Abstract of EMF RAPID Engineering Project #6: Survey of Personal Magnetic-field Exposure (Phase I) One Thousand People Personal Magnetic-field Exposure Survey (Phase II)

The objective of this project is to characterize personal magnetic-field exposure of the general population, by performing personal exposure (PE) measurements for a sample of the population.

Phase I

Phase I was designed to develop survey methodologies and to conduct a small-scale survey: it undertook a survey of personal magnetic-field exposure on a sample of 200 randomly chosen adults in the United States ("200-person statistical sample"), and developed and tested a protocol (including selection of instrumentation and exposure metrics, recruiting methods, and assessment of quality of data produced). Phase II includes a large-scale survey using that methodology.

The results obtained during the 200-person exposure survey, the experience gathered during the tests performed with a convenience sample, and the results of cost-effectiveness analysis of different survey methods were used to make the following recommendations for Phase II:

- The performing of special measurements (DC, waveform capture, wire code) should be abandoned because it is too costly (requires house visit).
- Neither special stratification nor the inclusion of institutionalized people is cost-justified.
- The optimum instrument has a fast sampling rate (every 0.5 seconds), permanent memory, small size, and capability of storing in memory frequent (e.g., once every 10 minutes) detailed summaries of the exposure quantities.
- Telephone recruiting (using a list-assisted random digit dialing method) is preferred.
- A consent form and a letter that illustrates the reasons and modality of the survey should be sent to all the people who have agreed to participate.
- Participants should receive a package containing a personal meter (with instructions), a small diary to record activities, a questionnaire, an envelope with prepaid label for returning the meter, and a $50 check for compensation.
- The PE meter should be the size of a pager, and it should be possible to clip the meter to a belt or place it in a pocket or (for infants) in a stuffed animal kept near the child.
- Participants should be asked to turn the meter on at the start of the 24 hours of recording, and to note the time then and at every change of specified activities. The participants should be asked to ship the meter, diary, and completed questionnaire as soon as possible after the 24 hours of exposure measurements.

Findings from the Phase I data are included in the report. Among other findings, the researchers reported on distribution of the time-weighted-average (TWA) fields during a 24-hour period. The following parameters appear to affect the distribution of exposures at home: residence type,

proximity to an overhead power line, residence size, location of the floor of the bedroom, and the type of water line. The data were too few to investigate the effect of other parameters, such as occupation and type of overhead power line.

Study Limitations

Several factors limit one ability of the small-scale survey to support statistical inferences for the general population. The survey did not cover non-telephone households (about 5% in the U.S.) or households with unlisted telephone numbers (about 30% in the U.S.). The response rate was very low, which means the potential for non-response bias is significant. The sample size was small, so the estimates will not be very precise. The study consisted of adults only. Survey methods involving a visit to recruit participants and to perform measurements were not tested, because they were assessed as not cost-effective within available budgets for Phase II.

Future Research

Future research should conduct a personal magnetic-field exposure survey for a large sample (e.g., 1000 persons), including people under 18.

Phase II

Just over 1000 people participated in this survey of personal exposure for a 24-hour period. The protocol developed under Phase I was used. Based on the time-and-event data in the activity diary, the measurements in each data file were partitioned into the following categories: at home not in bed, at home in bed, at work, at school, during travel, and other. A variety of measures of the magnetic field were extracted for each subject and for each type of activity, including time spent for the activity, mean, standard deviation, geometric mean, geometric standard deviation, minimum and maximum, various percentiles from 1st to 99th, time spent above various field thresholds (from 0.5 to 64 mG), number of sudden field changes, length of time with constant field, and an index of intermittence.

In order to generate representative sample estimators of the general population, each participant was assigned a proper statistical weight. In order to present the results as early as possible, the data for 853 of the total were analyzed and presented in an Interim Report.

The following conclusions could be drawn from the 1000-person sample.

1. The distribution of the average fields during a 24-hour period for the population of the U.S. is estimated to be log-normal with a geometric mean of 0.90 mG (95% CI from 0.85 to 0.96 mG) and a geometric standard deviation equal to 2.17 (95% CI from 2.08 to 2.27).
2. It is estimated that 14.7% (95% CI from 12.1% to 17.8%) of the U.S. population is exposed to a 24-hour average field exceeding 2 mG, 5.9% (95% CI from 4.2% to 8.2%) to a field exceeding 3 mG, 2.4% (95% CI from 1.49% to 3.9%) to a field exceeding 5 mG, and 0.41% (95% CI from 0.19% to 0.94%) to a field exceeding 10 mG.

3. About 26% of the people spend more than one hour in fields greater than 4 mG, and about 9% of the people spend more than one hour at fields greater than 8 mG.
4. About 2% of the people experience at least one gauss (1000 mG) during a 24-hour period.
5. The largest average fields (experienced by a few percentage of the people) were recorded during the period "at work." The lowest average fields were recorded during the period "at home, in bed." The average field "in school" exceeded 2 mG for about 3% of the students, while the field "at work" exceeded 2 mG for about 22% of the workers, and the field "at home" exceeded 2 mG for about 15.5% of the people.
6. For the periods "at work," the distribution of the average magnetic fields had the largest geometric mean for the service occupations (1.75 mG); followed by the electrical occupations (whose data, however, were few) with 1.17 mG; technical, sale, and administrative support occupations with 1.13 mG; managerial and professional specialty occupations with 1.05 mG; precision production, craft and repair occupation, and operators, fabricators, and laborers with 0.95 mG; and farming, forestry, and fishing occupations with 0.51 mG.
7. Very little difference in 24-hour average magnetic field was found between men and women (geometric mean: 0.90 mG versus 0.91 mG). The largest geometric mean among age groups was found for working-age people (geometric mean: 0.97 mG), followed by retirement-age people (0.83 mG), school-age children (0.78 mG), and pre-school children (0.59 mG). Little difference was found among different regions of the U.S. The largest geometric mean was found for the Northeast (0.96), followed by the West (0.96), the South (0.90), and the Midwest (0.83).
8. The lowest exposure at home was measured for people living in mobile homes, followed by single-family residences. Duplex and apartments correspond to the largest exposures. The highest exposures at home is in smaller houses and in houses with metallic rather than plastic pipes. The exposure at home tends to increase as the distance to the nearest overhead line decreases. Proximity to three-phase electric power distribution and transmission lines correspond to larger exposures than proximity to other types of lines or no line at all.
9. Despite its limitation, the survey provides data for an assessment of the number of people at risk, should researchers one day be capable of defining risk in terms of some of the quantities measured during this survey. The survey provided data not only regarding the 24-hour average magnetic field, but also data on the time above defined field values, on the length of time with constant field, on the number of sudden field changes, and on the magnetic-field values during different types of activities.

Study Limitations

In addition to the issue of statistical accuracy, there are other reasons why the results must be interpreted cautiously. The survey did not cover non-telephone households, military personnel, nursing homes, hospitalized people, people in prison, and any other institutionalized people. The response rate was very low, and there is the potential for a significant non-response bias. The strength of the survey is in the random selection of the participants. The response rate, although low, was relative uniform across the age groups, gender, and regions of the participants. The survey is the first significant study that quantifies the exposure of the general population for the entire day, not only for the time spent in one's residence but also for the time a person is outside the home, working, in school, traveling, or performing other activities.

Areas for Future Research

Investigate the variability of personal exposure from day to day, the effect of the day of the week (weekday versus weekend), and seasonal effects for different regions of the U.S. Perform magnetic-field exposure surveys in other countries in order to assess relative risk among countries. Perform more detailed magnetic-field exposure measurements for people whose occupation classification has shown the highest magnetic-field values during the 1000-people survey and for other occupations known or suspected to correspond to higher exposures.

EMF RAPID Engineering Project #6:
Survey of Personal Magnetic-field Exposure (Phase I)
One Thousand People Personal Magnetic-field Exposure Survey (Phase II)

Purpose and Focus

The objective of this project is to characterize personal magnetic-field exposure of the general population, by performing personal exposure (PE) measurements for a sample of the population. The project is in two phases:

- Phase I was designed to develop survey methodologies and to conduct a small-scale survey.
- Phase II includes a large-scale survey using the methodology developed in Phase I.

To achieve its goal, Phase I included two separate tasks:

(1) a survey of personal magnetic-field exposure on a sample of 200 randomly chosen adult individuals in the United States ("200-person statistical sample"), and

(2) the development and testing of the protocol for Phase II. As a part of this task, PE measurements were made on a sample of conveniently chosen individuals, including infants, toddlers, school age children, and adults ("convenience sample").

Recommendations for Phase II are derived from the analysis of the 200-person statistical sample survey, from the experience in conducting the survey, from the work performed to develop the protocol, and from the feedback received from participants in the convenience sample.

Tasks: Phase I

Two-hundred-person Statistical Survey

The protocol for the 200-person statistical sample consisted of the following steps:

(1) Households were randomly selected from listed telephone numbers.

(2) An introductory letter was sent, followed by phone calls until a contact was made. The respondent was interviewed in order to select a household member.

(3) The persons who agreed to participate were sent a Consent Form to be signed and detailed explanations about the purpose and the nature of the measurement survey.

(4) Upon return of the signed Consent Form, participants were sent a package containing a personal exposure meter, a diary, a questionnaire, a $50 check as compensation for their participation, and detailed instructions on how to use, wear, and mail back the meter.

(5) Participants wore or kept the meter with them for 24 hours from the moment when they first turned the meter on. Magnetic-field values were recorded and stored in the meter's memory every four seconds. The participants used a diary to record the time when certain activities started or ended. After 24 hours of measurements, they mailed the meter back.

(6) The meter's data were transferred to a computer file, merging information from the diary with the magnetic-field data. The magnetic-field exposure for the entire 24 hours and, separately, for different activities were calculated.

(7) Participants received a letter with the results of their individual measurements.

(8) The data were placed in a database and subsequently analyzed.

Based on the time- and event-data in the activity diary, the measurements in each data file were partitioned into the following categories: at home not in bed, at home in bed, at work, at school, during travel, and other. A variety of measures of the magnetic field were extracted for each subject and for each type of activity, including time spent for the activity, mean, mean, standard deviation, geometric mean, and maximum. The 24-hour time-weighted-average (TWA) results are shown in Tables 1 and 2.

Table 1: Number of Survey Participants with TWA Exceeding Given Values

24-Hour TWA (mG)	Exposures Exceeding Given Value (Number)	Exposures Exceeding Given Value (%)
0.0	201	100.0
0.5	162	80.6
1.0	105	52.2
2.0	37	18.4
5.0	5	2.5
10.0	1	0.5

Table 2: Descriptive Statistics of 24-Hour TWAs

Parameter	Result
Minimum	0.17 mG
Median	1.05 mG
Maximum	19.60 mG
Mean	1.41 mG
Standard Deviation	1.70 mG
Geometric Mean	1.02 mG
Geometric Standard Deviation	2.17

Participants were asked to keep a diary of their activities so that magnetic-field exposure could be evaluated not only for the total 24-hour period but also for different types of activities. The results for different activities are shown in Table 3.

Table 3: Descriptive Statistics for Different Activity Periods

Parameter	At home not in bed	At home in bed	At work	During Travel	Other	All activities
Number of Valid Data Sets	**181**	**182**	**128**	**158**	**162**	**201**
Average activity time of the people with valid data for each activity (% of 24 hr)	33.50	33.20	31.50	9.30	13.00	100.00
Minimum	0.08	0.00	0.08	0.23	0.07	0.17 mG
50th Percentile (**Median**)	0.85	0.61	0.97	1.14	0.90	1.05 mG
99th Percentile	5.94	12.10	7.23	5.03	7.99	7.05 mG
Maximum	14.20	62.00	8.49	6.65	11.80	19.60 mG
Mean	1.22	1.61	1.47	1.36	1.27	1.41 mG
Standard Deviation	1.46	4.88	1.56	0.92	1.39	1.70 mG
Geometric Mean	0.80	0.61	0.94	1.15	0.91	1.02 mG
Geom. Standard Deviation	2.47	3.83	2.63	1.74	2.20	2.17

The exposure distributions were affected by a number of parameters. The greatest effect occurred for the following parameters:

- variations of residence type (duplex residences corresponded to the highest exposures during the “at home” time, followed by apartments and single-family homes),
- proximity to overhead power lines (the largest exposures at home occurred for power lines closer than 25 feet to the residence and the lowest for residences with no overhead lines nearby),
- the residence size (the largest exposures at home occurred for residences with a floor area less than 1000 square feet, while residences with floor area greater than 2000 square feet corresponded to the lowest average exposure, which never exceeded 2.5 mG),
- the floor location of the bedroom (the lowest exposures at home in single-family residences occurred when the person’s bedroom was on the second floor), and
- the type of water line (the largest exposures at home occurred when the water line was metallic).

The following conclusions could be drawn from the 200-person sample.

(1) The distribution of the fields during a 24-hour period is estimated to be log-normal, with a geometric mean of 1.02 mG (95% CI from 0.88 to 1.16 mG) and a geometric standard deviation of 2.17 (95% CI from 2.09 to 2.26).

(2) The distribution of the time during a 24-hour period during which the field exceeded 10 mG has a geometric mean of 1.84 minutes and a geometric standard deviation equal to 7.8. The time above 10 mG exceeded 1 hour for 10% of the people.

(3) The distribution of the time during a 24-hour period during which the field exceeded 50 mG has a geometric mean of 0.12 minutes and a geometric standard deviation equal to 4.0. The time above 50 mG exceeded 10 minutes for 2.5% of the people.

(4) The largest TWAs were recorded "at home, in bed"; followed by "at work"; "at home, not in bed"; and "during travel." The lowest TWA were recorded "at home, in bed." The category of "at home, in bed" has both the lowest and the highest exposures. The distribution of the average field "at home, in bed," has the largest variance.

(5) In general, larger TWAs were recorded for men than for women. The period "at work" appears responsible for the difference.

(6) The following parameters appear to affect the distribution of exposures at home: residence type, proximity to an overhead power line, residence size, location of the floor of the bedroom, and the type of water line. The data were too few to investigate the effect of other parameters, such as occupation and type of overhead power line.

Development of the Survey Method for Phase II

A cost-effectiveness analysis of several different survey methods differing for meter selection, sample designs, and survey protocols was performed, considering (1) the cost of the survey, (2) the expected variance in the results, and (3) the quality of the information obtained.

The analysis revealed that area probability sample design overall has better properties if cost is not a serious consideration. A random digit dialing (RDD) sample design, on the other hand, is recommended if the survey cost has to be constrained. In this case, the most cost-effective method is achieved using a RDD sample design (including telephone recruitment), a mailing out of the instruments to the sampled persons, and instruments that can be easily worn and do not require much input from the user. This overall design avoids the cost of a visit to the user's residence. It requires, however, recruitment of the participants by telephone, which results in a refusal rate significantly greater than that which could be achieved by visiting the user's residence. In addition, mailing the instruments out (rather than personally delivering of them to the household) will also involve the extra loss of participation by persons who agreed to cooperate at the recruitment stage, but who fail to follow through in agreeing to use the meter.

The PE measurements on a 200-person sample constituted a pilot program for a much larger sample to be measured during Phase II of the study. However, several aspects of the protocol were not tested, and several others needed further testing. For example, the 200-person sample consisted only of adults, and a detailed debriefing of the participants was not possible. In order to formulate recommendations for the protocol to be used in Phase II, additional PE measurements were made on several infants, toddlers, school age children, and adults chosen among a “convenience sample” consisting of 53 people: 12 infants, 13 toddlers, 16 school age children, 6 adult males, and 6 adult females. When PE measurements were made of toddlers, PE measurements were simultaneously made of their mothers as well. For each school-age child, three different protocols were tested on three different days. The results have little statistical significance because the sample was small. It appears that the adults in the tested sample had considerably greater exposure than children, toddlers, and infants. The toddlers in the tested sample had considerably less exposure than their mothers, whose exposure data could not be used as proxy for the toddlers' data.

The results obtained during the 200-person exposure survey, the experience gathered during the tests performed with the convenience sample, and the results of the cost-effectiveness analysis of different survey methods were used to make the following recommendations for Phase II:

- The option of performing special measurements (DC, waveform capture, wire code) should be abandoned because it is too expensive, since it requires visiting the residences of the participants.
- No special stratification is justified.
- The cost of including institutionalized people (hospitalized, nursing homes, military, prison population) is not justified.
- The optimum instrument recommended for Phase II is one with a fast sampling rate (every 0.5 seconds), permanent memory, small size, and capability of storing in memory frequent (e.g., once every 10 minutes) detailed summaries of the exposure quantities.
- Survey participants should be recruited by telephone. The sample design should incorporate a list-assisted RDD method. The phone interviewer should use the same techniques used during Phase I to administer a questionnaire, make the selection, and solicit the participation of a member of the household.
- A consent form and a letter that illustrates the reasons and modality of the survey should be sent to all those who have agreed to participate.
- Upon return of the signed Consent Form, the participants should be sent a package containing a personal meter, the instructions for the its use, a small diary in which to record the type of activities performed, a questionnaire, a UPS envelope with prepaid label for returning the meter, and a $50 check for compensation for participation in the study.
- The PE meter should be the size of a pager, and it should be possible to clip the meter to a belt or place it in a pocket. For infants and toddlers, the meter should be placed inside a teddy bear kept near them for the day of the measurements.
- The only action required from the participants should be to turn the meter on at the start of the 24 hours of recording. Participants should be asked to note in the diary the time of day when the meter is first turned on, and then the time at every

change of the following types of activity: at home, in bed, traveling, at work, at school, and other activities.

- The participants should be asked to ship the meter, diary, and completed questionnaire as soon as possible after the 24 hours of exposure measurements.

Summary

Phase 1 of the project, consisting of measurements for 200 randomly selected adults, has been completed. Protocols for Phase 2 have been developed and implemented on a larger population. Analysis of the PE data from Phase 1 indicates a geometric mean PE exposure of 1.02 mG. Exposures were affected by several residence characteristics including residence type, proximity to an overhead power line, and residence size.

Tasks: Phase II

One Thousand Person Survey

The objective of this project is to characterize personal magnetic-field exposure of the general population, by performing personal-exposure copy measurements for a sample of the population. The project is in two phases. Phase I was designed to develop survey methodologies and to conduct a small scale survey. Phase II consisted of a large scale survey using the methodology developed in Phase I. A little more than 1000 people participated in the survey of personal exposure for a 24-hour period. The protocol of the survey consisted of the following steps:

1. Telephone numbers were randomly selected using list-assisted RDD methodology.
2. An introductory letter was sent to all persons corresponding to the selected numbers.
3. The letters were followed up by telephone calls. Calls were also made to households that were not sent an introductory letter. The respondent was interviewed in order to select and recruit a household member for possible participation in the survey.
4. A Consent Form and a letter that illustrated the reasons and modality of the survey were sent to all the people who had agreed to participate.
5. The Consent Form was to be signed by the participants (or their parents or guardians) and returned before measurements could be performed.
6. Upon return of the signed Consent Form, the participants were sent a package containing a personal meter, the instructions for the use of the meter, a small diary to be used to write the type of activities performed, a questionnaire, and a $50 check for compensation for participating in the study. The personal exposure meter was of the size of a pager and could be clipped to a belt or placed in a pocket. For infants and toddlers, the meter was to be placed inside a teddy bear, to be worn as a backpack or kept near them for the day of the measurements.

7. The participants wore or kept the meter with them for 24 hours from the moment they first activated the meter. Magnetic-field values were recorded every 0.5 seconds. Summary statistics were stored in the meter's memory every 10 minutes. The participants recorded the time when certain activities (at home not in bed, at home in bed, travel, work, or school) started or ended. After 24 hours of measurements, the meter was mailed back.
8. The meter's data were transferred to a computer file. The information from the diary and from the questionnaire was transcribed in a computer database. The magnetic-field exposure for the entire 24 hours was calculated using a special software developed for the meter. The meter's calibration was checked and the meters were prepared for new participants. A letter was sent to the participants with the results of their individual measurements.
9. The data from the meters, diaries, and questionnaire were analyzed.

The PE measurements began in November 1997 and were completed on April 3, 1998. In total, a little more than 1,000 meters with usable data were returned. Overall, 3867 households were contacted: 1796 persons were recruited by telephone, 1718 persons were sent a Consent Form to sign, and 1048 persons returned a signed Consent Form and were sent a meter. Based on the time and event data in the activity diary, the measurements in each data file were partitioned into the following categories: at home not in bed, at home in bed, at work, at school, during travel, and other. A variety of measures of the magnetic field were extracted for each subject and for each type of activity, including time spent for the activity, mean, standard deviation, geometric mean, geometric standard deviation, minimum and maximum, various percentiles from 1^{st} to 99^{th}, time spent above various field thresholds (from 0.5 to 64 mG), number of sudden field changes, length of time with constant field, and an index of intermittence.

In order to generate representative sample estimators of the general population, each participant was assigned a weight that takes into account the chance of selection of the person in the sample, and that can be interpreted as the number of persons in the population that the sample person is "representing." The estimated distribution of the 24-hour magnetic field for the U.S. population is shown in Table 4. The parameters of the distribution are shown in Table 5.

Table 4: **Estimated Percentage of People with 24-Hour Average Magnetic Field above Given Values** (results based on data from 853 of the little more than 1000 people surveyed)

24-Hour Average	Percentage of Population with Field Equal to or Exceeding Given Value
0.0 mG	100.00%
0.5 mG	77.20%
1.0 mG	44.40%
2.0 mG	14.70%
3.0 mG	5.87%
4.0 mG	3.33%
5.0 mG	2.40%
7.5 mG	0.45%
10.0 mG	0.41%

Table 5: **Personal Exposure Survey - Descriptive Statistics of the Distribution of 24-Hour Average Magnetic Fields** (results based on data from 853 of the little more than 1000 people surveyed)

Parameter of the Distribution of 24-Hour Average Fields	Result	Parameter	Result
Mean	1.26 mG	**Minimum**	0.07 mG
Standard Deviation	1.49 mG	1st Percentile	0.18 mG
Geometric Mean	0.90 mG	5th Percentile	0.26 mG
Geometric Standard Deviation	2.17	10th Percentile	0.37 mG
Median	0.88 mG	25th Percentile	0.52 mG
		50th Percentile (**Median**)	0.88 mG
		75th Percentile	1.47 mG
		90th Percentile	2.36 mG
		95th Percentile	3.26 mG
		99th Percentile	6.08 mG
		Maximum	25.7 mG

Participants were asked to keep a diary of their activities so that magnetic-field exposure could be evaluated not only for the total 24-hour period but also for different types of activities. The results for different activities are shown in Table S.3.

Table 6: Descriptive Statistics for Different Activity Periods

Parameter	**Home not in Bed**	**In Bed**	**Work**	**School**	**Travel**	**24-Hour**
Number of Participants with Valid Data	852	839	441	106	644	853
1st Percentile	0.09 mG	0.01 mG	0.16 mG	0.09 mG	0.18 mG	0.18 mG
5th Percentile	0.19 mG	0.08 mG	0.24 mG	0.16 mG	0.32 mG	0.26 mG
10th Percentile	0.27 mG	0.11 mG	0.33 mG	0.30 mG	0.42 mG	0.37 mG
25th Percentile	0.43 mG	0.23 mG	0.61 mG	0.41 mG	0.67 mG	0.52 mG
50th Percentile	0.73 mG	0.49 mG	1.01 mG	0.69 mG	0.97 mG	0.88 mG
75th Percentile	1.41 mG	1.22 mG	1.85 mG	1.10 mG	1.48 mG	1.47 mG
90th Percentile	2.63 mG	2.41 mG	3.40 mG	1.65 mG	2.29 mG	2.36 mG
95th Percentile	3.82 mG	3.55 mG	5.00 mG	1.92 mG	2.80 mG	3.26 mG
99th Percentile	8.80 mG	8.05 mG	10.6 mG	3.32 mG	4.68 mG	6.08 mG
Mean	1.27 mG	1.11 mG	1.79 mG	0.88 mG	1.24 mG	1.26 mG
Standard Deviation	1.72 mG	2.10 mG	3.13 mG	0.70 mG	0.99 mG	1.49 mG
Geometric Mean	0.80 mG	0.52 mG	1.09 mG	0.69 mG	0.99 mG	0.90 mG
Geometric Standard Deviation	2.52	3.52	2.49	2.06	1.96	2.17

The following conclusions could be drawn from the 1000-person sample.

1. The distribution of the average fields during a 24-hour period for the population of the U.S. is estimated to be log-normal with a geometric mean of 0.90 mG (95% CI from 0.85 to 0.96 mG) and a geometric standard deviation equal to 2.17 (95% CI from 2.08 to 2.27).
2. It is estimated that 14.7% (95% CI from 12.1% to 17.8%) of the U.S. population is exposed to a 24-hour average field exceeding 2 mG, 5.9% (95% CI from 4.2% to 8.2%) to a field exceeding 3 mG, 2.4% (95% CI from 1.49% to 3.9%) to a field exceeding 5 mG, and 0.41% (95% CI from 0.19% to 0.94%) to a field exceeding 10 mG.
3. About 26% of the people spend more than one hour at fields greater than 4 mG, and about 9% of the people spend more than one hour at fields greater than 8 mG.
4. About 290 of the people experience at least one gauss (1000 mG) during a 24-hour period.
5. The largest average fields (experienced by a few percentage of the people) were recorded during the period “at work.” The lowest average fields were recorded during the period “at home, in bed.” The average field “in school” exceeded 2 mG for about 3% of the students, while the field “at work” exceeded 2 mG for about 22% of the workers, and the field “at home” exceeded 2 mG for about 15.5% of the people.

6. For the periods "at work," the distribution of the average magnetic fields had the largest geometric mean for the service occupations (1.75 mG); followed by the electrical occupations (whose data, however, were few) with 1.17 mG; technical, sale, and administrative support occupations with 1.13 mG; managerial and professional specialty occupations with 1.05 mG; precision production, craft and repair occupation, and operators, fabricators, and laborers with 0.95 mG; and farming, forestry, and fishing occupations with 0.51 mG. The geometric standard deviation of the "at work" distribution of average field is significantly larger than for the distribution of the 24-hour period averages, meaning that some people at work are significantly more exposed than in other situations.
7. Very little difference in 24-hour average magnetic field was found between men and women (geometric mean 0.90 mG versus 0.91 mG). The largest geometric mean among age groups was found for working-age people (geometric mean = 0.97 mG), followed by retirement-age people (0.83 mG), school-age children (0.78 mG), and pre-school children (0.59 mG). Little difference was found among different regions of the U.S.. The largest geometric mean was found for the Northeast (0.96), followed by the West (0.96), the South (0.90), and the Midwest (0.83).
8. The following parameters appear to affect the distribution of exposures at home: residence type, residence size, type of water line, and proximity to an overhead power lines. The lowest exposure at home was measured for people living in mobile homes, followed by single family residences. Duplexes and apartments correspond to the largest exposures. The highest exposures at home are in smaller houses and in houses with metallic rather than plastic pipes. The exposure at home tends to increase as the distance to the nearest overhead line decreases. Proximity to three-phase electric power distribution and transmission lines corresponds to larger exposures than proximity to other types of lines or no line at all.
9. In addition to the statistical accuracy, there are other reasons why the results must be interpreted cautiously. The survey did not cover non-telephone households, military personnel, nursing homes, hospitalized people, people in prison, and any other institutionalized people. The response rate was very low and there is the potential for a significant non-response bias. The strength of the survey is in the random selection of the participants. The response rate, although low, was relative uniform across the age groups, gender, and regions of the participants. The survey is the first significant study that quantifies the exposure of the general population for the entire day, not only for the time spent in one's residence but also for the time a person is outside the home, working, in school, traveling, or performing other activities.
10. Despite its limitation, the survey provides data for an assessment of the number of people at risk, should researchers one day be capable of defining risk in terms of some of the quantities measured during this survey. The survey provided data not only regarding the 24-hour average magnetic field, but also data on the time above defined field values, on the length of time with constant field, on the number of

sudden field changes, and on the magnetic-field values during different types of activities.

SUMMARY

The second and last phase of the project, consisting of measurements of 24-hour personal magnetic-field exposure of 1000 people randomly selected within the U.S., has been completed. Exposure estimates for the general populations were made from the data collected. Detailed results of the survey of 853 people are presented in an Interim Report. The results of the survey of all the 1000 people will be presented in the Final Report. The data were entered in a database, which will be available to researchers to perform any further analysis that may be needed.