Environmental Health Criteria 69

MAGNETIC FIELDS

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World Health Organization

INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

ENVIRONMENTAL HEALTH CRITERIA 69

MAGNETIC FIELDS

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The International Programme on Chemical Safety (IPCS) is a joint venture of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. The main objective of the IPCS is to carry out and disseminate evaluations of the effects of chemicals on human health and the quality of the environment. Supporting activities include the development of epidemiological, experimental laboratory, and risk-assessment methods that could produce internationally comparable results, and the development of manpower in the field of toxicology. Other activities carried out by the IPCS include the development of know-how for coping with chemical accidents, coordination of laboratory testing and epidemiological studies, and promotion of research on the mechanisms of the biological action of chemicals.

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NOTE TO READERS OF THE CRITERIA DOCUMENTS

Every effort has been made to present information in the criteria documents as accurately as possible without unduly delaying their publication. In the interest of all users of the

environmental health criteria documents, readers are kindly requested to communicate any errors that may have occurred to the Manager of the International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland, in order that they may be included in corrigenda, which will appear in subsequent volumes.

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PREFACE

The International Radiation Protection Association (IRPA) initiated activities concerned with non-ionizing radiation by forming a Working Group on Non-Ionizing Radiation in 1974. This Working Group later became the International Non-Ionizing Radiation Committee (IRPA/INIRC), at the IRPA meeting held in Paris in 1977. The IRPA/INIRC reviews the scientific literature on non-ionizing radiation and makes assessments of the health risks of human exposure to such radiation. Based on the Environmental Health Criteria Documents developed in conjunction with the International Programme on Chemical Safety (IPCS), World Health Organization, the IRPA/INIRC recommends guidelines on exposure limits, drafts codes of safe practice, and works in conjunction with other international organizations to promote safety and standardization in the non-ionizing radiation field.

The first draft of this document was compiled by DR M. REPACHOLI. An editorial group chaired by DR P. CZERSKI and including DR V. AKIMENKO, PROFESSOR J. BERNHARDT, DR B. BOSNJAKOVIC, MRS A. DUCHENE, PROFESSOR M. GRANDOLFO, DR M. REPACHOLI, MR D. SLINEY, and DR T. TENFORDE met in Neuherberg in May 1985 to develop the second draft. A small editorial group consisting of DR P. CZERSKI, DR M. SWICORD, and DR P. WAIGHT met in Geneva in April 1986 to collate and incorporate the comments received from IPCS Focal Points and individual experts. The final draft was then sent to WHO/IRPA Task Group members and formally reviewed in Kiev, USSR, 30 June - 4 July 1986. Final scientific editing of the document was completed by DR M. REPACHOLI, with the assistance of DR M. SWICORD, in Geneva in July 1986. The scientific assistance and helpful comments of DR T. TENFORDE, and the permission to use his extensive literature files, are gratefully acknowledged.

This document comprises a review of data of effects of magnetic field exposure on biological systems, pertinent to the evaluation of health risks for man. The purpose of the document is to provide an overview of the known biological effects of magnetic fields, to identify gaps in this knowledge so that direction for further research can be given, and to provide information for health authorities and regulatory agencies on the possible effects of magnetic-field exposure on human health, so that guidance can be given on the assessment of risks from occupational and general population exposure.

Subjects reviewed include: the physical characteristics of magnetic fields; measurement techniques; applications of magnetic fields and sources of exposure; mechanisms of interaction; biological effects; and guidance on the development of protective measures, such as regulations or safe-use guidelines. Health agencies and regulatory authorities are encouraged to set up and develop programmes that ensure that the maximum benefit occurs with the lowest exposure. It is hoped that this criteria document will provide useful information for the development of national

protection measures against magnetic fields.

The WHO Regional Office for Europe prepared a publication entitled Non-Ionizing Radiation Protection (WHO, 1982). A revised and updated edition, completed in 1986, includes a section (5) on Electrical and Magnetic Fields at Extremely Low Frequencies.

1. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDIES

This document includes a detailed review and evaluation of data on effects on human beings and other biological systems exposed to static magnetic fields or to time-varying fields at extremely low frequencies (ELF) of up to about 300 Hz. Data from the biological effects of exposure to sinusoidally varying fields are mainly concerned with effects in the range up to 20 Hz or at 50 and 60 Hz, and only limited data are available on effects at higher frequencies. Data on studies with higher frequencies and pulse repetition rates, and non-sinusoidal waveforms have also been considered, but radiofrequency magnetic fields in the frequency range 100 kHz - 300 GHz have been excluded because these have been treated in the Environmental Health Criteria 16: Radiofrequency and microwaves (WHO, 1981).

Information for health authorities on the biological effects and possible health effects of magnetic fields, is given to provide guidance for the assessment of the occupational and public health significance of exposure to magnetic fields and to indicate areas that may be hazardous. Information on human exposure levels is provided, which, on the basis of present knowledge, is considered appropriate for the prevention of health hazards.

1.1. Physical Characteristics and Dosimetric Concepts

A magnetic field always exists when there is an electric current flowing. A static magnetic field is formed in the case of direct current, and a time-varying magnetic field is produced by alternating current sources.

The fundamental vector quantities describing a magnetic field are field strength, H (unit: A/m) and magnetic flux density, B (unit: T, tesla). These quantities are related through $B = \mu H$, where μ is the magnetic permeability of the medium.

The term "dosimetry" is used to quantify exposure. Present understanding of interaction mechanisms is insufficient to develop anything but preliminary dosimetric concepts for static or ELF magnetic fields.