BOOK REVIEWS

BIOLOGICAL EFFECTS OF MICROWAVES

Gordon, Z. V. Voprosy gigiyeny truda i biologicheskogo deystviya elektromagnitnykh poley sverkhvysokikh chastot (Problems of industrial hygiene and the biological effect of ultrahigh-frequency electromagnetic waves). Leningrad, Izd-vo "Meditsina," 1966. 164 p.

One of the most serious problems in radio engineering today is the danger of microwaves to the human body. Individuals engaged in the production of UHF generators and in the testing and operation of various microwave radiation instruments are said to be the prime targets of such radiation. The author has summarized the results of 10 years of research in the field of industrial hygiene and the biological effects of radiofrequency electromagnetic waves. The emphasis of the book is on hazards to personnel and measures to provide adequate protection to workers exposed to UHF radiation.

The book consists of an introduction and five chapters. A bibliography of 378 references is included. Of these references, 238 are Soviet. Chapter 1 deals with recent trends in the investigation of the biological effects of UHF. The basic approach to this problem, taken by the Laboratory of Radio-Frequency Electromagnetic Waves of the Institute of Industrial Hygiene and Occupational Diseases, Academy of Sciences, USSR, in 1953, was to study low-intensity UHF electromagnetic waves, which do not cause an increase in body temperature. The use of microwave effects for therapeutic purposes was

first investigated by F. M. Suponitskaya in 1938. Such work is now being conducted by the Central Institute of Health Resort Treatment and Physiotherapy under the supervision of Professor A. N. Obrosov, Corresponding Member of the Academy of Medical Sciences, USSR.

The use of pulsed microwaves has, so far, been limited. Another approach is to determine the extent of damage sustained by the human organism from exposure to microwaves. This trend is being pursued by hygienists, occupation pathologists, engineers, biologists, and radio physicists. Some 300 Soviet papers have been written on the subject, including the comprehensive review articles by A. S. Presman (1961, 1963, and 1964). The number of experimental efforts on low-intensity microwave effects has been large, particularly in recent years. The reaction of the organism, especially in the case of chronic exposure, was found to be well defined and mainly located in all branches of the nervous system. These changes are predominantly of a vagotonic nature, exhibiting either a reflex or a direct reaction of the central nervous system.

Chapter 1 also presents a retrospective view of research into the biological effects of microwaves conducted outside the USSR. Unlike comprehensive Soviet research, both clinical-hygienic and experimental, investigations in the USA are said to be carried out along specific lines by various scientific-research institutes. It is implied that American scientists are primarily interested in determining the effect of strong UHF radiation on radar operators and are less concerned with the health and safety hazards of the worker involved in the production of high-powered radars. In order to forestall the possibility of casualties in the future, the Soviets are establishing exposure limits and improving the protection of personnel working in high-power radio-frequency environment.

Chapter 2 deals with the physical characteristics of radiofrequency electromagnetic waves and with the methods used for measuring them. The first field strength measuring instrument, the IPP-10, was designed by the Institute of Industrial Hygiene and Occupational Diseases in 1952-1953; it was based on the principle of the absorption of total field strength acting upon the effective area of a horn antenna. In 1956-1957, 31Im and IMM-6 radar testers were widely used, the former in the 3.1—3.45 cm range, the latter in the 10—100 cm range. The third and final stage in the development of measurement technique was indicated by the construction of a new instrument which fully met

the requirements regarding the measurement of the exposure level within the UHF range (decimeter and millimeter waves). It is the PO-1 ("Medik-1") measuring device, which was built in 1960.

Chapter 3 discusses the safety and health of personnel working near UHF radiation sources. Industrial hygiene problems were studied by N. F. Galanin (1956), V. A. Senkevich (1959), T. V. Kalyada (1959), and Ye. L. Kulikovskaya (1963). A. Ya. Loshak (1963) investigated sanitary conditions at the airports of the civil aviation fleet. Only two papers, by Yu. A. Osipov (1962) and L. T. Frolova (1963), dealt with problems arising directly in the manufacture of microwave equipment. These authors showed that workers engaged in the tuning and testing of radio equipment using low-power oscillators (30 to 100 mw) may be exposed to local irradiation of an intensity up to 20—30 μ w/cm^2. Neural and general physiological effects of microwave radiation were studied by a group of Soviet specialists at the Institute of Industrial Hygiene and Occupational Diseases, which included A. A. Kevork'yan, Prof. E. A. Drogichina, M. N. Sadchikova, A. A. Orlova, S. F. Belova, V. V. Sokolov, N. A. Chulina, I. A. Gel'fon, S. N. Khmara, K. V. Glotova, and M. N. Smirnova. The investigative program was centered about clinical observations at microwave power absorption levels below those resulting in evident pathology. It extended over a period of 10 years and involved more than 1000 individuals. The findings of this group were characterized by functional disorders of the nervous and cardiovascular systems, certain shifts within the peripheral blood and endocrine glands, and by turbidity of the crystalline lens.

Chapter 4 discusses the experimental investigation of the biological effects of a UHF field. The following points are considered: methods of experimental irradiation and fixation of animals, animal survival rate in microwave fields, dynamics of the weight of animals subjected to chronic microwave irradiation, temperature reaction of animals to microwaves, the effect of microwaves on the blood pressure level of rats and certain functions of the nervous system of animals, and the morphological shifts in animals exposed to microwave irradiation. The role of the central nervous system in the causation of microwave radiation damage has been the source of much controversy. While some researchers point to the central nervous system as being among the most UHF-resistant portions of the body, most Soviet workers contend that it is the most sensitive to such radiation. The response to locally applied microwave radiation in the centimeter range was found to be nociceptive in nature and to in-

clude reflex withdrawal movements, elevation of blood pressure, and alterations in rate and depth of respiration. Reaction of the nervous system to microwave radiation is a function of radiation intensity, the range of microwaves, the functional condition of the nervous system, and the typological features of the animal. Intermittent exposure to low-intensity microwaves produced persistent functional shifts within the central nervous system which suggested the possibility of a cumulative biological effect of microwaves. Normalization of functional and morphological changes 30 to 60 days following irradiation points to the reversibility of the process. Studies of central nervous system involvement in microwave radiation effects were conducted by N. N. Livshits (1954, 1957), I. S. Tolgskaya (1960), Yu. A. Kholodov and Z. A. Yanson (1962), A. G. Subbota (1957, 1962), Ye. A. Lobanova (1959, 1964), K. V. Nikonova (1963), Z. P. Svetlova (1962), I. A. Kitsovskaya (1960, 1964), E. A. Drogichina (1962), E. A. Ginzburg (1964), M. N. Sadchikova (1964), and M. S. Bychkova and V. A. Syngayevskaya (1962).

Chapter 5 treats problems related to the improvement of labor conditions of workers exposed to UHF sources. The author challenges the validity of the 0.01 w/cm^2 maximum safety exposure level accepted in the United States and suggests that this level was selected because it was an operationally feasible level and not because it offered the promise of a safe environment for the worker. In the USSR, maximum safety exposure values for centimeter waves were established as follows: a) up to 10 $\mu w/cm^2$ in the case of irradiation throughout the working day; b) no more than 2 working hours per day allowed for radiation intensities between 10 and 100 $\mu w/cm^2$; 15—20 min per day allowed for radiation intensities ranging between 100 and 1000 $\mu w/cm^2$. Only a few papers exist which deal with measures for protecting individuals exposed to microwave radiation. Here again, the western literature is said to be concerned mainly with the protection of military personnel attending radar installations.

According to Z. V. Gordon and A. S. Presman (1956), the following criteria can be used for developing means for protecting personnel working in high-power radiofrequency environments: 1) decreasing the radiation at the source (antenna, waveguide, etc.); 2) partially (block by block) or completely shielding the high-frequency installation; 3) shielding the working place or removing it from the radiation source; and 4) providing individual measures for protection. Personal protective equipment includes curtains, shields, mesh,

metal screens, and suits and booths made of cotton impregnated with thin wire. To prevent occupational diseases, Soviet law provides for preliminary and periodic medical checkups to be performed by a neuropathologist, a therapeutist, and an oculist. [VM]