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Report to Rep. Elizabeth Holtzman; by Henry Eschwege, Director, Community and Economic Development Div.

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Nonionizing radiation has become a subject of national concern because of the rapid increases in its use and its potential harm to public health. The Environmental Protection Agency (EPA) is responsible for eliminating or reducing unnecessary potentially harmful health effects by limiting exposure from radiation sources. Findings/Conclusions: Currently, there is no official U.S. environmental public health standard for exposure to nonionizing radiation sources because U.S. research programs have not yet developed sufficient data to establish standards for microwave and other nonionizing frequencies. EPA has directed its program study to determine levels and effects of microwave radiation and radiation associated with radio broadcast activities. Most Federal research activities concerned with biological effects of nonionizing radiation are monitored by the Office of Telecommunications Policy (OTP), and there is concern that a proposed reorganization which would abolish OTP could result in reduced emphasis on this function. EPA identified uncertainties which need to be overcome in the areas of existing ambient environmental levels, criteria for acceptable levels, and the existence of nonheating effects. If EPA determines environmental nonionizing radiation exposure control is needed, it may need to seek new legislation to set an enforceable standard. (Author/HTW)

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REPORT BY THE U.S.

General Accounting Office

Efforts By The Environmental Protection Agency To Protect The Public From Environmental Nonionizing Radiation Exposures

The subject of nonionizing radiation has become a national concern because the population is receiving measurable exposures to the radiation. The health effects of such exposures even at low levels are controversial.

Currently, there is no official U.S. environmental public health standard for exposure to nonionizing radiation sources, because U.S. research programs have not yet developed sufficient data to establish standards for microwave and other nonionizing frequencies.

The Environmental Protection Agency is responsible for eliminating or reducing potentially harmful health effects by limiting exposures from radiation sources. This report discusses Agency activities to (1) evaluate the need for protection standards and (2) establish such standards where necessary.

CED-78-79
MARCH 29, 1978

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

COMMUNITY AND ECONOMIC
DEVELOPMENT DIVISION

B-166506

The Honorable Elizabeth Holtzman
House of Representatives

Dear Ms. Holtzman:

In accordance with your August 3, 1977, request and subsequent agreements with your office, we have reviewed Environmental Protection Agency (EPA) efforts to protect the public from environmental nonionizing radiation exposures, including microwave radiation. EPA is responsible for eliminating or reducing unnecessary potentially harmful health effects by limiting exposure from radiation sources.

Nonionizing radiation has become a subject of national concern because of the rapid increases in its use and its potential harm to public health. The population is receiving measurable exposures to nonionizing radiation. The sources are increasing, and the health effects of such exposures at low levels are controversial.

Currently, there is no official U.S. environmental public health standard for exposure to nonionizing radiation sources. According to EPA, research programs to detect and evaluate biological effects of nonionizing radiation have not yet generated a sufficient data base on which quantitative and scientifically sound radiation protection standards can be established for microwave and other nonionizing frequencies. EPA plans to decide on the need for protection standards in March 1978, developing Federal guidance by April 1979, if determined necessary.

The EPA protection activities and existing exposure standards are summarized in the appendixes. We have discussed it with EPA representatives and have considered their comments in this report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 3 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Henry Eschwege

Henry Eschwege
Director

EFFORTS BY THE ENVIRONMENTAL PROTECTION AGENCY TO PROTECT THE PUBLIC FROM ENVIRONMENTAL NONIONIZING RADIATION EXPOSURES

BACKGROUND

Everyone is exposed continuously to nonionizing radiation. Nonionizing radiation is radiation occurring in the electromagnetic wave spectrum used primarily by sources operating at radio (10 MHz to 300 MHz) and microwave frequencies (300 MHz to 300 GHz). 1/ This form of radiation, contrasted to the familiar ionizing radiation sources, such as X-rays and nuclear radiation, differs on (1) how it affects the human body and (2) its potential for causing harm. A quantity of nonionizing radiation energy, for example, contains far less energy, approximately one million times less, than amounts of ionizing radiation which can do significant biological damage. Significant sources producing nonionizing radiation include

--radio and television broadcast antennas,

--radars,

--industrial heating equipment,

--mobile communcations systems,

--satellite communications system earth terminals,

--microwave ovens, and

--point to point microwave communication systems.

Other nonionizing radiation sources include lasers, ultraviolet lamps, and overhead extra-high voltage power lines. A simplified electromagnetic energy spectrum is shown in appendix II.

Health effects

Nonionizing radiation energy gets absorbed by human tissue and does interact with biological systems.

1/ Megahertz and Gigahertz are units of freqency equal to one million to one billion cycles per second.

Human exposure at high levels--above 10,000 microwatts/square centimeter ($\mu W/cm^2$)--increases body temperature and results in such problems as heat stress, cataract formation, cardiovascular effects, testicular effects, and brainwave pattern changes.

The effects of exposure at low levels is a subject of controversy. Effects of exposure to 1,000$\mu W/cm^2$ or less have not been well documented, and U.S. scientists do not all agree that such effects exist. On the basis of animal research and statistical studies of workers' exposure histories and medical records, some Russian, Polish, and Czech scientists believe that exposure to low levels have effects on the human body. Considered mainly temporary central nervous system effects, symptoms attributed to low-level exposure include headache, weariness, dizziness, irritability, emotional instability, partial loss of memory, loss of appetite, cardiovascular effects, electroencephalogram changes, blood chemistry changes, changes in respiration, and possible genetic effects.

There are also some nonionizing radiation effects that result in interference with the operation of electronic equipment. Such effects can cause physical injury when they involve disruption of cardiac pacemakers; telemetering devices in hospitals; and critical communications used in aircraft guidance and police, fire, and rescue activities.

POTENTIAL RADIATION DANGER

The significance of this radiation to public health depends on the amount of the population exposed, the exposure time, the frequency and the power levels involved. EPA estimates the potential danger from nonionizing radiation has risen dramatically since 1945, when levels were very low. EPA estimates radiofrequency and microwave sources alone to be increasing by 15 percent annually. Sources producing radiation which impacts directly on the public include approximately 350 UHF TV stations, 600 VHF TV stations, 3,400 FM stations, and 4,400 AM stations; tens of thousands of search, navigation, and weather radars; hundreds of thousands of microwave communications towers; and millions of microwave ovens. EPA states that these sources result in measurable exposures to the population and are becoming a major concern because

--the harmful environmental levels are not known,

--the number of sources is rapidly increasing, and

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--the U.S. standard for extended human occupational exposure to microwave radiation is approximately 1,000 times greater than the Soviet Union's published standard.

In Eastern Europe exposure standards protect against nonheating effects of long-term exposure to low-level radiation. In this country and most Western European countries, standards were designed to protect against heating effects from high-level exposures. The existing occupational and environmental exposure standards for various countries are shown in the following table.

Simplified Nonionizing Radiation Standards
(note a)

	U.S.	U.S.S.R.	Czechoslovakia	Poland
Environmental Exposure ($\mu W/cm^2$):				
Above 300 MHz	none	1	2.50	10
30 - 300 MHz	none	1	.25	13
Occupational Exposure ($\mu W/cm^2$):				
Above 300 MHz	10,000	10	25	200
30 - 300 MHz	10,000	6	25	106

a/ Such standards also include provisions for exposure times where greater exposures are allowed for short periods of time (e.g. the U.S. standard allows exposures of more than 10,000 $\mu W/cm^2$ for periods of less than 6 minutes).

Although there are no U.S. environmental standards for nonionizing radiation, including microwaves, the Food and Drug Administration (FDA) does have a microwave oven performance standard limiting the permissible microwave radiation leakage from the device itself, rather than establishing a maximum exposure level an individual might receive.1/ The leakage limit for new ovens is 1,000 $\mu W/cm^2$, measured at any point 5 centimeters from the surface of the oven. Ovens in service may degrade to levels no greater than 5,000 $\mu W/cm^2$ at the same distance.

1/This standard and the FDA efforts to protect the public from microwave radiation-emitting products is the subject of an ongoing GAO review to be issued later this year.

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The occupational standard established by the Occupational Safety and Health Administration (OSHA) recommends allowable limits of 10,000 $\mu W/cm^2$ for specific periods. This standard was based on a 1966 standard established voluntarily by the American National Standards Institute. The U.S. military also controls exposure using regulations that are consistent with OSHA standards. In contrast, comparable U.S.S.R. standards limit exposure to 10 $\mu W/cm^2$ for the duration of a working day, with higher exposures allowed for shorter periods, such as up to 1,000 $\mu W/cm^2$ for 20 minutes of the working day.

In a December 31, 1975, decision, an Occupational Safety and Health Review Commission judge held that the OSHA standard was considered an advisory rather than a mandatory standard. In addition the Assistant Secretary for Occupational Safety and Health, Department of Labor advised EPA in a September 17, 1976, letter that the standard is only a recommended guide. Therefore, the standard is generally regarded as nonenforceable.

EPA and OSHA officials agreed that the current OSHA nonionizing radiation standard should be reviewed because it was established 12 years ago and better scientific data is now available. On October 28, 1977, the National Institute for Occupational Safety and Health (NIOSH) announced plans to study and to recommend new occupational exposure standards to the Department of Labor in 1979 for radiofrequencies and microwaves.

In other areas FDA's Bureau of Radiological Health (1) has issued a Federal performance standard for lasers, (2) has reissued guidance on the hazards of mercury vapor lamps, and (3) is working on a performance standard draft for microwave diathermy applicators.

EPA'S RADIATION AUTHORITY

EPA is responsible for protecting the American people and environment from avoidable exposure to radiation. These responsibilities involve providing recommendations to the President for Federal agency guides to (1) develop and issue environmental standards for radioactive materials, (2) perform environmental impact analyses, and (3) maintain assessments of environmental radiation levels. This latter responsibility requires an active environmental monitoring program.

The 1970 Reorganization Plan Number 3 directs EPA to advise the President on radiation matters that directly or

indirectly affected human health.1/ Thus, if approved, EPA recommendations would be published as guidance to all Federal agencies in formulating radiation standards. The authority does not provide for direct EPA enforcement, but rather would be implemented and enforced in specific regulations and procedures of agencies, such as the Nuclear Regulatory Commission; the Department of Defense; the Federal Communications Commission; and the Departments of Transportation; Labor; Health, Education, and Welfare (HEW); and Energy.

This EPA guidance authority is also a controversial subject. HEW officials question whether EPA can legally issue nonionizing radiation guidance, stating that existing EPA authority applies only to nuclear materials. Our January 20, 1978, report discussed such jurisdictional disputes and recommended to the Congress that EPA's role in environmental and public health radiation protection be better defined to clearly delineate its responsibilities.

EPA officials believe that their current authority to issue guidance to Federal agencies may be adequate to control environmental nonionizing radiation exposure. If EPA later determines, however, that the scope of exposure is extremely large and many radiation sources are not under present control, then EPA will have to seek new regulatory legislation and funding to set enforceable standards. To implement and enforce nonionizing radiation controls, EPA officials stated that a much greater entity would be needed than EPA, at its present size.

EPA'S PROTECTION EFFORTS

EPA is studying hazardous health and other radiofrequency and microwave radiation side effects. EPA's objective is to determine health and environmental impacts of this form of nonionizing radiation to assess the need for establishing standards for environmental levels and providing guidance for controlling environmental exposures.

Because of increased public use of microwave radiation, and a determination that radio broadcast activities are the major source of population exposure to nonionizing radiation, EPA has directed its program study to determine levels and effects of these two nonionizing radiation sources.

1/This radiation authority was the subject of a GAO report "The Environmental Protection Agency Needs Congressional Guidance and Support to Guard the Public in a Period of Radiation Proliferation" (CED-78-27, January 20, 1978).

EPA's concern with environmental nonionizing radiation arises from two exposure situations. One is the relatively high-level exposure in the immediate vicinity of individual high-powered sources, such as satellite communications, airport radars, broadcast antennas, industrial process applications. and military electronic applications. The other situation is low-level exposure from the overlapping of radiation from many sources. Both situations can result in exposing large populations to significant environmental levels of nonionizing radiation.

EPA environmental radiation activities are divided between the Office of Radiation Programs and the Office of Research and Development. Standards development, environmental measurements, and environmental evaluation are conducted by the Office of Radiation Programs. Biological effects research is conducted by the Health Effects Research Laboratory, Research Triangle Park, North Carolina, which is part of the Office of Research and Development. Environmental exposure data is collected, evaluated, and compared to known effects and research results to assess needs for criteria, guidelines, or standards to control exposure.

Measurement activities

EPA initial efforts at measuring the extent of nonionizing radiation began in 1973, concentrating on recognized high-powered sources in the categories of UHF TV, VHF TV, and FM broadcast stations; tracking and search radars; and satellite communications terminals.

With a staff of five professionals, EPA is currently obtaining data on environmental levels of radiofrequency and microwave radiation in U.S. urban areas. Data is being collected with a measurement system housed in a mobile van. This program is identifying levels of environmental radiation which exist at selected locations. The program is also establishing reference levels against which changes in environmental quality can be evaluated to determinine trends or to anticipate future radiation levels. By assessing the population distribution around these locations, EPA can provide population exposure estimates.

As of February 1978, EPA had collected measurements in 11 metropolitan areas, and will continue similar studies in Denver, Los Angeles, San Francisco, and Seattle during the next 18 months. The highest levels measured were about 150 $\mu W/cm^2$. According to EPA officials, the overall median exposure levels measured in urban areas were quite low (less than 1 $\mu W/cm^2$). About 98 to 99 percent of the population would appear to be exposed to levels meeting even the very

strict Soviet standard. One or two percent of the general population, however, may be exposed to higher levels. For example, EPA measurements approached 2,000 $\mu W/cm^2$ at the base of an FM antenna on Mt. Wilson, California. Measurements in excess of 180,000 $\mu W/cm^2$ were found on the FM tower itself, thus creating concern for workers who need to climb such towers.

Health effects research

In addition, EPA research facilities at Research Triangle Park are developing health effects data to investigate the possible low-level effects findings of the Soviet Union. The fiscal year 1978 research effort of $830,000 and 30 staff years is devoted to the study of rats, mice, and monkeys chronically exposed to various power densities including low radiation levels. A summary of recent EPA research projects is shown in appendix III.

Whether low-level environmental exposures constitute significant health risks remains an open question. EPA is finding preliminary results that such exposures may affect the immune system; create anomalies in mouse litters, such as hernias of the brain; and produce a trend toward lowered behavioral performance. Although the significance of these preliminary results is still being evaluated, EPA officials agree that to dismiss the Soviet observations of low-level effects would be a mistake.

Researchers we interviewed said delays in starting projects in the research program and in possible future program personnel reductions were affecting morale and would significantly delay program results. The researchers believe more effort is needed to base a good scientific decision on standards development, including additional resources for epidemiological and clinical investigations of effects on humans. Additional animal studies on the chronic low-level environmental exposure are also needed.

COORDINATION OF FEDERAL PROTECTION ACTIVITIES

EPA's coordinating effort is through the Office of Telecommunications Policy (OTP) of the Executive Office of the President. Currently, most Federal research activities concerned with the biological effects of nonionizing radiation are overviewed by OTP. OTP exchanges present and past scientific and technical data with all Federal agencies, informing them of proposed future efforts. OTP also provides

an overview of the entire research effort, sometimes suggesting the type of research needed. OTP efforts are based strictly on voluntary participation by Federal agencies.

Understanding the biological effects of nonionizing radiation is a developing field requiring much input from various sources. The problems associated with nonionizing radiation are, therefore, the responsibility of many Government agencies, each having its own scope and level of effort. For example, HEW is responsible for establishing performance standards to control radiation from electronic radiation-emitting products, such as medical diathermy or microwave devices. The Department of Labor is responsible for occupational health and safety, and EPA, is responsible for environmental and public health aspects. The Department of Defense is also involved in such research. An estimated $9.5 million was spent by the Federal Government in fiscal year 1976 on radio and microwave frequency health effects research.

There is concern over a proposed Federal reorganization plan to abolish OTP and transfer its function to the Department of Commerce. The radiation effort is only one of OTP's functions, but according to those interviewed, the loss or reduced emphasis to this function could result in ineffectiveness in the long run in many current U.S. radiation research efforts.

PROGRAM STRATEGY AND UNCERTAINTIES

EPA identified three major program uncertainties to be overcome in the nonionizing radiation area.

--Existing ambient environmental levels and their rates and patterns of growth should be determined.

--Criteria for specifying acceptable environmental levels should be established.

--The existence of nonheating effects, which are potentially detrimental to public health and welfare, should be confirmed.

EPA officials stated that a decision on the need for protection standards for population exposure to nonionizing radiation should be made in March 1978, and if determined necessary, Federal guidance development should be completed by April 1979. EPA presently believes that, on the basis of currently available data, protection guidance will probably be necessary.

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CONCLUSIONS

The population is receiving measurable exposures to nonionizing radiation. The sources are increasing while the health effects of such exposures at low levels is a controversial subject. Other countries have developed and issued both occupational and environmental standards for nonionizing radiation. Research programs, including EPA efforts to detect and evaluate biological effects of nonionizing radiation, have not yet been able to generate a sufficient data base on which quantitative and scientifically sound radiation protection standards for microwave and other nonionizing frequencies can be established. The current OSHA nonionizing radiation standard has been challenged for its enforceability and its protection adequacy.

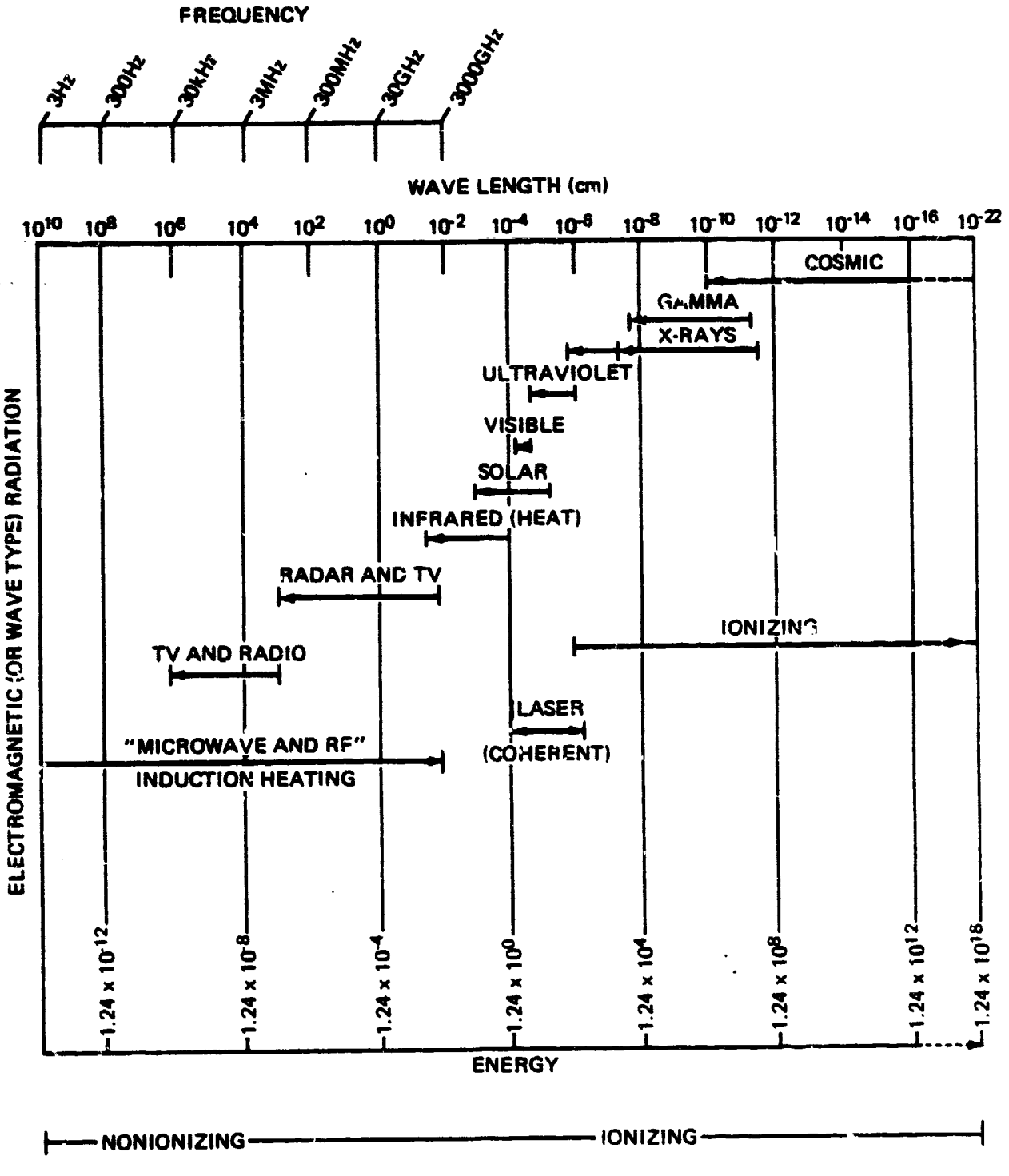
EPA is continuing to examine the need for issuing Federal guidance for environmental nonionizing radiation. If EPA determines environmental nonionizing radiation exposure control is needed depending on the extent of control necessary, EPA may need to seek new legislation to set an enforceable standard.

Many Government agencies are responsible for nonionizing radiation problems, each having its own scope. Most Federal research on the biological effects of nonionizing electromagnetic radiation are currently being overviewed by OTP. OTP has suggested program direction for needed Federal research vital to the nonionizing biological effects radiation area.

A proposed Federal reorganization plan includes the abolishment of OTP and the transfer of its functions to the Department of Commerce. The plan concerns EPA, OTP, and other Federal agencies involved in nonionizing radiation. Their concerns are whether the current OTP program will still be emphasized. Nonionizing electromagnetic radiation is a large and complex area and strong coordination is vital. A lack of Federal program coordination or overview could hamper not only EPA efforts in determining needs for environmental nonionizing radiation exposure controls, but other Federal Government radiation control activities as well.

APPENDIX II

SIMPLIFIED ELECTROMAGNETIC ENERGY SPECTRUM



SOURCE: EPA

APPENDIX III

EPA Nonionizing Radiation Health Effects Research Ongoing During FY 1977 and First Quarter FY 1978

Frequency (MHz)	Power density range ($\mu W/cm^2$) (note a)	Species
2450 (microwave oven)	5	Rats
2450	5-30	Mice
2450	5-30	Rats
2450	3.4-28	Mice
2450	5-28	Rats
2450	0.1-10	Monkeys
2450	0.3-9	Enzymes
425 (UHF-TV)	10	Rats
425	10	Rats
9000 (search radar)	10	Mice
9000	1-40	Bacteria
1000 (TACAN radar)	2-200	Dogs
147 (aircraft instrument landing systems)	0.5-2	Chicks
100 (FM radio)	25	Rats
DC	10-40,000 Volts per meter	Chicks

a/ milliwatts per square centimeter

Source: EPA.

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