APPENDIXES

APPENDIX A
The Effects of Electromagnetic Fields

Electric and magnetic fields exist in the natural environment and are present wherever there is electric power. At lower frequencies and long wavelengths, the fields can be identified separately as electric and magnetic fields. At higher frequencies, where these fields are usually coupled, the fields are often referred to as electromagnetic radiation or non-ionizing radiation. Electric and magnetic fields are collectively called electromagnetic fields (EMF). EMF can include alternating current (AC), which produces oscillating electric and magnetic fields, and direct current (DC), which produces steady fields.

Because magnetic levitation (maglev) uses electric propulsion and onboard power capabilities, passengers are exposed to EMF. In addition, local residents and others close to the right-of-way are exposed to fields, although the magnitude drops off sharply with distance. These exposures are comparable to those from electric power transmission and distribution lines. Figure A-1 summarizes the field strengths encountered in maglev systems and common appliances. However, precise health risks associated with EMF exposure, if any, are not understood. Researchers are confident that high-intensity DC fields are detrimental to human health, and low intensities are now of concern, but the effects of AC fields and interactions between electric and magnetic fields are not well known. Much more research is required before conclusions can be drawn about the potential dangers to human health associated with frequent exposure to weak EMF, as typically encountered in home, office, and urban environments.

Possible health concerns include cancer, alterations in the central nervous system, and effects on the reproductive system. It has been determined that even low EMF can trigger certain biochemical responses critical to the functioning of cells. Of special concern to the transportation industry are possible EMF effects causing depressed melatonin production and shifts in circadian rhythms. These affect fatigue, alertness, and reaction time, and therefore are especially important for transportation workers. However, the magnitude of these responses, whether they are transient and reversible and their effects on overall human health, are not understood.

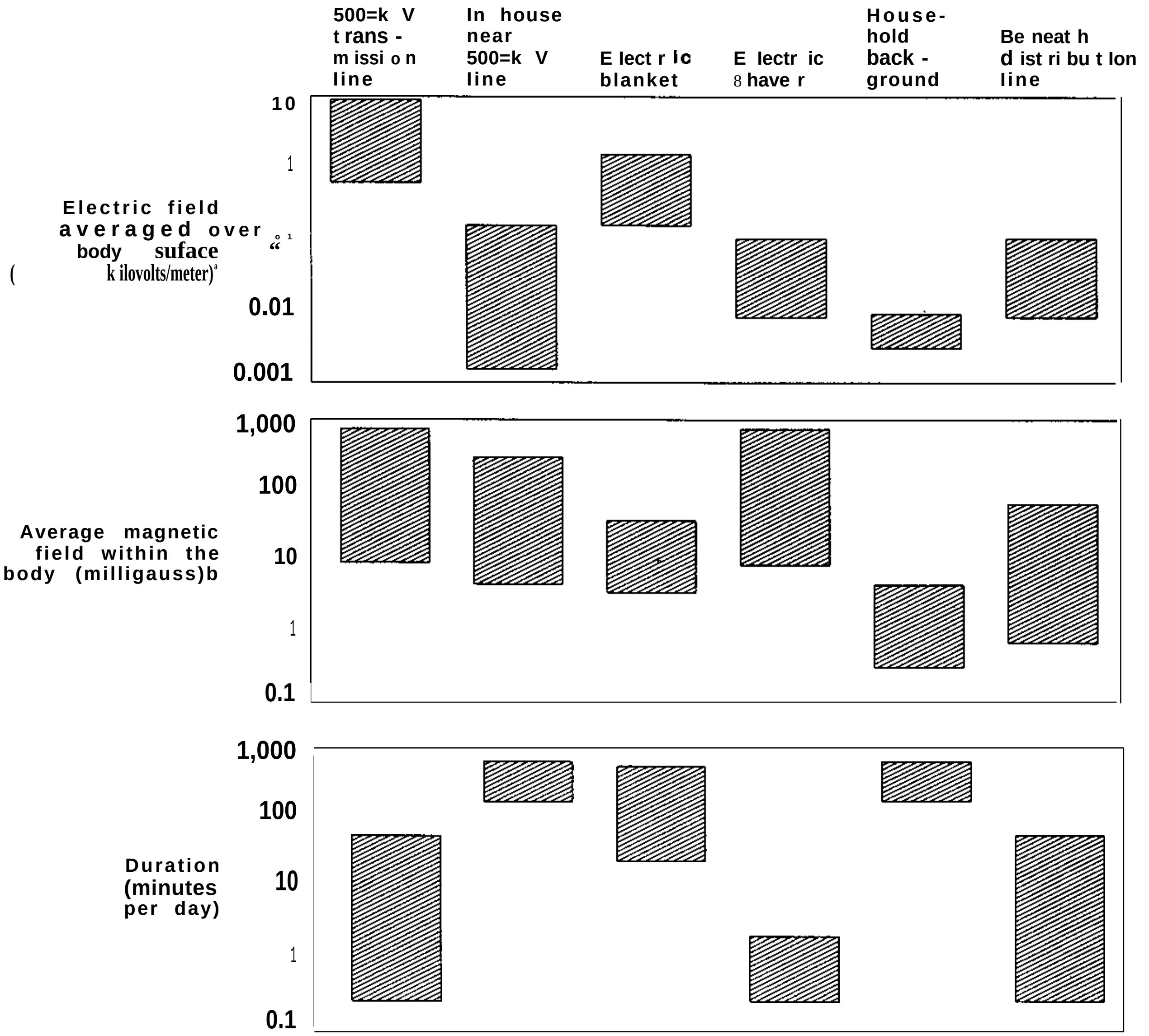
The lack of consistent data on human exposure to EMF pose barriers to any inferences about potentially harmful health effects. To compound the problem, consistent methods of measurement and modeling for EMF strengths, geometry, and frequency have not yet been developed.[1]

While it is clear that a maglev system will produce EMF, it is not known what, if any, health effects these fields would have on the system's passengers. In the early Japanese prototype maglev, superconducting magnets with very high-flux densities were used, resulting in high-strength DC magnetic fields in the cabin area (up to 350 gauss) without appropriate shielding. Passive shielding, incorporating ferrous or other special metals,[2] can combat this potential hazard, although light-weight shield materials are expensive and hard to obtain. The Japanese have recently redesigned the superconducting maglev vehicle to lower cabin exposure levels below a 10-gauss nominal level. Active shielding approaches, in which magnetic fields are purposely generated to cancel other magnetic fields, are another possible control measure.

The intensity of fields found adjacent to the right-of-way varies for different maglev designs, presenting potential new problems, since States have differing restrictions on permissible levels of DC and AC fields. Although the World Health Organization has published interim EMF guidelines for workplace exposure to higher frequencies, as of yet there is no national policy

1 For more information, see U.S. Congress, Office of Technology Assessment, *Biological Effects of Power Frequency Electric and Magnetic Fields*, OTA-BP-E-53 (Washington, DC: U.S. Government Printing Office, May 1989).
2 Ibid., p. 16.

Figure A-l—Typical Electromagnetic Fields Under Everyday Conditions



SOURCE: Office of Technology Assessment, 1991.

on EMF exposure limits, and States are subject to interest group pressure to lower the allowable levels.

maglev is not the only transportation system with potential EMF problems. Although no significant studies have been conducted on the subject, steel-wheel technologies, such as rail transit and intercity rail, which use a significant electrical power source, also create EMF. Because of the unknown health hazards of EMF, more studies and tests must be conducted before these systems are given final approval. Congress directed the Federal Railroad Administration (FRA) in the fiscal year 1991 maglev appropriations bill to adopt a safety research program to study and counter the potential problems associated with EMF in maglev and high-speed rail systems. FRA must develop safety and operating standards for maglev, address basic R&D questions (including superconducting magnets and magnetic shielding), and initiate a comprehensive research program to identify, characterize, and minimize potential health effects associated with magnetic fields generated by maglev systems. FRA assisted by the Volpe National Transportation Systems Center, is undertaking a multiyear research and development program on health effects of magnetic fields associated with maglev and high-speed rail technologies under the 1990 National maglev Initiative. The program will be integrated into a comprehensive system safety study of maglev and advanced rail concepts proposed for U.S. applications.