

## An International Program for Microwave Exposure Protection

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**Abstract**—In the developed countries there has been a remarkable increase in the number of processes and devices that utilize or emit microwaves. Such devices are used in all sectors of our society for military, industrial, telecommunications, medical, and consumer applications. Because of the world-wide implications of the rapidly developing technology and associated health-safety considerations, development and implementation of a program for international cooperation in the use and protective measures related to microwave/radiofrequency (MW/RF) exposure is required. Activity in this respect has been initiated by the Regional Office for Europe of the World Health Organization (WHO/EURO) which has developed a sector program concerned with the health effects of nonionizing radiation (NIR) as part of its long-term program in environmental pollution control. To implement this program, several steps have been taken with participation by scientists and administrators from several countries. These activities have engendered plans and proposals for facilitating exchange and evaluation of information on the biologic and health effects of microwave radiation and in focusing attention on those areas in which additional information and new approaches are needed.

### INTRODUCTION

Interest and concern about the biologic effects and potential hazards of microwave/radio-frequency (MW/RF) exposure are not insular in nature and require international understanding and cooperation. In this context, the Regional Office for Europe of the World Health Organization (WHO/EURO) has developed a sector program concerned with the health effects of nonionizing radiation (NIR) as part of its long-term program in environmental pollution control [1]. Although other nonionizing radiant energies come under the purview of this program, only that pertaining to MW/RF is reviewed and discussed in this short paper.

### PROGRAM DEFINITION

As part of this program, a Working Group met in The Hague, in November 1971, to review and assess the situation prevailing in Europe and elsewhere, consider trends and developments, recommend approaches, and suggest priorities for a long-term program [2]. The deliberations of the Working Group developed from consideration of several basic questions, namely, the following.

1) How serious are the problems in regard to MW/RF exposure; what are their dimensions?

2) What acute and/or chronic effects on the body are involved?

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The proceedings of the symposium, including papers, discussions, and recommendations, will be published by the three sponsors during 1974. The report of the Evaluation Group has already been published by the WHO Regional Office for Europe as Document EURO 3170, Copenhagen, Denmark, 1974.

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3) How adequate is our present knowledge about occupational risks and public health hazards from these types of radiation?

4) How can exposure be reduced?

5) Are protection standards adequate, and if not, how can better regulations be drafted and enforced to reduce exposure to these energies?

Certain needs were emphasized such as: 1) collection and evaluation of informative data in a systematic manner; 2) support for further investigations into the health hazards of MW/RF; 3) consideration of biologic criteria for damage; 4) development of criteria for health protection; 5) assistance in the establishment of rules and regulations and the proper means of enforcing them.

### PROGRAM RECOMMENDATIONS

Recommendations made to the World Health Organization (WHO) include the following.

1) Collect case histories of accidental exposure to NIR to provide more reliable indexes of the clinical disorders to be expected after such exposure.

2) Initiate appropriate surveys into the size and distribution of populations at risk (workers as well as the general public).

3) Support and coordinate prospective and retrospective long-term epidemiological studies on groups of workers exposed to NIR.

4) Encourage research where indicated.

5) Establish appropriate international reference centers to undertake these tasks and foster the setting up of similar centers at national levels.

6) Encourage the development and use of measuring equipment to register exposure of personnel to NIR.

7) Survey the field of health protection from NIR with the objective of producing model codes of practice for workers and the general public.

8) Survey existing training programs to assure adequate international standards of education.

9) Take steps to develop relevant recommendations for criteria of microwave effects on man.

10) Stimulate research and development of accurate probes for both near-field and far-field energy determination, including the development of implantable probes.

### PROGRAM IMPLEMENTATION

To implement this program, the European Regional Office of WHO has embarked on a survey of institutions and specialists in the field of NIR which, when compiled, will provide information for a Directory of Institutions. Meanwhile, a preliminary survey has revealed that only in a relatively small number of countries are there institutions dealing with NIR. In addition to the two countries long involved in this area, namely, the U.S.A. and the USSR, probably less than twenty other countries in the world are known to have institutions that are concerned with the study of NIR. Of these, about half are European countries. Over twenty institutions are already identifiable in the U.S.A. They include the National Institute of Environmental Health Sciences, the Bureau of Radiological Health, the Department of Health, Education, and Welfare, the Environmental Protection Agency, research centers of the Department of Defense, various universities, and a few industrial corporations.

Subsequent to the deliberations of the Working Group, at a meeting in Geneva, Switzerland, the scope of the program and its priorities were discussed [3]. To enable the preparation of a criteria document on NIR, it was considered essential to first prepare critical reviews of the existing knowledge of health effects of microwaves as an early priority. Consequently, a report was drafted for the WHO Regional Office for Europe on the potential hazard to human health from the exposure to microwaves and radio frequency. In this report attention has been given equally to work published in the U.S.A., Western Europe, the USSR, and Eastern Europe. This report has been commented on by a number of well-known reviewers.

Most recently, WHO, together with the United States Department of Health, Education, and Welfare, and the Scientific Council to the Minister of Health and Social Welfare of the Polish Peoples' Republic sponsored an International Symposium on Biologic Effects and Health Hazards of Microwave Radiation which was held near Warsaw, Poland, October 15–18, 1973 [4]. This symposium served

as the first international forum for personal exchange of research information and professional experience as well as discussion and evaluation of current information and concepts about the biologic effects and health implications of microwave exposure. Attention was focused on several areas to determine where additional information is needed and development of new approaches is appropriate.

Over fifty participants from twelve countries and representatives from five international organizations attended the symposium. Thirty-nine papers from nine countries were presented. Of these papers, nine were related to physiopathology of the central nervous and neuroendocrine systems, seven each to epidemiological surveys and energy absorption/measurement techniques, and five were based on cellular and molecular biophysics. Other subjects included ocular effects, thermal regulation, mammalian development, combined effects, and applications.

The major accomplishment of this symposium no doubt is that an initial step has been taken towards removal of barriers between countries to permit international cooperation. An important outcome of the symposium was the consensus of the participants that for convenience and uniformity of approach microwave intensities could be classified in three broad categories: 1) levels above 10 mW/cm<sup>2</sup>, at which thermal effects occur and in some instances (at high average power densities) may prove hazardous; 2) levels below 1 mW/cm<sup>2</sup>, at which thermal effects are improbable; 3) intermediate range in which weak but noticeable thermal effects occur as well as direct field effects. Other effects of a microscopic or macroscopic nature, the details of which have not yet been clarified, may also pertain.

This categorization was qualified with the notation that the limits of these ranges have not yet been determined. They may differ for various species of animals and may also depend on a variety of parameters such as frequency and modulation.

The material presented and discussed at the symposium was made the subject of a special Evaluation Group Meeting which was intended to provide the feedback into the NIR sector of the program of the European Regional Office [5]. The meeting concerned itself with identification of research gaps and the need for complementary information on the study of microwave radiation for possible future utilization through an expansion of the presently envisioned activities of the WHO Regional Office.

## RESEARCH REQUIREMENTS

More biomedical and biophysical investigations are needed before clarification and understanding of subtle effects will be possible. Special attention should be paid to investigations to determine the absorbed energy and its spatial distribution. Background information for such studies has been presented by Johnson and Guy [6].

There is a need for further research to clarify and improve our understanding of interaction of microwave and radio-frequency radiation with biological systems at all levels of biological organization to provide information on reported cumulative effects, delayed effects, and differential sensitivity (as a function of a selected system or stage of development).

Investigations of the effects of low-intensity microwaves at various MW/RF bands and threshold values at which biologic effects are induced are required. The significance of such effects should be assessed. Combined effects of microwaves and various radiant energies as well as other environmental factors require more extensive investigation [7]. Carefully controlled epidemiologic studies should be initiated.

## RECOMMENDATIONS

The work of the Evaluation Group culminated in a series of recommendations for the development of a program in NIR under the auspices of an international agency, such as WHO, which could exert leadership in coordination, and facilitate international communication among scientists active in this field of research (such a program has been started by the European Regional Office of WHO). Every effort should be made to establish internationally accepted definitions and nomenclature for quantities and units and to standardize measurement techniques. This would require international cooperation in microwave bioeffects research by means of continuing exchange of information; improved and timely translation services; exchange visits; and collaborative projects and publications.

It was recommended that the WHO European Regional Office

continue to foster and whenever possible, provide the encouragement and the environment for exchange and interaction between the physical and biological scientists from different laboratories and institutions. A fellowship program to implement this interaction was highly recommended.

The Evaluation Group recommended that WHO/EURO evaluate the requirements on pacemaker susceptibility which will permit freedom from interference in any fields likely to be encountered by a patient and to review the practices regulating the siting of transmitters near hospitals.

It was also suggested that WHO/EURO evaluate the use of microwave diathermy to determine whether an epidemiologic survey of groups of patients exposed to high levels of microwaves or other electromagnetic radiations could contribute data that would indicate the tolerance level of the human eye and brain to microwaves.

Although protection guides and personnel exposure standards have been recommended or introduced into legislation in various parts of the world, there is, nevertheless, lack of uniformity, and, in many cases, either misinterpretation or lack of understanding of some of these standards. Whereas in the field of ionizing radiations such groups as the International Commission on Radiation Protection (ICRP), the International Commission on Radiological Units and Measurements (ICRU), and International Labor Organization (ILO) have effectively brought order and agreement into the field on an international scale, this is not true in regard to RF/MW exposure. At its last meeting (Washington, D.C., September 1973), the International Radiation Protection Association (IRPA) included nonionizing radiation as part of its program. The Evaluation Group recommended that coordination of RF/MW protection guides and personnel exposure standards be fostered, an activity in which WHO/EURO can play an important role. It was further recommended that WHO/EURO undertake a survey of product performance standards for microwave emitting devices, with a view towards consistency with personnel exposure standards and standardization, whether official or nongovernmental.

The Evaluation Group finally recommended that WHO/EURO set up a training program for health physicists and public health officials responsible for the evaluation of MW and RF radiation. Such training should make the participants conversant with the field from the physical, the biological, as well as regulatory aspects.

## CONCLUSION

These activities and recommendations should permit us to realistically assess the potential hazards related to the use of nonionizing radiation emitting devices on an international scale. There is little doubt that international criteria for the use of some of these radiant energies are needed. Before workable international regulations for maximum exposure can be set up, a number of conditions have to be fulfilled. Most important of these conditions is agreement based on reliable scientific evidence, credibility, and experience on the level of exposure that represents the least potential hazard to man [7]. With such knowledge, it should be possible to formulate standards with a sufficiently large margin of safety which would then be the protection guideline to be used anywhere in the world. In this way can the full potential for use of these energies be developed without hazard to mankind.

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