SECTION 2

SURVEY PROTOCOL

2.1 Protocol Steps

The survey was conducted jointly by Westat and Enertech. Westat performed the tasks associated with sampling and telephone recruitment. Enertech performed the tasks of sending, receiving, and reading out the exposure meters. The protocol for the personal magnetic field exposure measurements survey with a 1000-person random sample consisted of the following steps:

1. Telephone numbers were randomly selected using list-assisted Random Digit Dialing (RDD) methodology. The sample, which included both listed and unlisted telephone numbers, was released to Westat interviewers, as needed.

2. An introductory letter (see Appendix A, Document #1) was sent by Westat to all persons corresponding to the selected numbers who were listed on telephone directories and for whom a complete name and mailing address were available.

3. The letters were followed up by a telephone screener conducted by Westat's experienced interviewers. Telephone calls were also made to households that were not sent an introductory letter. Repeated telephone calls spaced throughout different hours of the day and days of the week were made to each number until a contact was made or the number of calls reached 10. The respondent was interviewed in order to select and recruit a household member for possible participation in the survey. In some instances, the respondent refused to be interviewed. In several other instances, despite the initial willingness to be interviewed, the respondent refused to participate. In some cases, people who did not receive an introductory letter requested such a letter before agreeing to participate. These respondents were contacted again after the letter had been received. The interview followed a specific protocol, described in detail in Appendix A, Document #2.

4. The list with ID number, name, parent or guardian name (if a minor), address, telephone number, birthdate, sex, and household size of the persons who had agreed to participate in the survey was sent by Westat to Enertech. Enertech sent a Consent Form and a letter that illustrated the reasons and modality of the survey to all the people who had agreed to participate as a result of the telephone interview. Different letters with different illustrations were sent to participating adult males (see Appendix A, Document #3), participating adult females (see Appendix A, Document #4), parents or guardians of participating school-age boys (Appendix A, Document #5), parents or guardians of participating school-age girls (Appendix A, Document #6), parents or guardians of participating toddlers (Appendix A, Document #7), and

parents or guardians of participating infants (Appendix A, Document #8). The Consent Form approved by the ORAU/ORNL Committee on Human Studies was used (see Appendix A, Document #9).

5. The Consent Form was to be signed by the participants (or their parents or guardians) and returned before measurements could be performed. Enertech attempted to contact the participants by phone to explain the study and the measurement protocol, and to encourage the participants to sign and return the Consent Form. However, not all the people who had agreed to participate during the telephone interview returned the signed Consent Form. Failure to return the consent form was regarded as refusal to participate.

6. Upon return of the signed Consent Form, Enertech sent the participants a package containing a personal meter, the instructions for the use of the meter (see Appendix A, Document # 10 for adults and school-age children, Document # 11 for toddlers, and Document # 12 for infants), a small diary (see Appendix A, Document # 13) to be used to write the type of activities performed, a questionnaire (see Appendix A, Document #14) to be filled out by the participants, a UPS envelope with prepaid label to return the meter, and a $ 50 check for compensation for participating in the study. In order to complete the project in six months and accounting for the refusal rate, the meter and the associated material were sent to an average of about 60 people per week. The personal exposure meter was 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, provided by Enertech, to be worn as a backpack or kept near them for the day of the measurements.

7. Enertech contacted the participants to clarify, if needed, the use of the meter, diary, and questionnaire. The participants were encouraged to wear the meter as soon as possible during the week, Monday to Friday.

8. 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 ten 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 in their diary. After 24 hours of measurements, the meter was mailed back to Enertech.

9. Upon return to Enertech, 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 (see Appendix A, Document #15) was sent by Enertech to the participants with the results of their individual measurements.

10. If the participant did not return the meter, after two months Enertech sent a letter (see Appendix A, Document # 16) requesting the meter's return.

11. The data from the meters, diaries, and questionnaire were analyzed as described in Section 3 of this report.

A flow chart of the various phases of the protocol is shown in Figure 2.1

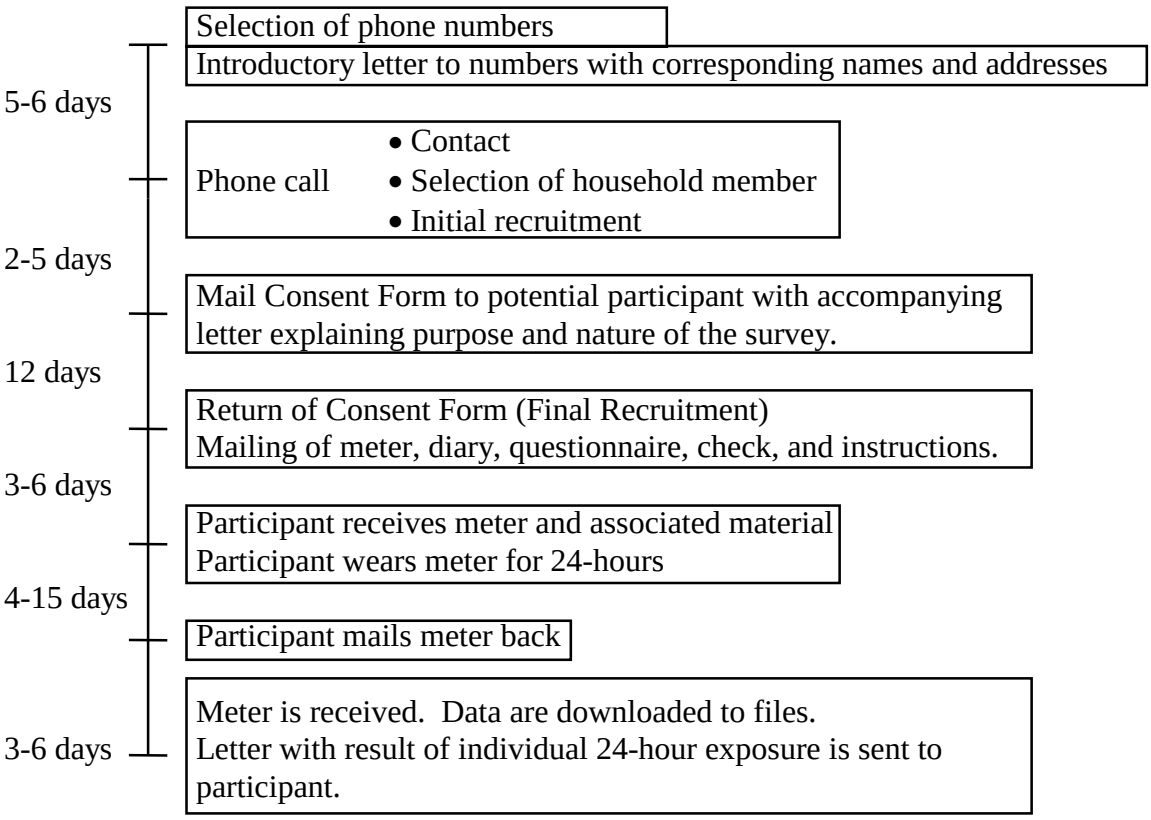

Figure 2.1 Protocol Flow Chart

2.2 Personal Exposure Meter

The meter used for this project was the EMDEX PAL™, the smallest available three-axis personal exposure meter (Figure 2-2). The meter is about the size of a pager (1" x 2.3" x3.7" [2.6 cm x 5.9 cm x 9.5 cm]), and is lightweight (4.5 oz [128 g]) and can be clipped to a belt if so desired. The meter came with a cloth pouch which has a pocket for the activity diary and room for a small pen. The meter measures the r.m.s. value of three orthogonal components of the magnetic field every 0.5 seconds.

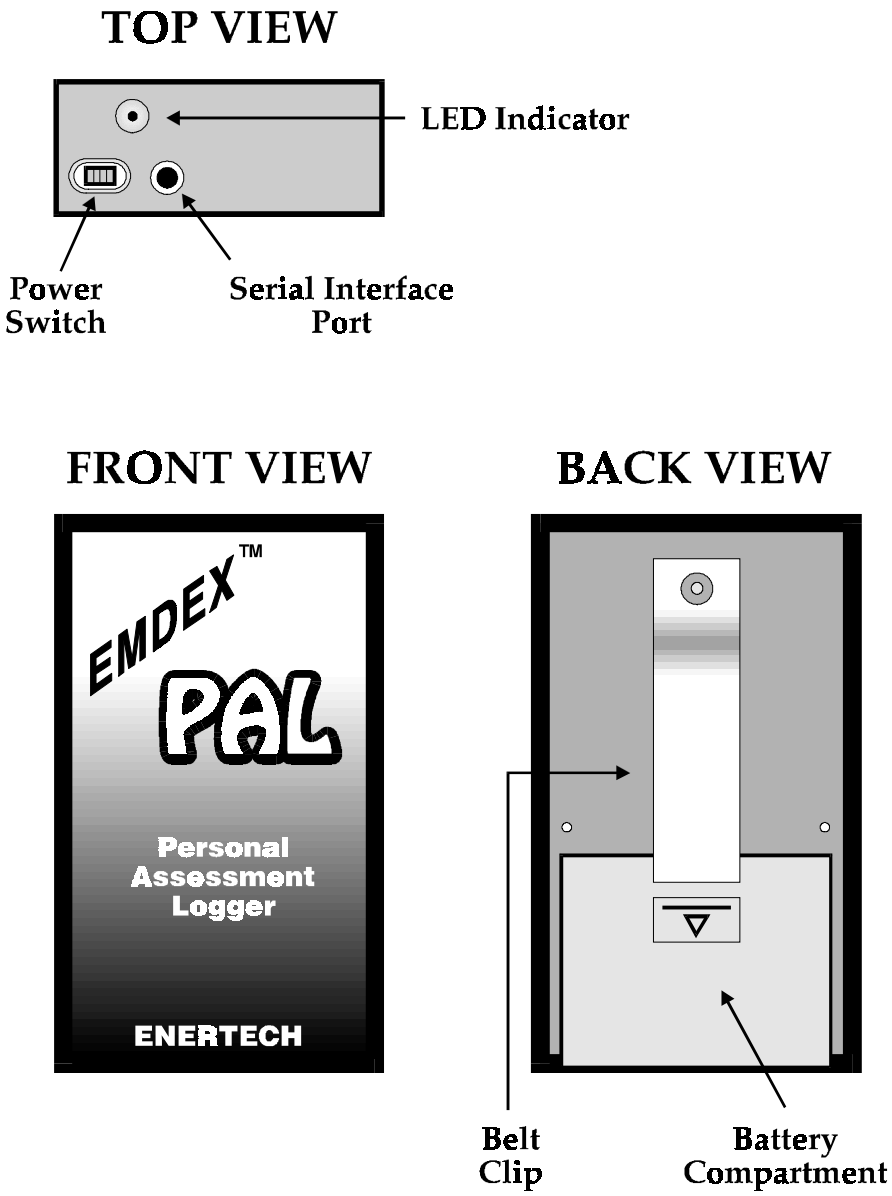

Figure 2-2. EMDEX PAL Meter Diagram - Front Back and Top Views

The meter is battery operated, does not have a display but only a small on-off switch. The meter has permanent memory, so the data are not lost even if the switch is turned off or the battery is discharged. The absence of a display was suggested to avoid any effect on participant behavior due to reading field values.

The magnetic field dynamic range is from 0.1 mG to 1,000 mG [0.01 to 100 μT] for each of three orthogonal axes, with a minimum resolution of 0.1 mG [0.01μT] and an accuracy of ± 0.1 mG [0.01μT] for fields in the range 0.1-10 mG [0.01 to 1 μT] and of ± 1 % for fields in the 10-1000 mG [1 to 100 μT] range. The frequency range is from 40 Hz to 1,000 Hz.

The meter internal software can be set to operate in a variety of modes. The meter used for the 1000-person survey was set to store the variables listed below in a permanent memory every ten minutes for 29 hours before the memory was filled.

- The "minimum magnetic field resultant" (the resultant field, B, is the square root of the sum of the squares of the 3 orthogonal components) value recorded during the ten minute period.
- The "maximum magnetic field resultant" value recorded during the ten minute period.
- The "average magnetic field resultant" during the 10 minute period. This is the average of 1199 records (one record every 0.5 second, except for the last 0.5 second during which the meter is busy placing the summary data in memory).
- The "standard deviation" of the 1199 magnetic field values recorded during the ten minute period.
- The "number of records" that fall in each of the following 9 bins:

  $B \leq 0.5$ mG
  $0.5 < B \leq 1.0$ mG
  $1.0 < B \leq 2.0$ mG
  $2.0 < B \leq 4.0$ mG
  $4.0 < B \leq 8.0$ mG
  $8.0 < B \leq 16.0$ mG
  $16.0 < B \leq 32.0$ mG
  $32.0 < B \leq 64.0$ mG
  $64.0 < B$

  From the number of records in the 9 bins, the minimum and the maximum values, and the average and the standard deviation, it is possible to estimate with relatively good accuracy the median, the different percentile levels, the geometric mean, and the geometric standard deviation of the magnetic field values recorded during the ten minute period.
- The average field change between successive readings, which may be regarded as an index of the intermittence of the field during the ten minute period.
- The length of time during which the field is constant and above a given value ("length of time with constant field"). The length of time with constant field is related to the concept of coherent field, which, according to some researchers [2], is a prerequisite

for biological effects. For this survey, the length of time with constant field was defined as the sum of the lengths of all periods of times (within the ten minute period) during which the magnetic field was greater than 2 mG and remained constant in amplitude and space orientation for at least 10 consecutive seconds. The criterion for constancy is that each orthogonal component of the magnetic field does not vary by more than 10% of the resultant.

- "Number of sudden field changes" in each of the following 3 bins:

  $2.5 < \Delta B \leq 5.0$ mG

  $5.0 < \Delta B \leq 10.0$ mG

  $10.0 < \Delta B$

  A field change is defined as the absolute value of the difference between two consecutive resultant field values. Because of the high sampling rate of the meter (2 readings per second) a sudden field change is more likely to be caused by a sudden insertion or removal of an electrical load than by walking by a source of field. Therefore, the number of sudden field changes is a surrogate for the number of transient magnetic fields which are associated with switching loads on and off. To be counted , a "sudden field change" must also be greater than or equal to the average value of the two consecutive records. For instance, a 10.0 mG resultant field following a 6.0 mG resultant field causes a field change of 4.0 mG, which is equal to 50% of the average of 6.0 and 10.0 mG, and thus qualifies as a "sudden" field change and will be counted in the first bin.

The only action required from people who wear the personal exposure meter is to turn it on at the start of the 24 hours of recording. The user is asked to note on the activity diary the time of the day when the meter is first turned on and then the time of the day at every change of the following types of activity: at home, in bed, traveling, at work, at school, and other activities. Every ten minutes since being turned on, the meter will store in its permanent memory a summary statistic which includes average, standard deviation, minimum, maximum, times in a number of field ranges, number of sudden field changes above selected thresholds, length of time with constant field, and average field change between successive readings.