006898

WORK STATION MAGNETIC FIELD SURVEY RESULTS IN THE METCALFE FEDERAL BUILDING

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A. BACKGROUND

On November 23, 1993, the Radiation Section (renamed the Radiation and Indoor Air Section) submitted a proposal to survey oscillating magnetic field intensities on USEPA-occupied floors in the Metcalfe Federal Building. The proposal was submitted at the request of the Regional Health and Safety Committee. The Regional Health and Safety Committee requested that the Air Toxics and Radiation Branch, Radiation Section, conduct a survey of the electric and magnetic field levels to which workers in the Metcalfe Building are exposed.

Magnetic field strength is measured in gauss or milligauss. A milligauss (mG) is 1/1000th of a gauss. Background magnetic field measurements taken outside of the Metcalfe Building range from 0.7 mG to 1.0 mG. Away from all appliances, a typical American home has background magnetic field levels ranging from 0.5 mG to 4 mG. The actual strength of the field at any given place in a room depends upon the number and kinds of sources, how far away they are, and how many are operating at one time.

No clear cause-and-effect relationship exists between magnetic fields and adverse health effects. Consequently, no national standards exist for exposure to magnetic fields in the United States. Also, it is not understood whether proximity to or duration within a magnetic field may contribute to adverse health effects.

Despite the lack of evidence regarding the relationship between magnetic fields and disease, organizations such as the World Health Organization, International Non-Ionizing Radiation Committee (WHO/INIRC) has proposed a 5,000 mG magnetic field intensity exposure limit. The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended a 600,000 mG occupational limit.

Jack Barnette, Radiation and Indoor Air Section Chief, believes that the exposure limits set by WHO/INIRC and ACGIH are problematic. "In light of what we now know about biological effects from exposure to EMF and the public's perception of potential risks, it would be imprudent to expose people to such intense magnetic fields."

B. SURVEY METHODOLOGY

In February, 1994, magnetic field measurements began to be taken on floors occupied solely by USEPA employees in the Metcalfe Building. Following protocols used by USEPA Headquarters, Region 1, the National Air and Radiation Environmental Laboratory (NAREL), and the State of California, and employing recently calibrated instruments from NAREL, the Radiation Section began a stratified random sample. Both 5 percent of non-enclosed work stations and 5 percent of enclosed work stations were tested. Furthermore, copy rooms, kitchenettes, and unique areas such as the main computer room and the library were measured. Sampling ended in March, 1994, and the data was compiled.

C. AVERAGES FOR SPECIFIC AREAS

The following table provides a summary of the magnetic field survey. A room description and the average of all the measurements for that room are given. All average measurements have been rounded to the nearest hundredth of a milligauss.

Room Description	Average Measurement (in mG)
Conference Rooms	0.36
Supervisor Offices	2.30
Offices (enclosed)	1.67
Work stations	1.37
File/Docket Rooms	0.66
Copy Rooms	4.38
Kitchenettes	2.62*

***This figure does not include the 73.14 mG measurement**

Of all the rooms sampled, the highest magnetic field measurements were found in kitchenettes. This is not surprising, given the large number of appliances that operate in these areas. The highest individual room measurement, 73.14 mG, was taken in the kitchenette on the eighth floor. Because measurement protocols were not followed when this measurement was taken, a comparatively higher measurement was recorded. To have a more accurate magnetic field profile of this room, remeasurement following the appropriate protocols should be performed.

Individual room measurements are provided in Appendix 1. Measurements taken in unique areas, such as the library and computer room, are also provided in Appendix 1.

D. REGION 1 SURVEY RESULTS

Magnetic field measurements taken in the Metcalfe Building may be meaningfully contrasted with magnetic field research performed by other Regional offices. In March, 1993, Region 1 published "Extremely Low Frequency [ELF] Magnetic Fields in Offices, and Their Mitigation," in which 5 mG is cited as a "useful tentative yardstick" for setting an occupational exposure standard in an office (see Appendix 2). An overall range of 0.1 to 50 mG for occupational exposure in a large office facility is cited as acceptable. All average room measurements fall well within an acceptable overall range of 0.1 mG to 50 mG.

Region 1 also performed a magnetic field survey of USEPA facilities at Canal Street and One Congress Street in February, 1993 (see Appendix 3). All the **offices** tested in that survey registered values which fell in the range of 5 mG to 50 mG. Most of the **work stations** (95%) in both facilities registered values which fell within the range of 5 mG to 50 mG. As stated earlier, the average magnetic field intensity for work stations in the Metcalfe Building measured 1.37 mG, while Supervisor offices measured 2.30 mG, and other enclosed offices measured 1.67 mG. These figures, when compared to those in Region 1, indicate generally weak magnetic field strengths in the Metcalfe Building.

E. SUMMARY

This magnetic field survey provides an excellent profile of the magnetic field environment in the USEPA-occupied portions of the Metcalfe Building. The research protocols followed and the use of recently-calibrated NAREL instruments ensure that the magnetic field profile presented here is accurate. Based on this profile, magnetic field strengths in the USEPA-occupied portions of the Metcalfe building appear to be on the lower end of the scale for a typical office building.

Currently, research is unclear regarding the possible health effects of exposure to magnetic fields in our everyday environment. USEPA has set no standards for exposure to magnetic fields.

APPENDIX 1
EMF BACKGROUND ASSESSMENT SURVEY RESULTS BY FLOOR

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 4

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS					
0452	Martha Armstrong	G-1	2/15	1:10 p.m.	M Murphy		Ø.83	1.9	Ø.4	Ø.2	—	—	
0456	Sharon Blackman	G-1	2/15	1:12 p.m.			.8Ø	1.9	Ø.3	Ø.2	—		
R0412	Copy Room/Lunch Room	—	2/15	1:16 p.m.			1.86	Ø.5	Ø.5	6.5	Ø.5	1.3	

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
Calibrated on October 1, 1993.

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 5

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
05005	Fred Bartman	H-1	2/15	1:37p.	M Murphy		.4Ø	Ø.5	Ø.3	—	—	—
05006	Frank J. Rollins	E-4		1:35p.			.47	Ø.9	Ø.4	Ø.3	—	—
05016	Stavros Emmanouil	G-1		1:40p.			.8Ø	1.7	Ø.5	Ø.2	—	—
05029	Laretha Taylor	G-5		1:41p.			2.5Ø	3.Ø	2.Ø	—	—	—
05042	Eileen Helmer	G-4		1:42p.			Ø.87	1.9	Ø.5	Ø.2	—	—
05080	Joseph Kawecki	G-1		1:44p.			Ø.83	1.5	Ø.5	Ø.5	—	—
05133	Ruth A Miles	G-1		1:45p.			2.2Ø	3.Ø	1.9	1.7	—	—

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
Calibrated on October 1, 1993.

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 6

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
06015	Dan Hopkins	G-4	2-17	1:04	MM		.80	1.5	.6	.3		
06025	Nanjundagowda	G-4		1:05			.67	1.4	.4	.2		
06054	Deborah Siebers	G-1		1:07			.63	1.3	.4	.2		
06066	Tinka Hyde	E-4		1:11			.53	1.1	.3	.2		
06076	William Ballard	G-4		1:12			.63	1.2	.5	.2		
06088	Pablo Valentin	G-4		1:13			1.03	2.0	.9	.2		
06105	NA	G-1		1:14			.83	1.6	.5	.4		
R0612	NA	Conf. Room		1:08			.42	.3	.2	.8	.4	.4

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 7

G1: (1) monitor/keyboard (2) visitor seat

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS						
07020	Fayola E. Wright	G-1 (2)	2/24	12:22	Robert Krsek	RK	1.13	2.0	.25				
07031	Marguerite Ryan	G-1	"		"	RK	1.10	2.0	.2				
07048	La Nita Marrable	G-1	"		"	"	1.25	2.0	.5				
07095 (1)	N/A	Carroll	"		"		1.34	.3	2.0	1.55	2.0	1.4	.5
07098 (3)	N/A	"	"		"		.18	.15	.2	.2			
07101 (7)	N/A	"	"		"		.18	.2	.15	.15	.2	.2	
R0202	N/A	Copy Room (5)	"		"		.99	.25	.75	.5	.45	3.0	
R0716	N/A	~~File~~ Viewing Room (5)	"		"	"	.20	.3	.2	.15	.15	.2	

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EMF BACKGROUND ASSESSMENT SURVEY

G-6 (2) ① Keyboard ② work [illegible]

E-4 (3) ① K ② Table ③ [illegible]

G-4/G-1 (2) : ① Keyboard ② Chair

FLOOR NUMBER 8

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
08020	Kenneth Bardo	G-4	2/24	12:47	Robert Krock		1.85	3.5	.2			
08039	William Butler	G-1	"				3.10	6.0	.2			
08069	Ann Kerbs	G-1	"				2.63	5.0	.25			
08086	Huk K. Cho	E-4	"				10.13	*30.0	.2	.2		
08094	F Robert Kim	G-6	"				5.1	+9.0	1.2			
08106	George C. Peters	G-1	"				5.1	+10.0	.2			
K08041	N/A	Kitchenette	"				3.14	.25	9.5	.5	.75	*500
												.7-

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
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* Elevated reading when monitor turned on.

\+ Cubicles had laptops as well

* with microwave running

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 9

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
09022	Kent Fuller	G-1	3/1	2:00pm	Michael Murphy		2.27	3.0	3.5	.3		
09045	unused	G-1		2:10	"		2.50	2.5				
09077	unused	G-1		2:12	"		1.33	3.0	.6	.4		
09088		G-1			"		—	will	use	last	set	
R0915		Office B-2D			"		.53	1.1	0.3	0.2		
R0920		Mail/Supply			"		.56	0.7	0.7	0.3	0.4	0.7
[redacted]		[redacted]			—		1.28	1.2	1.35			
R0920 con't.	[illegible]	Mail Room		2:21	"		5.32	7.0	17.0	0.6	0.4	6.5
								.4				
R0909	GIS			2:45	"		2.13	2.5	.3	1.1	5.5	.9
								2.5				

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 9

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
09022	Kent Fuller	G-1	2-24-93	1:05	Robert Krsek			9.0	.45			
09045	N/A	G-1						2.0	.40			
09077	N/A	G-1						4.0	.4			
09088	Bob Mayhugh	G-1					1.45	2.5	.4			
R0915	David Cowgill	B-2D						5.0	.35	.6	.4	.25
R0920	N/A	mail/Supply Room						1.5	.2	1.3	.3	.45
R0921	N/A	Storage										

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 10

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
10068	--	G-7	3/3		Michael Murphy	--	—	—			-	
10036	Unoccupado	G-1	"		"		.97	1.7	Ø.8	Ø.4		
10030	Mary Ellen Ryan	E-3	"		"		.57	Ø.3	1.2	Ø.2		
~~10045~~		~~G-4~~	"		"							
R1014	Anthony Audie	Conf. Rm	"		"		1.02	1.4	1.6	Ø.6	Ø.8	Ø.7
R1015		Conf. Rm	"		"							
~~Docket Rm~~	R1001 Kitchenette	Unique	"		"		2.86	2.Ø	Ø.4	Ø.6	10.Ø	1.3
Docket Rm 2	R1017	Unique	"		"		—					
10011	Karyn Nash	Unique	"	2:ØØpm	"		1.17	Ø.7	2.5	Ø.3		
10012	Donna Cox	Unique	"	2:Ø5pm	"		.73	Ø.6	1.3	Ø.3		
10013	Larhonda Jamerson	Unique	"		"		3.27	8.5	1.Ø	Ø.3		
10015	work area		"		"		.80	Ø.8				
10016	Elonia Stamps		"		"		.80	Ø.2	Ø.6	1.6		
10017	De Loris Clay		"		"		.70	Ø.3	Ø.5	1.3		
NB4	Karen Amy Vasquez		"		"		.63	1.3	Ø.3	Ø.3		
10Ø31	Debra Crume-Williams		"		"		1.30	1.1	2.5	Ø3		

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER ________

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
10092	Michele Anthony		3/3	2:35	MM		1.6	2.0	1.2			
10109	A Marie Hock			"	"		7.0	4.0	100			
	Typing Area						9.0	9.0				
	'Front Desk'						2.2	5.0	0.9	0.7		
	Counter						.93	1.5	0.6	0.7		

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 12

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
12074		H-1										
R1216	Graphics	Unique	3/8/94	1:24p	Murphy		1.92	1.5	.2	.4	6.0	1.5
Computer Room		Unique	" "	135p	"		17.72	3.0	25.	55.0	.6	5.0
Records Management Rm		Unique	"	140p	"		2.13	.6	5.0	.8		
Library/Copy room			"	143p	"		4.83	6/14	5.0	1.8	1.8	.4
Library N Carrell Rm.												
Library N Stacks												
Library - Help Desk												
Library S Stacks												
Library S Carrell 1	Microform Ctr		"	150p	"		4.9	9.0	0.8			
Library S Carrell 2												
Computer Training Rm		Unique	"	2:20PM			2.68	6.0	.5	6.0	.5	.4
Conference Reception Area		UNIQUE	"	200p	"		1.80	1.8				
Lake Erie				201PM			.3	.3	.3	.2	.4	.3
Lake Superior			"	202PM	"							
Lake Michigan												
Lake Ontario			"	205PM	"		.5	.5	.4	.6	.5	.5
Lake Huron												
Reception area												

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EMF BACKGROUND ASSESSMENT SURVEY

NUMBER ____________

STATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
R 1216	Graphics	unique	3/8/94	1:30 PM	MURPHY		1.65	3.0	.3			
Computer Room		unique	"	135PM	"		18.7	3.5	.6	70.0	.7	
Rear Proj		unique					4.0	4.0				
Computer Trng		unique	"	220pm	"							

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER ____________

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
Health+Safety	Health+Safety	½ cube	3/8/94	153p	MURPHY		1.20	1.2				
"	12071	½ cube	"	"	"		3.00	3.0				
"	12066	clerical	"	"	"		2.50	2.5				
"	12073	½ c	"	"	"		2.50	2.5				
"	12069	Clerical	"	"	"		1.30	1.3				

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 13

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
130~~95~~ 94	Janice Miller	G-3		1:44			2.30	6.0	0.7	0.2		
13082	~~Jodi~~ Jori SPOLAFICH	G-2		1:46			1.27	1.8	1.7	0.3		
13014	Odessa Blakemore	G-3	3/10/94	1:08			1.23	3.0	0.5	0.2		
130~~24~~ 25	———	G-2		1:10			.93	0.9	1.6	0.3		
13121	Walter Sanborn	G-1					.80	1.8	0.4	0.2		
R1309	Elissa Speizman	office B-2D		1:32			6.17	5.5	6.0	7.0		
R1314	Thomas Wysoglad	~~Conf.~~ off. ~~Room~~		1:37			.60	1.2	0.3	0.3		
R1307		Repair Room unique	3/10/94	1:12			~~1.13~~ 1.04	K 0.4	A .4	1.6	1.6	2.6
R1325		File Room					—					
R1316		Docket Room.					.28	0.3	0.3	0.3	0.2	0.3
R1307 Cont.		Cont.						C 0.3	0.6	2.0	1.8	G 2.0
~~13040~~	~~Carmen Sidney~~	~~unique~~						H 1.6	I ~~3.0~~ .3	J .3		
13040	Carmen Sidney	unique		1:25			1.30	4.0	0.6	0.4	0.2	
13042	Cheryl Britton	unique		1:28			1.70	3.0	2.0	0.7	1.1	

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 14

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS					
14038	IDa Levin	G-1	~~IDa Levin~~	1:15			.80	1.5	.7	.2			
14081	Mary Lou Argento	G-5		1:28			2.20	4.0	.4				Floresc.
14044	Stephanie NGuyen	G-1		1:22			1.70	4.0	.8	.3			
14095	??	G-1		1:43			.43	.6	.5	.2			
14061	Marlene Bronson	G-1		1:25			.90	2.0	.4	.3			
14013	Barry Bolka	G-1	3/15/94	1:07	MA		.73	1.7	.3	.2			
R1420		Docket Rm		1:45			.22	.2	.2	.3	.2	.2	
R 1421 → 8		Docket Rm					—						
G15 Room R1409		unique		1:10			1.67	.2	.2	1.7	1.9	.2	
"		"						.2	1.7	1.9	7.0		

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 15

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
15027	~~Paulette~~ Laura ~~Forentes~~ Flyn	G-4	3/22	1:37			.80	~~1.1~~ 1.6	~~.2~~ .6	~~.2~~ .2		
15022	Paulette Exeste	G-1	"	1:33			.50	1.1	.2	.2		
15021	Marcia Damato	G1	"	1:31			.60	1.4	.2	.2		
15130	Roger K. Coppock	E-4	"	1:50			.63	1.2	.4	.3		
15103	PC Area	G-7	"	1:48			.73	1.5	.5	.2		
15124	——	G-4	"	1:58			.30	.4	.3	.2		
15046	Thomas Bramscher	E4	"	2:01			.67	1.2	.5	.3		
R1517		Conf. Room	"	1:54			.24	.3	.2	.3	.2	.2
R1509		Docket Room	"	1:56			.54	1.5	.2	.3	.4	.3
R1520		Docket Room	"	1:52			.42	.5	.4	.4	.5	3
* 15028	Ingrid Enriquez		3/22	1:43			1.37	3	.9	.2		

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
Calibrated on October 1, 1993.

* Not part of EMF Background Assessment

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 16

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
16088	Rob ~~Pepin~~ Pepin	G-1		2:25			2.13	3	3	.4		flores.
16082	William A. Melville	E-4		2:20			.80	1.9	.4	.1		
16060	PC Room	G-1		2:15			4.57	7	6	.7		
16014	Willa Winston	G-1		2:06			.27	.4	.2	.2		
16003	Anita Chico	G-1	3/22	2:05			.97	1.8	.9	.2		
16054	Charles Orzehoskie	E-4		2:10			.40	.8	.2	.2		
16070	Douglas Ehorn	E-4		2:18			.63	1.1	.6	.2		
R 1613		Conf. Room		2:13			.22	.2	.3	.2	.2	.2
R 1601		Kitchenette		2:08			3.3	3	8	.2	2	
R 16141		unique					.64	1.1	.8	.5	.3	.4
cont.								.9	.5			

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 17

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
17016	[illegible] Pellegrini	G-1			Mike Murphy		.47	1.8	0.4	0.2		
17094	Debra Flowers	G-1			"		.43	0.4	0.5	0.4		
17021	Charles Anderson	G-1			"		.87	1.7	.5	.4		
17107	Mary McAuliffe	G-1			"		1.03	1.6	0.7	0.8		
17100	Jeffrey Bratko	G-1			"		.93	1.9	0.7	0.2		
17006	Rebecca Harvey	E-4			"		.40	0.6	0.4	0.2		
R1710		Conf. Room			"		.58	0.5	1.0	.15	0.4	0.5
R1707		Docket Room			"		.60	0.2	0.3	1.9	0.3	0.3
R1717		Docket Room			"		2.62	1.4	1.8	0.6	8.0	1.3
R170[illegible]		Kitchenette			"		2.44	1.4	8.0	0.5	0.9	1.4 [illegible]

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
Calibrated on October 1, 1993.

EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 18

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS					
18038	Jacqueline Nwia	G1		2-2:30	Mike Murphy		1.17	3.Ø	Ø.6	Ø.2			
18127	Katherine Keith	G-1			"		.87	1.6	Ø.7	Ø.3			
18061	Beverly Short	G-1			"		3.3Ø	1.6	5.Ø				[illegible]
18090	Jay Bortzer	E-3			"		.63	1.Ø	Ø.7	Ø.2			
18104	Don Woznicki	G-1			"		.3Ø	Ø.3	Ø.3	Ø.3			
18047	Brad Beeson	G-1			"		1.00	1.5	Ø.7	Ø.8			
R1809		Office			"		3.45	12.Ø	1.3	Ø.3	Ø.7		
R1813		Conf. Room			"		.32	Ø.5	Ø.4	Ø.2	Ø.2	Ø.3	
R1802		Copy Room			"		10.17	Ø.5	12	18		copier running	

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EMF BACKGROUND ASSESSMENT SURVEY

FLOOR NUMBER 19

WORKSTATION #	NAME	CUBE TYPE	DATE	TIME	MEASURER	INI	AVE	MEASUREMENTS IN MILLIGAUSS				
19014	no-one	G-1					.53	1.1	Ø.3	Ø.2		
19003	Linette Kinder	G-5					1.2	1.7	Ø.7			
19075	Robert Hartian	G-4					.47	Ø.9	Ø.3	Ø.2		
19069	Janette Marsh	G-4					.77	1.8	Ø.9	Ø.2		
R1901	Margaret McCue	office					.33	Ø.6	Ø.2	Ø.2		
R1911		Conf ? Room					.50	0.6	0.5	0.5	0.4	0.5
19201		unique					—					
R1917		Copy Room					4.48	20.Ø	Ø.0	Ø.3	Ø.7	Ø.6
R1935	Dave Ulrich	unique					.48	1.6	Ø.2	Ø.2	Ø.2	Ø.2
R1928	Valdas Adamkus	unique					.23	Ø.3	Ø.2	Ø.2		
R1927		Meeting unique Room					.34	Ø.5	Ø.3	Ø.3	Ø.4	Ø.2
R1926	Michelle Jordan	unique					.46	1.3	0.3	0.3	0.2	0.2
R1932		unique					.24	Ø.2	Ø.3	Ø.3	Ø.2	Ø.2
?		OPA Fileroom					—					
R1914		Fileroom					.38	0.5	0.4	0.3	0.3	0.
Sec. for Dave	Annie Williams						5.30	14.Ø	1.8	Ø.2		
Sec. for Val	Minnie Brantley						2.77	5.Ø	3.Ø	Ø.3		

INSTRUMENT USED IS THE HOLADAY HI-3627 ELF MAGNETIC FIELD METER S/N: 77796
Calibrated on October 1, 1993.

APPENDIX 2
"EXTREMELY LOW FREQUENCY [ELF] MAGNETIC FIELDS IN OFFICES, AND THEIR MITIGATION"

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

Extremely Low Frequency [ELF] Magnetic Fields in Offices, and Their Mitigation

N. A. Beddows CIH, CSP

Abstract

60 Hz, magnetic fields exist in the occupiable space of offices, generally at one-half to five milliGauss levels. In a relatively small number of cases, magnetic flux density is higher, by two or three orders of magnitude. This is attributable invariably to closeness to fixed electrical equipment, but only within the facility. Elevated magnetic fields are often discovered by a malfunction of a PC monitor which is correctable by relocation.

Personal exposures and area flux density can be measured. Two standards-setting organizations have established daily occupational limits for exposure. The World Health Organization (WHO) daily, occupational limitation is 0.5 milliTesla (5,000 milliGauss). This is based on potential induction of a current density level (~ 10 mA. m^{-2}) which is comparable to the levels occurring normally in the body. The WHO limitation is (i) three orders of magnitude greater than the magnetic flux density which exists in most occupiable spaces, (ii) seldom if ever encountered in offices, and (iii) is far greater than the minimal level which affects computer monitors (10 milliGauss).

A tentative "yardstick" for magnetic flux density in offices is five milliGauss. No deterioration of acceptable work space quality, and minimizing potential exposures is appropriate and prudent policy.

Elevated field strengths in offices may be reducible, economically, by a judicious use of low carbon steel and/or 48% or 80% nickel content alloys. A magnetic shield must have very low reluctance and remain unsaturated. When wall shielding is required, 80% nickel content alloy is especially useful because of its high permeability.

Shield design involves attaining low magnetic reluctance while averting magnetic saturation, and excessive incremental structural loading, thermal overloading, disruption to business, and costs.

Success in shield engineering is meeting the customer's expectation. In many mitigation projects, this translates to a twenty to thirty decibel average attenuation in flux density in occupiable spaces.

Feasibility of successfully, economically engineering a solution to an intrusive magnetic field problem can be evaluated. Mitigation projects are described. To assure project reliability and cost-containment, the services of a shielding specialist who can demonstrate capability and experience is desirable, and may be necessary.

☞ *This material summarizes certain personal recent inquiries and findings on the practical aspects of magnetic fields in offices, consequences of their presence, and mitigation possibilities. It is intended to be useful in a practical sense to office and facilities managers, and employees who are looking for basic information on the captioned subject, and as relevant safety engineering material.*

N.A.B. 3/25/93

Introduction

Magnetic fields are non-ionizing. Unlike X-rays and other types of ionizing radiation, including sunlight, they do not cause actual breakage of molecule bonds. However, they can induce low density electrical currents into the head and trunk. Magnetic fields are not perceived by humans, and they can penetrate non-ferromagnetic materials, unlike electric fields which cause hairs on the body to stand up, and which are stopped by all materials.[1]

Extremely low frequency (ELF) magnetic fields occur in every office environment. Their frequencies are predominantly 60 Hz, with higher harmonics to 300 Hz. Other, lower frequencies (e.g., 5 Hz) occur. These fields are created by alternating current in single-phase or three-phase electrical conductors.[2] The 60 Hz flux density average levels in the occupiable spaces of most offices are about one-half to five milliGauss†, but the average magnetic flux density levels may be elevated in a relatively small number of cases. And, of course, some variation can exist within each setting. The existence of ELF magnetic fields in offices is now well-known. First evidence of their presence is likely to be computer screen flickering which stops when the monitor is placed outside of the fields. An ambient magnetic flux density of about ten milliGauss will cause a monitor to jitter or lose image or color integrity. PC computers themselves create external magnetic fields. Their contribution to the average flux density in an office is minor.

† *MilliGauss is used in field surveying; and microTesla, in Industrial hygiene and health physics, for exposure. Some interchanging of flux density terms is necessary in this paper to maintain the broad perspective.*

Personal exposures from PC computers, even ones with high resolution monitors, are minimal, about one-tenth to one-half of a microTesla, at about (i) 24 inches from the screen and (ii) 36 inches from the side or back of any nearby unit.

Average magnetic flux density levels several orders of magnitude greater than the upper limit of the general office range may be encountered in a relatively small number of offices. Elevated average flux density is attributable invariably to proximity to unshielded bus bars, distribution centers, open cabling in trays, or cabling in walls.

Exposure to magnetic fields in offices may become a concern in some situations. The public is aware that associations between various cancers and leukemia and electromagnetic fields have been claimed in some epidemiologic studies.[3] And, public exposures and possible biological effects have been featured recently in the press and television. Explaining magnetic fields and discussing the associations of potential exposures and diseases is difficult. The popular media have heightened public awareness of issues surrounding magnetic field exposures, however, some underlying factual aspects have gone unrealized. Some studies which suggest a cancer association with electromagnetic exposures were based on indirect assessments of exposure, such as the wiring codes employed in home construction in geographic areas near power lines, rather than actual measurement of magnetic flux density. Some studies which suggest associations between health and magnetic fields indite exposures which are less than the theoretical threshold level for creation of an electrical current density in the head or trunk which is comparable in magnitude to current density levels which occur in normal body processes. And, some studies indicate that there is no significant linkage at the surrogate exposure levels reported in studies which suggest some association. Other studies indicate that weaker magnetic field flux densities are associated with an adverse response, while stronger ones are not;[4] and, data in some studies would even support a hypothesis of potential, beneficial effect. At this time, it is evident that there is extreme uncertainty in effect-exposure-response matters concerning weak magnetic fluxes.

In considering the epidemiological reports on extremely low frequency magnetic fields, it may be helpful to know the position[5] of the World Health Organization, International Non-Ionizing Radiation Committee (WHO/INIRC) of the International Radiation Protection Association. The WHO/INIRC states:

" Although these epidemiological data can not be dismissed, there must be additional studies before they can serve as a basis for health hazard assessment. Furthermore, scant laboratory evidence exists to support the hypothesis that there is an association between 50/60 Hz fields and increased cancer risk."

The preceding WHO/INIRC position is echoed by other authorities, including the National Radiological Protection Board (NRPB), and the Committee on Interagency Radiation Research and Policy Coordination (OSTP). These organizations and others, however, support a major research initiative. And, on this point, to quote the EPA Scientific Advisory Board:

"Research is needed. The Subcommittee therefore recommends that scientific information sufficient to support credible formal risk assessment of exposure to electric and magnetic fields be developed....."

EPA is pursuing research on ELF and higher frequency band, electromagnetic fields; with cancer, bio-mechanisms and exposure assessment being high priorities.

Flux Density Levels & Factors

Strong magnetic fields do not exist in occupiable spaces in a typical large office facility. The average, 60 Hz magnetic field flux density in such spaces in most offices in a typical large facility, is less than five milliGauss, and the corresponding range is typically about an order of magnitude. However, a small percentage of offices in such a facility may have (i) higher than average flux densities and (ii) area magnetic hot-spots due to the influence of external but close, fixed power distribution centers, bus bars, open cabling in trays, sub-stations, elevator machinery rooms, electrical cables in walls or main-frame computer equipment. The materials used in construction, and room orientation also can influence the level of effect from electrical apparatus.

Magnetic field flux density at a point is weakened greatly by separation of the point from the source. Attenuation is an inverse function of the square of the distance.[6] In most office layouts, separation of occupied space from fixed high-power electrical services or equipment is substantial. Some offices will be close to, and affected by, such electrical services or equipment.

With some affected offices, rearrangement of desks, computers or seats will reduce potential exposures or eliminate video monitor problems. Some affected offices, however, will need to be physically shielded to adequately attenuate magnetic fields created by external electrical apparatus and cabling, if they can not be relocated.

Survey Meters & Monitoring

Most office facilities have electrical apparatus which generate two or three 60 Hz harmonics, as well as lower frequencies.

Monitoring[7] magnetic flux density levels in offices is performed using a survey meter which can measure down to about one-tenth of a milliGauss [0.01 microTesla] on the maximum-sensitivity scale. The meter should have an accuracy of ±5% at the calibration frequency. It needs to be accurate over the frequency range encountered. Readout is "milliGauss" or "microTesla." Apart from area survey meters (which can also be used to determine time weighted average exposures), magnetic field dosimeters are available for monitoring personal exposures. They can be linked to data loggers to facilitate large scale data collection and analysis.

A magnetic flux density meter uses either a single-axis probe or a three-axis probe. The single axis probe is sensitive to a field only in one direction. This feature, however, is invaluable in determining field magnitude and direction, which is needed in shield design work. When a single-axis meter is used as an area or personal dosimeter, the operator turns the probe in all directions, takes spot measurements in three perpendicular axes, computes the square root of the sum of the squares of the three perpendicular plane readings, and reports the computed (rms) mean as the flux density. Taking readings in the three axes is necessary because of the vector nature of magnetic fields. The computation is conservative when the field is elliptically polarized (as with a three-phase generator). The three-axis probe simultaneously senses magnetic fields in three perpendicular directions. The meter automatically integrates the three, directional flux densities and displays a single (rms) value.

Survey meters and dosimeters must be calibrated before use, and at least quarterly. The calibration source must be traceable to a national primary standard. Guidelines for calibration are provided in MIL-STD 4566A, and in an ANSI/IEEE[8] standard. Portable calibrators are available. Users must follow the recommendations of both the calibrator manufacturer and the meter manufacturer.

A large number of measurements need to be made over the day, when work places or personal exposures are to be characterized. This is necessary to factor in power usage, which may or may not change over time and cause a change in the ambient magnetic field strength. Evaluating a work space requires measuring the mean (three-axes) flux density in at least five locations, including the room center, any walls near seating, and the wall centers and top and bottom corners. Evaluating a personal exposure involves determining the time weighted average, mean flux density at waist height.

When spot measurements are made in occupied spaces for any purpose, upon an employee's request, it would be reasonable to (i) explain what is being measured, and (ii) make the results available. Transmittal of data might best be made by letter, with a clear explanation of the situation. This will avoid misunderstanding or misinterpretation.

Guidelines & Limitations

A knowledge of guidelines and limitations for occupational exposure and the rationale for setting the limitations is invaluable when potential occupational exposure to magnetic fields becomes an issue. Two organizations provide relevant occupational guidelines and limitations:

- The World Health Organization, International Radiation Protection Association, International Non-Ionizing Radiation Committee (WHO/INIRC).

- The American Conference of Governmental Industrial Hygienists,[9] ACGIH.

The 1989 WHO/INIRC occupational limitation is the more stringent of the two limitations.

The basic criterion of the WHO limitation is a biological one. This criterion is that of maintaining flux density below the level which can induce an electrical current density in the body of about 10 mA m^{-2}.

The criterion limitation carries no implication whatsoever that the referenced biological change progresses to any adverse health effect.

The WHO, International Non-Ionizing Radiation Committee, in referring to the daily magnetic field occupational limitation, states:

*"The magnetic flux density, **B**, ... is accepted as the most relevant quantity for expressing magnetic fields associated with biological effects."*

"... to be conservative, current densities induced by external... magnetic fields should not significantly exceed 10 mA m^{-2}."

"[The limits recommended] correspond to induced current densities that are at or slightly above those normally occurring in the body (up to 10 mA m^{-2})."

"[A reduction factor of ten is applied to the WHO/INIRC occupational, whole-body exposure limitation (5 milliTesla) which corresponds to an induced current density of 10 mA m^{-2}] because of the sparseness of data on long-term exposures ...."

"[The x10 factor-modified] magnetic flux density for continuous exposure in the occupational environment is limited to 0.5 mT."

The ACGIH Committee, in referring to its occupational standards, states in the preamble to all of the standards:

"[A limitation to which] it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects."

The 1993 ACGIH occupational limit is 60 milliTesla, it is unchanged from 1992.

OSHA[10] has no applicable standard, and its [§5(a)1] General Duty clause is not applicable because no recognizable, serious hazard exists. Electromagnetic exposure is not on the 1993 OSHA Regulatory Agenda.

A Yardstick for Decision-Making. Minimizing Potential Exposures

Offices in proximity to large, fixed electrical equipment can be expected to have stronger field strengths than offices which are remote from such equipment. If higher than average magnetic fields being present in an office becomes an issue, some sort of yardstick will be needed for making a decision. If one accepts the WHO/INIRC daily occupational limitation as a conservative guideline (many industrial hygienists do), and, that the magnetic field flux density in a typical large office facility is two or three milliGauss, which is three orders of magnitude lower than the WHO/INIRC limitation, then one might agree that a useful tentative yardstick for decision-making is five milliGauss, or one-half of a microTesla, in exposure terms. [At this flux density, one would not expect any interference with computer monitors].

Apart from having an acceptable yardstick for use in decision-making, one might also want to employ certain criteria for prudent avoidance, even though no basis exists to believe that there is any degree of hazard with office-level exposure. One may elect to adopt measures to avoid exposures, even if doing so may or may not reduce any potential, albeit unknown, risk. A criterion for this philosophy could be one of "no significant deterioration." Another criterion could be a goal of reducing flux density when this is practicable and economical.

The relation of the WHO/INIRC and ACGIH guideline-limitations and typical levels of magnetic flux density in offices is illustrated in the following text box.

1992 - 1993 ACGIH DAILY, OCCUPATIONAL LIMIT - 60 MilliTesla.

2 ORDERS OF MAGNITUDE LOWER ▼ ▼

1989 [& 1993] WHO / INIRC DAILY, OCCUPATIONAL LIMIT - 0.5 MilliTesla. [5,000 MilliGauss]

3 ORDERS OF MAGNITUDE LOWER, AGAIN ▼ ▼ ▼

PC Video Problems [at 10+ MilliGauss]

MOST OFFICES at 5 MilliGauss or Less. [0.5 MicroTesla or Less]

Reducing office magnetic field strengths might require physically shielding a work space from intrusive magnetic fields emanating from adjacent electrical power apparatus, equipment or cables. Reducing personal exposures might be achieved by rearranging desks and seats, or relocating an employee. [Relocation might be offered as an accommodation for an employee]. Regardless of whether an engineering or an administrative effort is made, an assessment of the area will be needed. This will involve representative monitoring of office spaces.

Characterizing an office facility and assessing potential exposures in offices require a large data base of magnetic flux density and duration of exposure. Data ought to be resolved in terms of office-flux density distributions. Setting an overall range for this purpose is arbitrary, but it can be done sensibly. A range of 0.1 to 50 milliGauss is believed to be appropriate, because: (i) the upper limit is two orders of magnitude below the WHO limitation, and is only rarely exceeded in offices; and (ii) 0.1 milliGauss is the lowest flux density which one can measure ordinarily.

Depending on observations, the quality of the available information, and the reference point (yardstick) used, one can decide whether or not to mitigate a flux density problem in a particular work space. In this matter, one might bear in mind that:

- Optimal work space quality may be equated to magnetic field flux density, but it is most definitely related to good lighting, uniform acceptable temperatures, low noise level, and a high rate of fresh air supply; compromise is needed, invariably.

- Employees having to work with continually malfunctioning video monitors is unacceptable, might be construed to be an ergonomic hazard, and ought not to be part of a space-quality compromise.

- Work places which are perceived to be of less-than-optimal quality might better be used for minimal-occupancy activities: record-keeping, and equipment storage.

- There is no requirement on an employer to make an extraordinary effort to measure or attenuate magnetic fields in offices when there is no likelihood of a recognizable serious health hazard existing. Initiating such an effort, however, may be necessary to maintain good employee relations and productivity.

Economically Feasible Engineering.

When considering the desirability of reducing potential personal exposure or eliminating electronic interference, associated with an intrusive magnetic field caused by an external electrical current, the manager needs answers to two questions:

○ What is involved in, and what is the economic feasibility of, attenuating magnetic fluxes in an affected work space?

○ What has been successful in efforts to attenuate intrusive magnetic fields using economically feasible and practical methods?

Project performance data is propriety information to the designers and installers of magnetic shields. One respected source for shield design and manufacture conditionally agreed to provide the writer with pre-treatment and post-treatment, average flux density data and information on methodology and material selection, for several remedial projects. These particular projects were described as "conventional and generally economical." The prescribed conditions were: (i) data were to be described in terms of "attained minimal decibel attenuation" [rather like acoustical engineering] and, (ii) only a general description would be made of the construction materials and arrangements used. These restrictions, however, do not prevent one from assessing the feasibility of employing economical engineering to attenuate fields to eliminate an equipment interference problem or an exposure issue. And, they do not stop one from providing a sense of the engineering effort that can be involved in their mitigation. Feasibility information, and summaries of reported projects are provided in the following parts.

1. *Feasibility-Related Information.*

- Intrusive magnetic fields can be attenuated to non-problematic average flux density levels by implementing a program of surveillance, shield design and installation.

- Success, in context with economical, conventional shielding for offices and laboratories, means attaining the goal set by the customer. Depending on the average value of flux density initially existing, an attenuation of average flux density of twenty to thirty decibels or greater may be attained without having to resort to extraordinary (high cost) shielding engineering. In general, the lower the value of the starting point flux density, the lower will be the decibel level of attained attenuation.

- Conventional magnetic shielding design and installation has had many customers with office type problems. The record of numerous projects is evidence for the economic feasibility of shielding offices.

- Methodology for assessing economical engineering feasibility is illustrated in the following example:

A large, premium office space is being affected by intrusive magnetic fields believed to be caused by apparatus in an accessible electrical vault situated in a basement immediately below the affected space. One employee, using an inexpensive hobby-type Gaussmeter, has found about 50 to 60 milliGauss in the occupiable spaces, and higher levels on some walls. The management wants to make the occupiable space the same, magnetically, as the other (unaffected) offices, but, it is "not going to pay for any extraordinary engineering work." The Building Manager has asked "Would using physical shielding be feasible? What would be involved?"

The level to be attained is the "good" office average level, say, an average of two milliGauss. Let us accept that the meter which the employee used was fairly accurate. The preliminary challenge is to assess the feasibility of attenuating flux density from an average of sixty (H_m) to an average of two (H_i) milliGauss, using conventional, economical shielding engineering (which may yield 20 decibels (dB) to 30 or greater dB attenuation, depending on the circumstances). We will use certain historical attenuation data; in this case, an average attenuation of 30 decibels, attained for a moderately elevated flux density situation, without resorting to extraordinary (high cost) engineering:

$$\text{Decibel (dB)}_{\text{Attenuation}} = 20\log(H_m/H_i)$$
$$dB = 30 = 20\log(H_m/H_i).$$
$$\text{Log}\,(H_m/H_i) = 30/20 = 1.5$$
$$\text{Log}\,H_m = (1.5 + \log 2) = 1.8010.$$
$$H_m = 63 \text{ milliGauss.}$$

Here, the estimated upper limit for attenuation is about the same average flux density measured by the employee. Economically-feasible methodology probably could be used satisfactorily to mitigate the magnetic field.

- For success, proper selection and sizing of materials is critical. The shield must have suitable magnetic reluctance and saturation characteristics. Placement and construction is also critical.

- Ferromagnetic materials - low carbon steel, 48% nickel content alloy, and 80% nickel content alloy - and certain combinations of these materials - are used. The reluctance of low carbon steel is often adequate for its use as a cost-effective alternative to using a thinner but much more expensive, nickel alloy material. As a practical matter, past a certain point of required efficiency for attenuation level, partial or extensive use of nickel alloy is necessary.

- 48% nickel and 80% nickel content alloys are especially effective in shielding low frequency, relatively low density fields. 60 mil thick, 80% nickel content alloy may be used for cost-effectiveness and efficiency to shield magnetic "hot-spots" on walls adjacent to power distribution equipment.

- The 48% and 80% nickel content alloys provide magnetic reluctance - a path for the magnetic flux to be directed to the shield - which is very much lower than low carbon steel. The 80 % nickel content alloy has the lower magnetic reluctance (higher permeability).

  [Reluctance (R) is inversely proportional to magnetic permeability (μ). Reluctance in magnetic circuits is somewhat like resistance in electricity: $R = L/\mu A$. Magnetic permeability is a factor relating to concentrating magnetic lines of force (H), to create a flux density (B), in the material. Permeability is not a constant. It increases with flux density, up to a maximum in non-saturated conditions. For this reason, attenuation is generally better at higher field strengths, but only to saturation. $\mu = B/H$].

- Nickel alloys have relatively low values of magnetic saturation. They are not used directly in very dense fields.

  [Saturation is where increasing field strength does not increase flux density, on a magnetization curve. It prevents more lines of force being conducted, which then causes a shield to become ineffective].

- An alloy with a 80% nickel content weighs approximately 0.315 lbs per cubic inch, and costs about $0.9 / sq.ft / mil.

- The thicker the ferromagnetic material, the greater is the shielding, up to a maximal efficiency limit. [The relation of ELF magnetic shielding efficiency and thickness is proprietary information].

- Electrical grounding is not a requirement for efficient magnetic shielding.

- Efficient shielding is a matter of balancing permeability against saturation, while maintaining material workability, and project simplicity and economy.

- Multiple layers of material or a laminated arrangement may have to be used in some cases for efficiency. Laminar structures offer the great benefit of effective attenuation by air spacing.

- It is generally preferable to shield the source, when possible, consistent with maintaining adequate heat dissipation and required equipment operational temperatures. The benefits are (i) generally, minimal surface area treated, and (ii) minimal disruption of work place activities.

- Shielding at the receptor site may involve affixing one-quarter or even one-half inch thick, low carbon steel plates to floors, and a laminate of low carbon steel, plywood, and a 80% nickel content alloy to walls. Placing a one-quarter inch thick steel plate on a floor creates an incremental uniform loading of about ten pounds per square foot. Generally, this level of incremental floor loading is not a problem. Shielding arrangements of these types, reportedly, are quite usual as required treatment for affected work spaces.

In some circumstances, an alternative (or a complementary action) to physical shielding might be a preferred solution. Such an alternative might include - but is limited to - eliminating open bus bars and replacing them with shielded cables, twisting three-phase conductors to achieve EMF-cancellation, re-routing cabling to achieve maximum distance from the affected receptor site, and terminating conduits in heavy steel enclosures to further confine magnetic fields.

2. Reported Successful Projects.

Reportedly successful cases, for which certain proprietary information and attenuation data have been provided, are described in the following sections.

- A large room with interference of computer operations and video screen problems, caused by external magnetic fields, was treated successfully by covering certain wall sections, which had magnetic hot-spots, with 60 mil thick, 80% nickel content alloy sheeting; and the floor, with one-quarter inch thick, low carbon steel plates. Reported average attenuation: 30 dB.

- A room with sensitive electronic analytical equipment was affected by magnetic fields created by a power control center in a vault below the room. Elimination of interference, with an average ambient flux density less than ten milli-Gauss, was attained. Reportedly, this involved using 1/4" 1010 steel plates for the floor, and 60 mil, 80% nickel content alloy sheets for the wall, magnetic hot spots. Average flux density attenuation: 30 dB.

- A hospital room affected by 60 Hz magnetic fields from adjacent power distribution equipment, reportedly, was effectively treated using only low carbon steel plates placed on the floor and on some wall areas. Average attenuation: 25 dB.

- Designed, fabricated-to-order, nickel alloy (high magnetic permeability) enclosures are reported to be effective in shielding video monitors from screen jitter and image distortion caused by ambient 60 Hz magnetic fields created externally. Reported average attenuation: 40+ dB.

Concluding Remarks

It may be worth summarizing a personally associated, failed project: Low carbon steel plates were fixed to the ceiling of a power distribution equipment vault located almost directly beneath offices which were having problems with video monitors. The average flux density in the vault space exceeded 40 Gauss. The average flux density in the affected room, before treatment, was about fifty milliGauss. The average flux density after treatment exceeded ten milliGauss. The monitor problems remained. Treatment was not a success. Now, it is obvious that, as a minimum, comprehensive area shielding, and significantly greater shielding efficiency, in the vault space itself, was needed.

This experience prompts me to make two, closing comments on the point of looking for engineering solutions:

1. Knowing what works and what does not, and knowing what is cost-effective and what is not are invaluable for cost avoidance and project reliability. This knowledge must come from first-hand experience. Trying to remedy a major magnetic field problem without prior experience could result in repeated, failed attempts and excessive cost.

2. Shield design is the province of the expert. Design, and probably installation also, might better be left to a company which specializes in this work.

* * *

References & End-Notes

1,2,6. For a good explanation of the creation of magnetic fields and electric fields, and their properties, see Engineering Electromagnetics, William H. Hayt, Jr. McGraw-Hill Book Company. Also, EPA Publication 402-R-92-009: "Questions and Answers About Electric and Magnetic Fields"

3,4. Feychting, M. Anders, A.: Magnetic fields and cancer in people near Swedish high voltage power lines. IMM-rapport 6/92. Stockholm Instutet for miljomedicin, Karolinska institet, Stockholm, Sweden.

5. For a thorough review of the WHO.IRPA/INIRC Guidelines and Limitations, see Health Physics Vol. 58, No.1 (January) pp. 113-122, 1990.

7. Monitoring for exposure assessment is different than area/home surveillance. Spot measurements are taken over the day, at waist height, to establish a time weighted average for the daily exposure. A minimum of 16 readings, spaced evenly through the day, per personal exposure is recommended.

8. IEEE Standard #644-1979, Institute of Electrical and Electronic Engineers, New York, NY.

9. Technical Information Office: 6500 Glenway Avenue, building D-7, Cincinnati, OH 45211-4438.

10. The Occupational Health and Safety Administration. OSHA sets occupational standards. The General Duty clause may apply when no specific standard is relevant and a serious recognizable hazard exists.

Acknowledgment

The test data and work contributions of my colleagues L. Darveau and J. Cherniack are acknowledged with pleasure. My thanks to W. Chenoweth, W. Holbrook and R. Hinten for their reviews and comments. Special thanks go to L. Maltin, Amuneal Manufacturing Corporation, Philadelphia, PA 19124, for sharing with me proprietary attenuation information from some of his mitigation projects, as well as information on material properties and proven uses.

☞ *The author would welcome additional information on the matters mentioned here - especially information on mitigation efforts which have proven to be either successful or unsuccessful.* *Norman Beddows, Region 1 Safety, Health and Environmental Program Manager. United States Environmental Protection Agency, J.F. Kennedy Federal Building, Boston, Massachusetts 02203-2211. (617) 565-3388.*

APPENDIX 3
REGION 1 MAGNETIC FIELD SURVEY ASSESSMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING. BOSTON. MASSACHUSETTS 02203-2211

To: P. Meaney, Acting Deputy Regional Administrator.

Through: S. Perkins, Deputy Assistant Regional Administrator.

From: N.A. Beddows, CIH, CSP 2/11/93
Regional Health and Safety Manager.

Subject: Extremely Low Frequency (ELF) Magnetic Fields in Regional Off
Information For Use in Addressing Possible Employees' Concerns

A. Consideration of the Presence of A Hazard

At the outset, I want to assure you and our employees that there are no kn recognizable health hazards related to ELF magnetic fields in any office or work s in either of the Canal Street or the Congress Street EPA Facilities.

With respect to this assurance, I should explain that occupational exposures to extre low frequency (ELF; 60 hertz) magnetic fields occur in every office environment. trical power sources, power distribution centers, elevator electrical machinery, com centers, lighting and personal computers generate electromagnetic non-ionizing radia However, the magnetic component of every electromagnetic field from such sour weakened dramatically by separation by distance. Such separation by distance ex: all of the office layouts employed in the two Boston offices of Region 1.

J. Charniack, L. Darveau, R. Hinten and myself were involved in one or more as of monitoring (1) magnetic flux densities in offices and researching relevant guide: Several hundred spot measurements of magnetic flux densities in our offices have measured in the last few weeks by J. Cherniack and L. Darveau, using a Holad 3627 Electromagnetic Field Survey Meter. I believe that the extent and quality c monitoring used, most of which I either witnessed or identified as required, adeq characterizes the referenced facilities.

In the offices in the EPA facilities at Canal Street and One Congress Street, pot office ELF magnetic (B flux density) exposures span two orders of magnitude. T evident from the flux density data that J. Cherniack and Linda Darveau have me and reported. However, the highest flux density reported for any work station in an of a station is two orders of magnitude less than the World Health Organiz International Radiation Protection Association's (WHO/IRPA) Occupational Lim for continuous occupancy exposure to ELF magnetic fields (discussed later).

What we have determined is sufficient to allow me to feel comfortable in declaring there are no known, recognizable hazards associated with ELF magnetic fields in referenced offices. In saying this, I realize that data gaps and unanswerable quest abound on many aspects of this topic.

B. Background Information

As you know, exposure to ELF electromagnetic fields is an emerging public con because cancers have been associated with exposure in some epidemiologic studies, more significantly, perhaps, the topic has featured recently in the press, televisior in a few well-publicized litigated cases.

Explaining ELF magnetic fields in offices and the significance of measured expo to employees is difficult in most situations, and it is especially difficult when fac emotion generated out of articles, whether sensational or evenly balanced.

While the media have heightened public awareness of issues surrounding electromagnetic exposures, some underlying factual aspects, which are too diffic address in a few sound bites, go unrealized. To the point, some studies which suggested a cancer association with certain ELF electromagnetic exposures were on indirect assessments of exposure - the types of wiring codes employed in construction in geographic areas near power lines, et cetera - rather than actua measurements of magnetic flux densities in homes. Some studies which sugg association are at odds with the theoretical basis for establishing the magnitud magnetic field density which could induce a current density in skin and comparable to those current density levels which occur normally in the body. And studies made by competent authorities indicate that there is no significant linkage at comparable to the surrogate exposure levels reported in studies which say the op

It seems fair to say that no one is even sure that weak electromagnetic forces human health and that there is even greater uncertainty in regard to exposure-r questions with such fields.

C. Occupational Standard

After reviewing the technical literature, there are two relevant occupational lim to consider: the limitation of the American Conference of Governmental Ind Hygienists (ACGIH), and the limitation of World Health Organization\Intern Radiation Protection Association (WHO\IRPA). The WHO\IRPA limitation is th stringent of the two. OSHA has no applicable standard, and its [5(a)1] Gener clause is neither relevant nor applicable.

Dealing with the WHO/IRPA Occupational Limitation, the following points are mad

- The criterion underlying the magnetic flux density-based limitation predicated on that flux density which may induce a current density in huma tissue which is comparable to the levels of those which correspond to norm physiological functioning [reportedly, 10 mA m^{-2}].

- The limitation includes a reduction factor of 5. This factor is used to accou for the scarcity of relevant human data. As a concluding remark, th WHO\IRPA limitation is provided with the acknowledgment that criteric employed does not signify that a human health hazard occurs with the releva induced current density.

- The WHO\IRPA established (ELF magnetic field density) threshold limit val for occupational daily exposure is 0. 5 milliTesla†.

  † The unit Tesla is the accepted international unit for describing (B) magnetic fl density. It is employed in the scientific journals and by standards-setting authoritie One Tesla equals 10,000 Gauss. It is employed herein to facilitate reference.

- The rationale stated by the WHO\IRPA Committee for establishing th limitation has wide support among industrial hygienists and health physicist

- The value of the WHO\IRPA-limitation is two orders of magnitude less th the threshold limit value (60 milliTeslas) for continuous, daily, whole-bo exposure established by the American Conference of Governmental Industr Hygienists (ACGIH) in 1992.

I believe that the WHO/IRPA Occupational Limitation is entirely relevant and applica as an interim guideline for large office environments. Of course, nothing prevents from establishing a more stringent limit as an interim internal standard. Moreove attaining a significantly more stringent limit for continuous occupational exposure achievable without any effort by most office facilities.

D. <u>Assessment, Reported Spot Measurements of Magnetic Flux Density</u>

An assessment of the reported magnetic flux density data on the 90 Canal Street offic all of which have the usual electrical services and electronic equipment, is provided the following part.

Assessment:

- All the offices' magnetic flux density values fall in the range of 0.05 microTeslas.

  Please note that the upper limit of this range is two orders of magnitude below WHO\IRPA limitation for a daily occupational exposure.

- Most [95%] of the work stations in both facilities have magnetic fields of fl density values which fall in the range of 0.1 - 0.5 microTesla.

  Please note that the upper limit of this range is three orders of magnitude below WHO\IRPA limitation.

- 15 offices have the higher measured values. However, all have magnetic densities which fall within the range of 0.15 - 5.0 microTesla.

  Please note that the upper limit of this range is two orders of magnitude below WHO\IRPA limitation.

Based on the matters reported and for the reasons stated above, I believe that there no known, recognizable ELF magnetic field related health hazards in any office or w space in either of the Canal Street or the Congress Street EPA Facilities.

E. Related Matters

There are several related but separate matters that I believe should be addressed at point. They are:

- What should be the philosophy in regard to providing quality 8-h occupiable work spaces?
- What should we establish as a (Regional only) interim internal standard establishing office facilities?
- What engineering and administrative opportunities are there for minim magnetic fluxes and exposures in the office work spaces?

On the first point (applicable philosophy), I believe that in establishing layouts a providing office work spaces one should place employees in optimal quality spaces (need to keep in mind that natural lighting, even temperatures, low noise level, and h: ventilation rate are very major components of quality) to the best extent possible, and utilize lesser quality spaces for minimal-occupancy activities: record-keeping cente equipment storage, and the like. I am not aware of the existence of an employer-duty any possibly relevant health standard which requires an employer to engage in . extraordinary research on attenuating ambient magnetic fields (i.e., fields with f densities less than 5 microTeslas) for the purpose of minimizing potential exposures offices. Of course, we might need to do this in some cases.

> *Please note. We could make a preliminary evaluation of the feasibility of engineering out ~ magnetic fluxes in offices. This might be merited when spurious electromagnetic fields apc to be affecting computer video units in some office locations (as appears to be the case in a locations at 90 Canal Street).*

On the second point (establishing a Regional occupant exposure standard), we alre: far exceed the work space quality which is afforded by application of the WHO\IR limitation. We have employed a metallic shielding with apparent marginal success minimize the weak but higher than average magnetic fields present in a small numbe: currently occupied work spaces. Given the current situation, I believe that it appropriate to base a Regional-only internal standard on the principle of "no signific deterioration."

The existing range of potential magnetic flux density exposures in our facilities as : currently exist would establish the standard.

The Interim Magnetic Field Flux Density, 8-hour, Daily, Occupant-Exposure Stan. which I am recommending for Region 1, is:

1. **An average value of 0.5 microTesla (5 milliGausses) evaluated as an weighted mean value. And,**

2. **An upper limit of 5 microTeslas (50 milliGausses) for 8-hour occupancy**

In my judgment, these values characterize our current occupied office facilities respect to ELF magnet flux density.

On the ultimate point (engineering and administrative opportunities), I think tha attenuating the existing weak magnetic flux density in offices by using an inexpensiv engineered approach is unlikely. An initial proposal to employ a grounded mild stee shield over the ceiling in a power distribution equipment vault was tried, with less tha notable success. However, on reflection, one should not have expected a major reductio because the material used has low magnetic permeability; using a metal of hig permeability might have been more successful. We might have gained a little reductio of the electrical component strength by what we did.

Please note:

- *It might be possible to achieve a meaningful reduction of existing weak magnetic fiel in some offices by using either (a) partial shielding using Mu metal sheeting strategica placed according to the respective (spherical) geometry, or (b) localized shielding using M metal sheet material placed on an office floor, under carpeting or placed beneath or arou computer However, we have no experience in doing this, and I do not know of anyo who has. Never-the-less, a preliminary assessment of the feasibility of employing magne shielding material in/near offices and in proximity to computer equipment which is affect by an ambient magnetic field might be worthwhile and be of interest, Agency-wide.*
- *A version of Mu metal is available as Hypernom® Shielding: Approximately 80% nick 0.316 lbs/cubic inch. $14/square feet, as 20 mil thick, 30" x 10'sheets. US distribu is Carpenter Steel, per W. Holbrook. 817-565-3396.*
- *Fully lining the interior walls of a (typical?) 10'x10'x20' electrical vault with Mu me sheeting (20 mil stock, 30" x10', 23 #/sheet, $15.14/lb) might cost ($28,000, mater installation, $3,000) $31,000, as a scope estimate.*

In conclusion, concerning people, it seems to me that an administrative decis (relocate people) would be much cheaper and faster than an engineered effort, becomes necessary for any reason to provide a small number of employees with w places with lower levels of ELF magnetic flux density.

Annotated Reference

(1) In monitoring for compliance with this internal standard, the following protocol was used b Cherniack and L. Darveau:

- *Magnetic flux density measured at waist height.*
- *Electromagnetic field survey meter used mostly was the Holaday Industries Model HI 3 (Holiday Industries: Eden Prairies, MN. (617) 934-3604).*
- *Meter calibrated annually per MIL-STD 45662A.*
- *Fields monitored on three axes in a least five locations in any single office, includin center and any wall surface which was near any seating.*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 23 1994

REPLY TO THE ATTENTION OF:

MEMORANDUM

SUBJECT: Region 5 Electromagnetic Field (EMF) Survey

FROM: David A. Ullrich Dave
Deputy Regional Administrator

TO: Division and Office Directors

Attached are two copies of the results of the Electromagnetic Field (EMF) Survey which was conducted in February 1994, by the Air Toxics and Radiation Branch, Radiation Section, of EPA-occupied space in the Metcalfe Building. The survey covered approximately five percent of the non-enclosed workstations, enclosed offices, copy rooms and kitchenettes on each floor, and also included unique areas such as the main computer room and the library. This survey was primarily designed to determine background EMF levels in the Region.

This EMF Survey provides an excellent profile of the magnetic field environment in EPA-occupied portions of the Metcalfe Building. Based on this profile, magnetic field strengths appear to be on the lower end of the scale for a typical office building.

A copy should be maintained by your Administrative Officer and be available to any employee interested in viewing this document.

Attachments