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Effects of Electric and Magnetic Fields

Since the late 1960s there have been controversy and litigation about health effects of electric and magnetic fields produced by power transmission lines. Recent studies have heightened this concern and have led to a request by a subcommittee of Congress that the Office of Technology Assessment (OTA) review the problem. In turn, OTA contracted for a study by a group at Carnegie-Mellon University. Their recently published report* provides a comprehensive review and analysis of the pertinent literature together with policy recommendations. A key finding is that if there are effects on human health from exposure to fields created by electricity, they arise mainly from use in the home. Household appliances and wiring produce electric and magnetic fields that in magnitude are comparable to those near the right of way of a transmission line.

Until recently, conventional wisdom held that fields associated with power systems posed no threat to human health. There is no substantial transfer of energy from power fields to biological systems. Moreover, naturally occurring fields in vivo are at least 100 times as intense as those induced by 60-hertz power fields. In addition, there has been an absence of any large-scale obvious public health effects associated with electrification.

However, a growing number of positive findings have demonstrated that under special circumstances weak low-frequency electromagnetic fields can produce changes at the cellular level. Among the responses found in laboratory studies of animal cells and tissues are modulation of ion flows, interference with DNA synthesis and RNA transcription, and interaction with the biomedical kinetics of cancer cells. In a few instances effects have been demonstrated at the level of the whole animal. Experiments involving calcium-ion efflux from chick brain tissue in vitro produced interesting but puzzling effects. At 60 hertz, enhanced efflux occurred at three intermediate values of field strength, but not at higher or lower values. In addition, when field strength was held constant, enhanced efflux occurred at a series of specific frequencies but not in between them. The values of these frequencies were influenced by the strength and orientation of static magnetic fields.

To evaluate electromagnetic effects on humans, one must rely on epidemiological studies. These are notoriously difficult to conduct with certainty due to confounding factors. For example, in cancer studies one must control for smoking, diet, food preparation, and other variables. Perhaps the two most quoted epidemiological studies were conducted in and around Denver. Both reported a doubling of the frequency of childhood leukemia in homes where fields were higher than average. One of the two studies showed that high appliance use leading to magnetic fields greater than 2.5 milligauss was associated with increased risk in the offspring for all cancers. Also childhood electric blanket and isolette exposures were associated with increased cancer risks.

Studies other than those at mile-high Denver have yielded mixed results regarding the question of association between cancer and low-frequency electromagnetic fields. The OTA report states, "Overall the evidence now available is too weak to allow firm conclusions either way."

If there are human health effects, what are the cogent variables? For example, it is not certain whether the changing electric fields or magnetic fields are the causative agents. Are effects related to the integral of field strength over time, or are infrequent exposures to very high fields crucial? If regulators wished to set standards now, they would not have a solid knowledge base to guide them. They could mandate the expenditure of tens of billions of dollars to little effect.

The situation calls for much more effort in research than has hitherto taken place. The previous level of support in the United States has been of the order of a few million dollars a year. The new work should include more animal studies and substantial epidemiological studies, coupled with accurate measures of fields. In the meantime, one option suggested by the OTA study is to "adopt a 'prudent avoidance' strategy. That is, systematically look for strategies which can keep people out of 60 Hz fields . . . but only adopt those which look to be 'prudent' investments given their cost and our current level of scientific understanding about possible risks."—PHILIP H. ABELSON

*I. Nair, M. G. Morgan, H. K. Florig, "Biological effects of power frequency electric and magnetic fields" (Office of Technology Assessment, Washington, DC, May 1989).