7.06 mG	3.83 mG	5.75 mG
Fundamental Result	0.05 mG	16.95 mG	5.51 mG	3.22 mG	4.45 mG
Harmonic Result	0.15 mG	7.95 mG	4.31 mG	2.22 mG	3.75 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST205.MAT
 Data Set Label: HS-8 Wd Process
 Data Set Number: 0

#3 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.45 mG	12.65 mG	1.30 mG	0.70 mG	1.15 mG
Fundamental Result	0.05 mG	12.35 mG	1.19 mG	0.69 mG	1.05 mG
Harmonic Result	0.15 mG	3.65 mG	0.37 mG	0.14 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST207.MAT
 Data Set Label: HS-8 Wd Process
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	5.95 mG	1.36 mG	0.53 mG	1.35 mG
Fundamental Result	0.05 mG	5.85 mG	1.26 mG	0.53 mG	1.25 mG
Harmonic Result	0.15 mG	2.55 mG	0.30 mG	0.13 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST216.MAT
 Data Set Label: HS-8 WD Process
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.35 mG	56.3 mG	1.43 mG	1.38 mG	1.25 mG
Fundamental Result	0.05 mG	55.7 mG	1.32 mG	1.35 mG	1.15 mG
Harmonic Result	0.15 mG	8.75 mG	0.39 mG	0.30 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: B:TEST228.MAT

Data Set Label: PS-2 Programmer

#4 Baseline

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	40.1 mG	0.98 mG	0.80 mG	0.85 mG
Fundamental Result	0.05 mG	39.9 mG	0.80 mG	0.75 mG	0.65 mG
Harmonic Result	0.05 mG	4.15 mG	0.50 mG	0.31 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST243.MAT

Data Set Label: PS-2 Programmer

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	42.3 mG	1.84 mG	3.92 mG	0.75 mG
Fundamental Result	0.05 mG	41.9 mG	1.49 mG	3.41 mG	0.55 mG
Harmonic Result	0.15 mG	17.65 mG	0.98 mG	1.95 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST246.MAT

Data Set Label: PS-2 Programmer

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.05 mG	9.65 mG	1.35 mG	0.80 mG	1.15 mG
Fundamental Result	0.05 mG	9.55 mG	1.09 mG	0.70 mG	0.95 mG
Harmonic Result	0.05 mG	13.35 mG	0.74 mG	0.47 mG	0.65 mG

Data File: b:TEST255.MAT
 Data Set Label: PS-2 Programmer
 Data Set Number: 0

#4 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	11.65 mG	1.37 mG	0.93 mG	0.85 mG
Fundamental Result	0.05 mG	11.25 mG	1.08 mG	0.76 mG	0.65 mG
Harmonic Result	0.15 mG	4.45 mG	0.80 mG	0.57 mG	0.55 mG

***** DESCRIPTIVE STATISTICS *****

Data File: L:TEST262.MAT
 Data Set Label: PS-2 Programmer
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	14.45 mG	0.97 mG	0.97 mG	0.45 mG
Fundamental Result	0.05 mG	14.35 mG	0.76 mG	0.82 mG	0.35 mG
Harmonic Result	0.15 mG	4.75 mG	0.54 mG	0.55 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST266.MAT
 Data Set Label: PS-2 Programmer
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	8.65 mG	0.97 mG	0.81 mG	0.55 mG
Fundamental Result	0.05 mG	7.35 mG	0.75 mG	0.67 mG	0.45 mG
Harmonic Result	0.15 mG	5.75 mG	0.57 mG	0.48 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST229.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

#5 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	9.95 mG	1.85 mG	1.82 mG	0.65 mG
Fundamental Result	0.05 mG	9.85 mG	1.43 mG	1.43 mG	0.55 mG
Harmonic Result	0.15 mG	4.05 mG	1.12 mG	1.13 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST239.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	25.7 mG	1.86 mG	3.73 mG	0.85 mG
Fundamental Result	0.05 mG	20.75 mG	1.46 mG	2.94 mG	0.65 mG
Harmonic Result	0.05 mG	15.05 mG	1.10 mG	2.31 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: B:TEST244.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	16.45 mG	0.63 mG	0.62 mG	0.45 mG
Fundamental Result	0.05 mG	16.25 mG	0.49 mG	0.57 mG	0.35 mG
Harmonic Result	0.15 mG	12.55 mG	0.32 mG	0.30 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST249.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

#5 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	8.55 mG	0.55 mG	0.60 mG	0.25 mG
Fundamental Result	0.05 mG	8.25 mG	0.39 mG	0.51 mG	0.15 mG
Harmonic Result	0.15 mG	1.95 mG	0.33 mG	0.33 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST253.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	21.25 mG	0.73 mG	0.69 mG	0.45 mG
Fundamental Result	0.05 mG	21.15 mG	0.58 mG	0.64 mG	0.35 mG
Harmonic Result	0.15 mG	10.55 mG	0.39 mG	0.32 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST257.MAT
 Data Set Label: PS-2 Comp Info Oper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	12.65 mG	0.64 mG	0.53 mG	0.45 mG
Fundamental Result	0.05 mG	12.55 mG	0.50 mG	0.47 mG	0.35 mG
Harmonic Result	0.05 mG	5.45 mG	0.33 mG	0.28 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

#6 Baseline

Data File: b:TEST230.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	20.45 mG	1.07 mG	1.40 mG	0.55 mG
Fundamental Result	0.05 mG	16.75 mG	0.91 mG	1.21 mG	0.45 mG
Harmonic Result	0.05 mG	12.33 mG	0.43 mG	0.75 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST236.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.05 mG	39.9 mG	0.70 mG	0.85 mG	0.55 mG
Fundamental Result	0.05 mG	34.7 mG	0.56 mG	0.81 mG	0.35 mG
Harmonic Result	0.05 mG	19.45 mG	0.29 mG	0.37 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST241.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	13.25 mG	0.68 mG	0.70 mG	0.45 mG
Fundamental Result	0.05 mG	12.85 mG	0.57 mG	0.68 mG	0.35 mG
Harmonic Result	0.05 mG	12.05 mG	0.29 mG	0.27 mG	0.25 mG

Data File: D:\TEST247.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

#6 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.35 mG	6.65 mG	0.52 mG	0.34 mG	0.45 mG
Fundamental Result	0.05 mG	6.55 mG	0.42 mG	0.34 mG	0.35 mG
Harmonic Result	0.15 mG	0.75 mG	0.18 mG	0.06 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST251.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.05 mG	11.85 mG	0.78 mG	0.79 mG	0.45 mG
Fundamental Result	0.05 mG	11.65 mG	0.54 mG	0.63 mG	0.35 mG
Harmonic Result	0.05 mG	12.45 mG	0.43 mG	0.60 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: B:TEST254.MAT
Data Set Label: PS-2 Group Leader
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.35 mG	5.85 mG	0.50 mG	0.32 mG	0.45 mG
Fundamental Result	0.05 mG	5.75 mG	0.39 mG	0.32 mG	0.35 mG
Harmonic Result	0.15 mG	0.65 mG	0.16 mG	0.05 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST231.MAT
Data Set Label:
Data Set Number: 0

PS-2 Comp Sup

7
Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	11.15 mG	0.81 mG	0.35 mG	0.85 mG
Fundamental Result	0.05 mG	11.05 mG	0.68 mG	0.33 mG	0.65 mG
Harmonic Result	0.05 mG	2.35 mG	0.38 mG	0.16 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST238.MAT
Data Set Label:
Data Set Number: 0

PS-2 Comp Sup

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	106.3 mG	0.76 mG	1.28 mG	0.65 mG
Fundamental Result	0.05 mG	106.1 mG	0.63 mG	1.27 mG	0.55 mG
Harmonic Result	0.05 mG	6.45 mG	0.32 mG	0.26 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST240.MAT
Data Set Label:
Data Set Number: 0

PS-2 Comp Sup

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	75.7 mG	1.16 mG	1.46 mG	0.95 mG
Fundamental Result	0.05 mG	75.5 mG	0.97 mG	1.42 mG	0.85 mG
Harmonic Result	0.15 mG	13.25 mG	0.54 mG	0.51 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST248.MAT
Data Set Label: PS-2 Comp Sup
Data Set Number: 0

#7 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	39.1 mG	0.80 mG	1.18 mG	0.65 mG
Fundamental Result	0.05 mG	38.7 mG	0.66 mG	1.15 mG	0.55 mG
Harmonic Result	0.05 mG	5.05 mG	0.31 mG	0.32 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST258.MAT
Data Set Label: PS-2 Comp Sup
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	16.85 mG	0.85 mG	0.43 mG	0.85 mG
Fundamental Result	0.05 mG	16.75 mG	0.71 mG	0.40 mG	0.65 mG
Harmonic Result	0.15 mG	8.05 mG	0.40 mG	0.25 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST259.MAT
Data Set Label: PS-2 Comp Sup
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	17.05 mG	0.95 mG	0.73 mG	0.75 mG
Fundamental Result	0.05 mG	16.65 mG	0.80 mG	0.71 mG	0.65 mG
Harmonic Result	0.05 mG	11.35 mG	0.39 mG	0.30 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST232.MAT
 Data Set Label: PS-2 Recs. Super
 Data Set Number: 0

#8 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	163.5 mG	1.93 mG	3.30 mG	1.05 mG
Fundamental Result	0.05 mG	160.9 mG	1.55 mG	2.87 mG	0.85 mG
Harmonic Result	0.05 mG	29.1 mG	1.05 mG	1.68 mG	0.55 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST267.MAT
 Data Set Label: PS-2 Records Sup
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	30.5 mG	2.14 mG	1.88 mG	2.35 mG
Fundamental Result	0.05 mG	27.7 mG	1.72 mG	1.64 mG	1.85 mG
Harmonic Result	0.05 mG	13.55 mG	1.21 mG	1.02 mG	1.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST270.MAT
 Data Set Label: PS-2 Records Sup
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	38.9 mG	1.54 mG	2.23 mG	0.95 mG
Fundamental Result	0.05 mG	33.9 mG	1.28 mG	2.01 mG	0.85 mG
Harmonic Result	0.15 mG	19.05 mG	0.76 mG	1.05 mG	0.55 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST271.MAT
 Data Set Label: PS-2 Records Sup
 Data Set Number: 0

8 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	15.05 mG	0.97 mG	0.90 mG	0.85 mG
Fundamental Result	0.05 mG	13.55 mG	0.80 mG	0.82 mG	0.75 mG
Harmonic Result	0.05 mG	12.05 mG	0.43 mG	0.46 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST275.MAT
 Data Set Label: PS-2 Records Sup
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	43.3 mG	1.12 mG	1.87 mG	0.85 mG
Fundamental Result	0.05 mG	42.9 mG	0.96 mG	1.72 mG	0.75 mG
Harmonic Result	0.15 mG	21.85 mG	0.46 mG	0.79 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST281.MAT
 Data Set Label: PS-2 Records Sup
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	74.9 mG	0.86 mG	1.83 mG	0.35 mG
Fundamental Result	0.05 mG	74.5 mG	0.72 mG	1.75 mG	0.25 mG
Harmonic Result	0.15 mG	12.05 mG	0.35 mG	0.59 mG	0.15 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST233.MAT
 Data Set Label: PS-2 Clerk1
 Data Set Number: 0

#9 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	44.5 mG	1.35 mG	1.54 mG	0.95 mG
Fundamental Result	0.05 mG	44.3 mG	1.07 mG	1.33 mG	0.65 mG
Harmonic Result	0.15 mG	21.05 mG	0.73 mG	0.85 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST261.MAT
 Data Set Label: PS-2 Clerk1
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	25.7 mG	1.64 mG	1.84 mG	1.35 mG
Fundamental Result	0.05 mG	22.9 mG	1.30 mG	1.61 mG	1.05 mG
Harmonic Result	0.15 mG	12.85 mG	0.93 mG	0.95 mG	0.85 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST265.MAT
 Data Set Label: PS-2 Clerk1
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	15.35 mG	0.77 mG	1.23 mG	0.45 mG
Fundamental Result	0.05 mG	13.15 mG	0.63 mG	1.04 mG	0.35 mG
Harmonic Result	0.15 mG	11.65 mG	0.37 mG	0.68 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST283.MAT
 Data Set Label: PS-2 Clerk1
 Data Set Number: 0

#9 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	24.9 mG	1.33 mG	1.01 mG	1.25 mG
Fundamental Result	0.05 mG	24.7 mG	1.10 mG	0.93 mG	0.95 mG
Harmonic Result	0.05 mG	12.75 mG	0.63 mG	0.53 mG	0.55 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST284.MAT
 Data Set Label: PS-2 Clerk1
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	20.05 mG	1.34 mG	1.16 mG	0.95 mG
Fundamental Result	0.05 mG	18.55 mG	1.07 mG	1.03 mG	0.85 mG
Harmonic Result	0.15 mG	7.65 mG	0.71 mG	0.62 mG	0.55 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST234.MAT
 Data Set Label: PS-2 Records Keeper
 Data Set Number: 0

#10 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	36.7 mG	0.67 mG	0.78 mG	0.45 mG
Fundamental Result	0.05 mG	36.1 mG	0.55 mG	0.73 mG	0.35 mG
Harmonic Result	0.15 mG	20.05 mG	0.31 mG	0.43 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST260.MAT
 Data Set Label: PS-2 Recordskeeper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	108.1 mG	0.93 mG	1.53 mG	0.65 mG
Fundamental Result	0.05 mG	107.9 mG	0.79 mG	1.48 mG	0.45 mG
Harmonic Result	0.15 mG	12.55 mG	0.39 mG	0.59 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST264.MAT
 Data Set Label: PS-2 Records Keeper
 Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	10.85 mG	1.38 mG	1.05 mG	1.15 mG
Fundamental Result	0.05 mG	10.05 mG	1.09 mG	0.91 mG	0.95 mG
Harmonic Result	0.15 mG	10.15 mG	0.78 mG	0.62 mG	0.65 mG

Data File: b:TEST268.MAT
Data Set Label: PS-2 Records Keeper
Data Set Number: 0

#10 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	121.3 mG	0.79 mG	1.67 mG	0.55 mG
Fundamental Result	0.05 mG	121.1 mG	0.65 mG	1.62 mG	0.45 mG
Harmonic Result	0.15 mG	12.45 mG	0.36 mG	0.53 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST272.MAT
Data Set Label: PS-2 Records Keeper
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	27.7 mG	1.18 mG	1.44 mG	0.75 mG
Fundamental Result	0.05 mG	26.3 mG	0.99 mG	1.34 mG	0.65 mG
Harmonic Result	0.15 mG	24.3 mG	0.55 mG	0.65 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST276.MAT
Data Set Label: PS-2 Records Keeper
Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	78.7 mG	0.96 mG	1.54 mG	0.45 mG
Fundamental Result	0.05 mG	77.1 mG	0.79 mG	1.38 mG	0.35 mG
Harmonic Result	0.15 mG	15.45 mG	0.46 mG	0.72 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST235.MAT

Data Set Label: PS-2 Recs Kpr

Data Set Number: 0

11 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	42.5 mG	0.88 mG	1.82 mG	0.45 mG
Fundamental Result	0.05 mG	41.9 mG	0.71 mG	1.70 mG	0.35 mG
Harmonic Result	0.15 mG	15.65 mG	0.44 mG	0.71 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST263.MAT

Data Set Label: PS-2 Rcrds Kpr

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	13.75 mG	0.95 mG	1.08 mG	0.45 mG
Fundamental Result	0.05 mG	13.15 mG	0.76 mG	0.95 mG	0.35 mG
Harmonic Result	0.15 mG	6.95 mG	0.51 mG	0.56 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST269.MAT

Data Set Label: PS-2 Rcrds Kpr

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	17.85 mG	1.04 mG	1.33 mG	0.55 mG
Fundamental Result	0.05 mG	16.95 mG	0.83 mG	1.09 mG	0.45 mG
Harmonic Result	0.15 mG	12.15 mG	0.54 mG	0.81 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST273.MAT

Data Set Label: PS-2 Rcrds Kpr

Data Set Number: 0

11 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	130.7 mG	1.32 mG	3.01 mG	0.95 mG
Fundamental Result	0.05 mG	130.5 mG	1.10 mG	2.92 mG	0.85 mG
Harmonic Result	0.15 mG	27.7 mG	0.61 mG	0.93 mG	0.45 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST274.MAT

Data Set Label: PS-2 Rcrds Kpr

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	11.95 mG	1.21 mG	0.96 mG	0.85 mG
Fundamental Result	0.05 mG	11.85 mG	1.02 mG	0.87 mG	0.75 mG
Harmonic Result	0.05 mG	10.95 mG	0.56 mG	0.46 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: B:TEST280.MAT

Data Set Label: PS-2 Rcrds Kpr

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	10.75 mG	1.03 mG	0.82 mG	0.55 mG
Fundamental Result	0.05 mG	10.65 mG	0.87 mG	0.75 mG	0.45 mG
Harmonic Result	0.15 mG	13.85 mG	0.49 mG	0.43 mG	0.35 mG

Data File: b:TEST237.MAT
Data Set Label:
Data Set Number: 0

PS-2 Clerk3

#12 Baseline

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	155.3 mG	1.05 mG	3.08 mG	0.65 mG
Fundamental Result	0.05 mG	154.9 mG	0.89 mG	3.02 mG	0.55 mG
Harmonic Result	0.15 mG	40.1 mG	0.40 mG	0.87 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST242.MAT
Data Set Label:
Data Set Number: 0

PS-2 Clerk3

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	171.1 mG	1.14 mG	3.89 mG	0.75 mG
Fundamental Result	0.05 mG	170.9 mG	0.98 mG	3.83 mG	0.65 mG
Harmonic Result	0.15 mG	22.3 mG	0.43 mG	0.80 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST245.MAT
Data Set Label:
Data Set Number: 0

ps-2 Clerk3

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	146.7 mG	1.06 mG	4.20 mG	0.65 mG
Fundamental Result	0.05 mG	146.5 mG	0.90 mG	4.12 mG	0.55 mG
Harmonic Result	0.15 mG	23.5 mG	0.43 mG	1.05 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST250.MAT

Data Set Label: PS-2 Clerk3

Data Set Number: 0

12 Post

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	103.1 mG	0.82 mG	1.30 mG	0.65 mG
Fundamental Result	0.05 mG	102.9 mG	0.67 mG	1.25 mG	0.55 mG
Harmonic Result	0.15 mG	30.9 mG	0.39 mG	0.45 mG	0.35 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST252.MAT

Data Set Label: PS-2 Clerk3

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.15 mG	159.9 mG	0.87 mG	3.05 mG	0.55 mG
Fundamental Result	0.05 mG	159.3 mG	0.73 mG	2.99 mG	0.45 mG
Harmonic Result	0.05 mG	30.1 mG	0.35 mG	0.78 mG	0.25 mG

***** DESCRIPTIVE STATISTICS *****

Data File: b:TEST256.MAT

Data Set Label: PS-2 Clerk3

Data Set Number: 0

	Min	Max	Mean	Std Dev	Median
Broadband Result	0.25 mG	30.9 mG	0.63 mG	0.62 mG	0.55 mG
Fundamental Result	0.05 mG	27.3 mG	0.52 mG	0.57 mG	0.45 mG
Harmonic Result	0.15 mG	14.75 mG	0.26 mG	0.33 mG	0.25 mG

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