period. This was possibly due to the greater intensity of the vertical field. In addition, in the vertical field experiments, a relatively constant dorsi-ventral exposure vector existed, particularly for the central nervous system, regardless of the movement of the mice. The increased mortality of the vertical field exposed mice may indicate the existence of a directionally sensitive sensing mechanism within the mouse which initiated a response proportional to the time the electric field existed along the dorsi-ventral axis. The authors recommend further studies to explore the basic causative factors for the observed effects. (8 refs.)

0000 PROCEDURES FOR STUDYING THE ACTION OF ELECTROMAGNETIC WAVES OF RADIO-BAND FREQUENCY IN OCCUPATIONALLY EXPOSED INDIVIDUALS. (Rus.) Gabovich, R. D. (A. A. Bogomolets Medical Inst., Kiev, USSR); Zhukovskii, O. M. *Gig. Tr. Prof. Zabol.* (10): 26-29; 1976.

The light and color sensitiveness of the eye was examined in 25 workers occupationally exposed to centimeter waves with intensities of 235-370 mW/cm^2, in 22 workers exposed to electromagnetic fields with intensities of 10-50 mW/cm^2, in 19 workers exposed to reflected electromagnetic waves with intensities of up to 10 mW/cm^2, and in 25 control subjects. The daily exposure time was 60-90 min. A highly significant increase was observed in the color discrimination thresholds for blue, green, and especially for red, and in the temporary light sensitivity threshold in the first group compared with the control. The second group showed a significant increase in the color discrimination thresholds but not in the light sensitivity. No significant difference was found between the third group and the control. However, the incidence of increased red discrimination threshold was 15.8% versus 9.1% in the control. The changes observed intensified with increasing period of employment in all groups. (4 refs.)

4861 BIBLIOGRAPHY OF REPORTED BIOLOGICAL PHENOMENA ('EFFECTS') AND CLINICAL MANIFESTATIONS ATTRIBUTED TO MICROWAVE AND RADIO-FREQUENCY RADIATION: COMPILATION AND INTEGRATION OF REPORT AND SEVEN SUPPLEMENTS. (Eng.) Glaser, Z. R.; Brown, P. F.; Brown, M. S. (Naval Medical Research Inst. Detachment, Naval Surface Weapons Center, Dahlgren Lab., Dahlgren, VA 22448). 185 pp; 1976. [available through the Naval Medical Research & Development Command, Bethesda, MD 20014].

More than 3,700 references on the biologic responses to radiofrequency and microwave radiation, published up to May 1976, are included in this bibliography of the world literature. Particular attention has been paid to the effects of nonionizing radiation on man at these frequencies. Soviet and East European literature is included in detail. This report is a compilation and integration of seven bibliographies prepared previously by the Naval Medical Research Institute, Dahlgren Laboratory, Dahlgren, Virginia. (3,700 refs.)

4862 SUPERCONDUCTIVITY--A POSSIBLE MECHANISM FOR NON-THERMAL BIOLOGICAL EFFECTS OF MICROWAVES. (Eng.) Cope, F. W. (Biochemistry Lab., Naval Air Development Center, Warminster, PA 18974). *J. Microwave Power* 11(3): 267-270; 1976.

The evidence pointing to superconductivity as a possible mechanism for nonthermal biologic effects of microwave radiation is reviewed. Superconduction is the passage of electron current without generation of heat and therefore with zero electrical resistance. Although it has not been demonstrated experimentally, it has been predicted that superconduction should occur in organic materials at room temperature and above, as it occurs in certain metals. Biologic phenomena, difficult to understand in terms of classical physical-chemical mechanisms, can be explained by superconductive mechanisms. These include the abrupt changes observed in rates of metabolism of growing tissues caused by magnetic fields of 50-150 G; the ability of birds, insects, snails and possibly man to detect very low magnetic fields (0.5-0.1 G), and the observed nonlinear Arrhenius plots of these processes. The hypothesis of biologic conductivity has been strengthened by experimental evidence for superconductivity in bile acids at temperatures as high as 277°K. It was found that abrupt changes in magnetic susceptibility occurred as a function of temperature and magnetic field. Other studies showed that current through thin pyrolyzed carbon films was a periodic function of magnetic field for fields of 0.1 G and below. Only superconductive tunneling can explain this phenomenon. Subsequent studies showed that microwave irradiation of these carbon films at room temperature caused steps in the voltage-current curves, as experimentally observed in metallic junctions with two-electron superconductive tunneling. It is concluded that since the microwave effect on two-electron superconductive tunneling in metals has been used as a sensitive detector for microwaves, the same might serve as a sensitive nonthermal mechanism for the biologic actions of microwaves. (29 refs.)

4863 MICROWAVE OVENS. (Ger.) Roehl, D. (Kreiskrankenhaus Main-Taunus, 6232 Bad Soden, Kronbergerstr. 36, W. Germany). *Dtsch. Med. Wochenschr.* 101(18): 721; 1976.

The possible health hazards of microwave ovens and the possible contamination of food prepared in such ovens are discussed. There are presently no data on any harmful effect of foods prepared in microwave ovens. The mean radiation density at 5 cm distance from the microwave oven is limited to 5 mW/cm^2, versus a tolerance of 10 mW/cm^2 for whole-body irradiation. Microwave ovens satisfying the safety standards do not represent a biologic hazard for their operators. Since pacemakers, not encapsulated in a metal casing, may be disturbed even by a radiation density as low as 10 mW/cm^2, patients with pacemakers should avoid microwave ovens. (3 refs.)

4864 EVALUATING OPHTHALMOLOGIC CHANGES IN PERSONS EXPOSED TO MICROWAVES. (Rus.) Artamonova, V. G. (Inst. of Hygiene and Medicine, Leningrad, USSR); Samorodova, L. M.; Saikina, A. S. *Gig. Tr. Prof. Zabol.* (10): 24-26; 1976.

Ophthalmologic changes were studied in 269 persons occupationally exposed to radiofrequency microwaves with intensities not exceeding 10 mW/cm^2, and in 245 non-exposed control subjects aged 22-40 yr. The exposed persons were under 40 yr old, and the period of employment was 5-23 yr in 78.4%. Pruritus of the eyelids, lachrymation, and blepharitis were diagnosed in four exposed persons. Reduced visual acuity due to anomalous refraction was diagnosed in 17.8% of the test group, and in 21.6% of the control. Changes in the fundus of the eye were found in 6 exposed persons, and in 10 control subjects. Biomicroscopic examinations revealed turbidity of the crystalline lens in 70.2% of the exposed persons, and in 82.4% of the control. The changes were bilateral in most cases in both groups. There was no relationship between the incidence of turbidity and the period of employment. The findings indicate no significant differences between the exposed group and the control. (11 refs.)

4865 POSSIBLE INFLUENCE OF ATMOSPHERIC ELECTRICITY ON WELL-BEING. (Ger.) Reitner, R. (Institut fuer Atmosphaerische Umweltforschung, Garmisch-Partenkirchen, W. Germany); Scheld, K.; Zoebisch, E.; Wanner, H. U.; Fischer, G.; Land, S. *Klima Kaelte Ing.* 4(11): 65-68; 1976.

An interview with investigators concerned with the possible effects of atmospheric electricity on human health is presented. Certain investigators doubt that atmospheric electricity has any effect, either beneficial or hazardous, on humans. However, others recommend that electric field generators be installed in large office rooms to generate a constant field with superimposed square-wave impulses of 10 Hz at stochastic intervals. They claim that such a field would have a positive effect on the well-being, performance, and mental processes of workers. The effect, however, varies among individuals. Screening humans from atmospheric electricity has been shown to cause a reduction of fat deposits and an increase in the water content of tissues. (No refs.)

4866 DETERMINATION OF EXPOSURE TO ELECTRIC FIELDS IN EXTRA HIGH VOLTAGE SUBSTATIONS. (Eng.) Loevstrand, K. G. (The Research Inst. of Electricity, Husbyborg, S-755 90 Uppsala, Sweden). *Scand. J. Work Environ. Health* 2(3): 190-198; 1976.

The physical parameters of electric field strength, capacitive current, and electrical discharge related to extra high voltage were studied to determine the occupational exposure of personnel to electric fields in substations and to relate the results to health effects. A capacitive probe was constructed to measure the electric field strengths at the ground and on top of the head of a man (1.8 m in height) in a 400-kV substation. The symmetric dipole probe was constructed with flat rectangular electrodes placed at opposite sides of a shielding metal case, which contained the electronic components. The circuit consisted of a transient protection device, current shunt resistance, a two-stage voltage amplifier, and a rectifier. Electric field strengths were measured with the dipole at 1.8 m height in a 400 kV-substation. The values agreed, within 30%, with the values reported in similar Soviet studies. To measure the internal distribution of the capacitive current to man, a dummy was built and painted with a semi-conducting paint with a surface resistivity of about 1,000 ohms/square. The capacitive current distribution to a person in an electric field was measured with the dummy at two different places in the substation with different field strengths at the ground, 8.6 kV/m and 18 kV/m, respectively. The capacitive current in the dummy in various positions (arms up, arms down, etc.) ranged from 11 μA to 89 μA at the 8.6 kV/m field strength. The exposure to electric field strength is recommended for use as the single parameter of stress related to extra high voltage. The constructed instruments can measure exposure, and correlate analysis made by medical investigators with any observed health deviations. (17 refs.)

4867 *ELECTROMAGNETIC FIELDS* BY HENRYK MIKOLAJCZUK (BOOK REVIEW). (Pol.) Mika, T. (No affiliation given). *Wiad. Lek.* 29(1): 71-72; 1976.

In a generally descriptive manner without supplying data, a book dealing with the effects of electromagnetic radiation on the physical properties and biophysical aspects of the human and animal organism is reviewed. The review contains information about natural and artificial sources of electromagnetic radiation, dosimetry methods, pertinent equipment, and the effect of force fields on matter. It also touches on dispersal of electromagnetic energy, protective measures, exposure, control, domestic and foreign legally permissible intensities, and the presence of electromagnetic radiation in occupational environments. Penetration and absorption of radiation energy as well as electric conductivity of biologic materials are mentioned. The demodulation of electric processes in the cell membranes as the result of electromagnetic radiation is also discussed. Regulatory systems of live organisms, their positive or negative reaction, and their organ sensitivity to the radiation are pointed out. Pathologic changes due to radiation, based on experimental data, and disease syndromes in exposed individuals are indicated. A discussion of the biologic hazards in man exposed to electromagnetic radiation concludes the book review. The publication is considered to be valuable from the standpoint of popularizing knowledge of electromagnetic radiation risks in contemporary life and in the occupational environment. (No refs.)

4868 MICROWAVE RADIATION. (Pol.) Bogucka, A. (No affiliation given); Bogucki, J. *Ochr. Pr.* (10): 7-8; 1976.

The harmful effects of human exposure to an electromagnetic high frequency field (microwave radiation) are discussed. Pathophysiologic changes occur only after an appropriately long exposure time. The main effect is a thermal one, which causes the temperature to rise in the affected tissues. Depth of penetration depends on the radiation wave length. Although 100 mW/cm^2 attain permissible human temperature of 39°C, lower levels can affect the central nervous system over longer exposure times. The effiency of wire mesh screens, used to prevent the effect of microwave radiation, can be determined by means of a nomogram. The suppression of electromagnetic waves is calculated upon passage through the wire mesh for variable mesh and wave length parameters. For higher frequencies, sheet metal screens are frequently employed. Individuals most susceptible to microwave radiation suffer phychologic and physical traumata or severe infections. Polish labor legislation differentiates four areas with varying field intensity levels: (1) safe area—field intensity less than 0.1 $watt/m^2$, (2) intermediate—0.1-0.2 $watt/m^2$, (3) hazardous—2-100 $watt/m^2$, and (4) dangerous area—field intensity above 100 $watt/m^2$. The length of stay/per day in each zone is legally determined for medically qualified workers. (No refs.)

4869 INVISIBLE ENVIRONMENT. (Ger.) Koenig, H. L. (Lehrstuhl fuer technische Elektrophysik, Technische Universitaet Muenchen, Munich, West Germany). *Umsch. Wiss. Tech.* 76(20): 636; 1976.

Highlights of a colloquium on "Bioclimatic Effects of Electrical and Electromagnetic Fields" are presented. Electrical and magnetic fields have biologic effects on humans. Depending on the type of field, its frequency, and on the circumstances of the exposure, such fields may have beneficial or hazardous effects. The effects of electrical and magnetic fields are especially hazardous on fatigued individuals. There is no strict dose-effect relationship. Man-made electrical fields above a certain intensity level cause stress due to the inability of man to have adapted himself to such fields during the past 50-100 yr. Driving simulator tests showed that electrical fields have no effect on the reaction time of the driver, but they reduce the incidence of errors while driving. Even alternating magnetic fields, whose intensity accounts for only 0.1% of that of the magnetic field of the Earth, were demonstrated to influence electrocardiograms. (No refs.)

4870 SAFETY FROM MICROWAVE HAZARDS IN USING MICROWAVE POWER EQUIPMENT-AN IMPI POLICY STATEMENT. (Eng.) Anonymous. (International Microwave Power Inst.). *J. Microwave Power* 10(4): 333-341; 1975.

Hazards of microwave radiation are reviewed in relation to exposure standards. Since microwave radiation has a frequency lower than that of light, it is non-ionizing in nature, and damage of molecules or biologic tissue cannot result from a single absorbed quantum of microwave energy. The basic biologic effects of microwaves underlying exposure safety standards are associated with significant tissue temperature rise, which requires exposure to at least moderate levels of radiation intensity for a substantial exposure duration. Damage from such heat-producing radiation can be in the form of burns, which may be repairable or unrepairable. Exposure to at least 100 mW/cm^2 for extended durations (many min) appears to be required to produce thermal damage. The exposure standard developed by the American National Standards Institute, known as ANSI C95.1, specifies safe unlimited duration whole-body exposure up to 10 mW/cm^2 or a maximum energy density exposure of 1 $mW\text{-}hr/cm^2$ in any 1-hr period. Contrasted with exposure standards are conservative federally regulated emission standards, which specify maximum leakage level at external surface of equipment, such as, microwave ovens. United States standard defines the maximum emission level as 1 mW/cm^2 at 5 cm before purchase and 5 mW/cm^2 at 5 cm when the equipment is operated. The International Microwave Power Institute's voluntary standard on industrial equipment specifies that a maximum emission level should be 10 mW/cm^2 at 5 cm when operated with the minimum load specified by the manufacturer. (11 refs.)

4871 ELECTRONIC SMOG AS A POTENTIATING FACTOR IN CARDIOVASCULAR DISEASE: A HYPOTHESIS OF MICROWAVES AS AN ETIOLOGY FOR SUDDEN DEATH FROM HEART ATTACK IN NORTH KARELIA. (Eng.) Zaret, M. M. (No affiliation given). *Med. Res. Eng.* 12(3): 13-16; 1976.

The possibility that nonionizing electromagnetic radiation is a factor in the development of cardiovascular disease is discussed. A Soviet study is cited that analyzed 100 cases of microwave sickness in which clinical follow-up was obtained over a period of 1-10 yr. Of 71 patients with cardiovascular findings, 49 had continuing occupational exposure and 22 did not. Of the 49 patients with continuing exposure, all exhibited progression of the disease. Of the 22 patients whose occupational exposure to microwaves terminated, none recovered, 20 stabilized, and 2 exhibited progression. It was concluded from this study that microwave exposure was a potential contributing factor in the genesis of cardiovascular disease and that in some cases microwave exposure was the precipitating or potentiating factor. To test the Soviet hypothesis that microwave exposure is a contributing factor in the development of heart attack, the World Health Organization has sponsored an epidemiologic study--the North Karelia Project. North Karelia, a region of Finland bordering the Soviet Union, has experienced an unusual increased incidence of heart attack involving a shift toward younger age of onset. In addition, an unexplained increased incidence of cancer has occurred. Microwave irradiation has been implicated in the high incidence of

heart attack in this region, since North Karelia lies directly in the path of a Soviet defense communications system, which includes troposcopic scatter units. The inhabitants are exposed continuously to ground waves and scatter radiation every day of the year. An additional observation, which incriminates microwaves as a major factor in the North Karelia health problem is the increased incidence of sudden death from heart attack that appeared after World War II. As with other delayed radiant energy effects on man, the North Karelia Health problem also exhibited latency, as it did not manifest until after the Soviet radar networks became operational. It is concluded that the North Karelia Project represents a unique opportunity to investigate the potentiating role of microwaves in the evolution of cardiovascular disease. (17 refs.)

4872 EFFECTS OF ELECTRICAL STIMULATION ON BONE GROWTH IN VITRO AND ON FRACTURE HEALING (ABSTRACT). (Eng.) de Haas, W. G. (Dept. Surgery, Univ. Calgary, Calgary, Alberta, Canada); Watson, J. *Can. J. Surg.* 19(4): 333; 1976.

The effect of electrical stimulation on bone growth and fracture healing was studied *in vitro* and in a patient with a fracture. The growth of embryo chick tibias was found to accelerate in pulsed magnetic and pulsed electric fields. In osteotomized radii of rabbits subjected to a pulsed magnetic field, an inconsistent acceleration of bone healing was also observed. In a 50-yr-old man with post-traumatic pseudarthrosis of the tibia, treatment in a pulsed magnetic field for 6 wk resulted in bone union 6 mo later. The authors suggest that the use of a pulsating magnetic field to induce an electric field at fracture sites to effect bone healing should have clinical applications. (No refs.)

4873 THE EFFECT OF CHOLINERGIC AGENTS ON THE OUTCOME OF ACUTE AFFECTION OF MICE IN IRRADIATION WITH MICROWAVES. (Rus.) Koldaev, V. M. (Vladivostok Medical Inst., Vladivostok, USSR). *Biull. Eksp. Biol. Med.* 81(3): 285-286; 1976.

The effect of cholinolytic and cholinomimetic drugs on the survival of male albino mice irradiated with microwaves (wavelength 12.5 cm, intensity 62±5 mW/cm^2) over 15-16 min by contact method was studied. The drugs were administered intraperitoneally or subcutaneously immediately after irradiation. The survival in the control amounted to 47-52%. Treatment with pilocarpine (10 mg/kg), proserine (0.05 mg/kg), and cytisine (1-5 mg/kg) resulted in a 1.2-1.3 increase in the survival rate; whereas, other cholinomimetics did not increase the survival rate. Cholinolytics (atropine sulfate, scopolamine hydrobromide, aprophen, tetamone, benzohexonium, pachycarpine hydroiodide, azamethonium bromide, and pyrilene) decreased the survival of irradiated mice. The findings indicate the lesion of the parasympathetic region of the nervous system under the influence of high-intensity microwaves. (3 refs.)

4874 EFFECT OF ADENOSINE MONOPHOSPHORIC ACID ON OXIDATIVE PHOSPHORYLATION IN THE LIVER DURING PROLONGED EXPOSURE TO MICROWAVES. (Rus.) Rudichenko, V. F. (Inst. of General and Communal Hygiene, Kiev, USSR); Dumanskii, Iu. D. *Gig. Tr. Prof. Zabol.* (10): 51-52; 1976.

The influence of exposure to microwaves (wavelength = 12 cm, intensity 100 or 1,000 mW/cm^2, 3x40 min/day, 4 mo) on the effect of adenosine monophosphate and triphosphate on oxidative phosphorylation in liver mitochondria was studied in albino rats. After irradiation, the animals received intraperitoneal injections of adenosine monophosphate and triphosphate before decapitation. In the animals exposed to 100 mW/cm^2, reduction of oxidative phosphorylation, complete regeneration of the activity of the hepatic mitochondria, and increase in the rate of phosphorylation of adenosine diphosphate under the action of adenosine monophosphate were observed. Exposure to 1,000 mW/cm^2 caused more pronounced changes in oxidative phosphorylation. Adenosine monophosphate caused only partial recovery of oxidative phosphorylation in these animals. Adenosine triphosphate, administered to animals exposed to 100 mW/cm^2, caused no recovery of respiration and phosphorylation. (15 refs.)

4875 PRELIMINARY RESULTS USING LOCALIZED CURRENT FIELD HYPERTHERMIA IN ORAL CAVITY CARCINOMAS (MEETING ABSTRACT). (Eng.) Sternhagen, C. J. (Cancer Res. and Treatment Center, Univ. New Mexico, Albuquerque, NM); Doss, J. D.; Day, P. W.; Edwards, W. S.; Doberneck, R. C.; Herzon, F. S.; Powell, T. D.; O'Brien, G. F. *Int. J. Radiat. Oncol. Biol. Phys.* (Suppl. 1): 101; 1976.

A clinical trial was instituted using localized current field (LCF) hyperthermia to treat accessible malignancies uncontrolled by conventional methods. Three previously irradiated patients were treated using both noninvasive and invasive techniques. Radiofrequency current (500 kHz) was used in four treatments. Thermistors, strategically placed within the tumor treatment volumes, controlled and monitored the temperature. Two patients presented with advanced squamous cell carcinoma of the base of the tongue. Each received a single noninvasive LCF treatment with electrode plates. Prior to hyperthermia the first patient had massive obstructing local disease with widespread metastases. The patient became ambulatory with tumor shrinkage; pain was palliated, and there was airway improvement. She expired after a cardiopulmonary arrest on the sixth posthyperthermia day. The second patient, debilitated with advanced local disease prior to LCF, obtained excellent temporary tumor regression and pain palliation. The tumor decreased initially, stabilized for 4 wk, and then increased in size. Methotrexate, 20 mg, intravenously, was given weekly; however, pain, inanition, and tumor growth increased. At 11 wk methotrexate was stopped. The patient expired with progressive disease 15 wk posthyperthermia. The third

patient, a debilitated alcoholic, presented with a rapidly regrowing 3 cm mass in the floor of the mouth, the second local recurrence. Two courses of hyperthermia were given. Tumor regression occurred only after the second course at a higher temperature (44°C). Pain diminished rapidly the first week. The patient gained 19 pounds and was alive and well over 4 mo posthyperthermia. In all cases, the complications, which ranged from mild erythema and mucositis to vesicle formation, chronic mucositis, and ulceration, were related to temperature and duration of treatments. (No refs.)

4876 THE RELATION OF DOSE RATE OF MICROWAVE RADIATION TO THE TIME OF DEATH AND TOTAL ABSORBED DOSE IN THE MOUSE. (Eng.) Rugh, R. (U.S. Dept. Health, Education, Welfare, Public Health Service, Food and Drug Admin., Bureau Radiological Health, 5600 Fishers Lane, HFX-120, Rockville, MD 20852); Ho, H.; McManaway, M. *J. Microwave Power* 11(3): 279-281; 1976.

The effect of graded exposure rates of microwave radiation was studied in relation to both the time of death and the total absorbed dose at death, as altered by the single variable of dose rate. Six groups of male and female CF1 white mice were irradiated in a microwave waveguide with six levels of forward power, from 4.83-8.56 W mean value. For both males and females, as the forward power was increased, the average absorbed dose rate also increased, while the average time to death decreased by approximately 90%. In male mice exposed to 4.82 W forward power, the average absorbed dose rate was 50.47 mW/g, compared with 125.36 mW/g in male mice exposed to 8.56 W forward power; the time to death was ≥ 60 min compared with 7.62 min. Parallel with this was a decrease in the average absorbed dose to death expressed in joules per gram to 31% in the males and 24% in the females between the lowest and the highest exposure rates. For male mice exposed to a forward power of 4.82 W, the average absorbed dose was 181.7 J/g compared with 55.9 J/g in male mice exposed to 8.56 W forward power. The data for both males and females were similar at comparable dose rates. It is concluded that the average absorbed dose cannot be used as the sole criterion of microwave radiation sensitivity, since as the rate of exposure was increased, the absorbed dose in joules per gram and the time to death both decreased. The absorbed dose rate and the duration of exposure must both be determined in any microwave biologic effects experiments. (6 refs.)

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13. ABSTRACT

This digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (microwave and radiofrequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, news items, and a directory of meetings and conferences.

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