PRESENTATION

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The material below, prepared from the transcript of the proceedings and from Dr. Bracken's slides, reflects the substance of his presentation. This summary has been reviewed by the presenter for accuracy.

The purposes of Dr. Bracken's talk on Occupational and Non-residential Exposures were:

- to characterize EMF exposures in occupational and other non-residential environments, and
- to identify groups and situations with elevated exposures above residential levels.

In the absence of guidance from biological effects research he chose the following metrics to characterize exposures: TWA magnitude, maximum magnitude, and frequency content. TWA magnitude and frequency content are associated with time frames representative of chronic exposures and maximum magnitude and frequency content are associated with time frames representative of acute exposures. Comparative field levels at the residential level are available from the 1000-person study (RAPID Project #6): for residential TWA, the level is about 1 mG; for maximum field, about 2% of people experience a field greater than 1 G each day; the frequency content of residential exposures is principally 60 Hz.

In order to examine non-residential exposures it is important to recognize where persons spend their time. Based on time/activity data from a California Air Resources Board Study (1991), employed adults and teens, on average, spent about 62% of their time in the residential environment, about 20% in work, 9% in travel, and 9% in other environments. Children and unemployed adults and teens spent about 80% of their time in residential environments, with children, on average, spending 8% of their time in school. These distributions of time point out that, if non-residential exposures are going to affect overall exposure, they will need to exceed residential exposures by considerable amounts. The important non-residential environments with the approximate time spent in them are: work (for employed), 20%; school (for children attending), 20%; travel, 8%; and other, 9%.

Occupational Exposures

Occupational exposures are highly variable within and across job categories. For most occupations the contribution of exposure at work to total exposure is not significant: TWA exposures do not exceed residential levels by more than a factor of two or three, and the maximum levels and frequency content are not unusual.

However, there are certain occupations for which relatively high exposures occur. These jobs are primarily in the electric utility industry and have been studied extensively. Jobs in other industries that have relatively high exposures are welders, electric-train operators, and operators of electric furnaces, demagnetizers, and other high-current equipment. Exposures in these high exposure jobs include elevated TWA and maximum fields. However, fields above 1 G occur infrequently even for these workers; for example, generation-plant workers experience fields above 1 G on approximately 15% of days, while line workers experience such fields on 3.5 % of days. The frequency content of high-exposure jobs depends on the particular source associated with the job: electrical-system sources are primarily 60 Hz, but other sources may have unusual frequency content.

RAPID-sponsored projects that have included occupational-exposure measurements include the following: magnetic field surveys in several industries performed by NIOSH; PE measurements of office workers by the University of Washington; and survey measurements in machine shops, office buildings, grocery stores, hospitals, and schools performed during RAPID Project #3.

School Exposures

Field measurements in schools have indicated that exposures there, both TWA and maximum magnitude, are generally at or below levels found in residential surroundings. Exceptions to this observation can be schools near transmission lines. The frequency content of field in schools is generally 60 Hz; however third-harmonic (180-Hz) fields can also be present due to the presence of fluorescent lights. Sources of elevated field levels in schools are external power lines, internal wiring, and electric appliances/tools.

An extensive survey of fields in schools is underway in California. RAPID Projects that have included measurements in schools are as follows: Project #3, which modeled exposures in four schools based on survey measurements; a pilot study in Project #4 that included PE measurements for students at two high schools; and TWA PE exposures for 106 periods in the school environment collected during Project #6.

Travel Exposures

Exposure during travel can occur over relatively long periods: average times for persons reporting riding in an auto or van are 100 minutes and in a train are 123 minutes. The fields in both modes of transportation can be larger than residential exposures in terms of TWA and maximum, especially in electrified rail systems. The frequency content of exposures in vehicles is much more diverse than that in residences. Exposure characteristics in the case of travel are dependent on the mode of transportation and the specific vehicle.

Other Exposures

Other indoor locations where significant time is spent (by those reporting time in the location) include shopping malls, restaurants, hospitals, and grocery stores. There are no data available for shopping malls or restaurants. However, we can anticipate that such data would be comparable with residential exposures. Similarly, patients and visitors to hospitals have exposures

comparable with residential exposures (RAPID Project #3). TWA exposures for customers in grocery stores are elevated somewhat above residential levels. Thus, exposures in other locations appear to be comparable with residential exposures in terms of TWA, maximum magnitude, and frequency content. However, as with all environments, including residential, specific situations that occur infrequently can result in elevated exposures.

Conclusions

- Residential exposure generally predominates TWA exposure. This is especially true for children and not-employed adults.
- Occupational exposures are generally the only non-residential exposures that can significantly affect total exposure, and this occurs only for certain occupations.
- High-exposure groups have been identified among electric utility employees and a few other occupations. If other groups cannot be identified, exposure assessment may require PE.
- Contributions to exposure from school and other locations are not appreciably different from those in the residential environment.
- Travel introduces exposure to frequencies other than the power frequency.
- Except for infrequent incidental exposures near transmission lines, elevated electric-field exposures are limited to a small group of job categories within the electric-utility industry.

SUMMARY OF DISCUSSION

Several issues came under discussion following the presentation on occupational and non-residential exposures. The summary below was prepared from the symposium transcript.

In response to questions about the source and nature of the time/activity data used in his presentation, Bracken identified the data as coming from a study funded by the California Air Resources Board in 1991 to address indoor and outdoor air pollution exposures. Other large time/activity databases are located at the University of Michigan and the EPA. However, none of these time/activity databases are directly linked to EMF-related activities.

Bracken stated that the time-activity data cited in his presentation are averages over large numbers of people and are designed to give a view of the general population. They represent percent of time during a 24-h day, averaged over a year. Time-in-bedroom was noted by one commenter as being easily identified and a large portion of the day. Bracken agreed and noted that it had been partitioned out in the RAPID Project #6 data.

One discussant confirmed the observation that elevated fields are found in rail cars, and cited AMTRAK sleeping cars as a location where he had observed this. The question was raised whether systematic studies had been done of the exposures of rail commuters, especially in the Northeast Corridor: they would seem to be good candidates to comprise a highly exposed group. Dr. Gyuk of DOE mentioned that NIOSH is currently performing an exposure assessment of train riders for the Department of Transportation, with funding from DOE.

One discussant emphasized the concern for children's exposure and the need to focus on this exposure both in the school and in general exposure areas. He also pointed out the need to deal with exposures to magnetic-field transients. Bracken agreed that exposures to transients was an area that had not been totally characterized.

With respect to schools, Bracken was asked whether he had considered schools near high-voltage installations such as substations, where ambient fields might be high. (In a later comment, it was noted that the elevated fields near substations are due to the transmission lines entering and leaving the substations, not the substations themselves.) Bracken indicated that he had not measured fields in many schools, but had referred to data from three RAPID projects, which included a general population of schools. He did not know the percentage of schools near transmission lines and substations, but noted that an ongoing study in California might provide that information. Dr. Zaffanella, who is conducting the study for the California Department of Health Services, indicated that results from that study will be available soon. The study design purposefully over-sampled schools with transmission lines nearby: 28 to 30 of the 90 measured schools were near such facilities.

A discussant asked whether sufficient exposure data were available to make an estimate of how much magnetic-field exposure contributed to the total number of childhood cancers in the US. The question assumed that an odds ratio associated with exposure as a VHCC house was available. Bracken indicated that he was not familiar with the actual computation, but that, in his opinion, exposure data were now available to look at exposures across the general population, to estimate the prevalence of VHCC houses, and to estimate field distributions in those houses.

A discussant noted that, in a recently published Swedish study, the highest risk for cancer was found for individuals with magnetic-field exposures in the high categories, both at home and at work. In response to Bracken's remark that most occupations do not contribute substantially to overall exposure, the discussant asked whether the high-exposure occupations in the Swedish study overlaid the high-exposure jobs cited in the presentation. Bracken said that he had not made the comparison between the two sets of job titles, but that the JEM cited in the presentation was based in part on the Swedish researcher's data and that one might expect some overlap. The discussant stressed that there are limitations to JEMs for magnetic fields outside the electric-utility industry and to job titles based on death certificate listings of occupations. It was remarked that classifications of occupations on death certificates in Europe seemed to be less secure than those in the U.S. The original commenter expressed skepticism as to the accuracy of U.S. death certificates.