

Other titles available in the ENVIRONMENTAL HEALTH
CRITERIA series include:

1. Mercury
2. Polychlorinated Biphenyls and Terphenyls
3. Lead
4. Oxides of Nitrogen
5. Nitrates, Nitrites and N-Nitroso Compounds
6. Principles and Methods for Evaluating the Toxicity of Chemicals, Part 1
7. Photochemical Oxidants
8. Sulfur Oxides and Suspended Particulate Matter
9. DDT and its Derivatives
10. Carbon Disulfide
11. Mycotoxins
12. Noise
13. Carbon Monoxide
14. Ultraviolet Radiation
15. Tin and Organotin Compounds
16. Radiofrequency and Microwaves
17. Manganese
18. Arsenic
19. Hydrogen Sulfide
20. Selected Petroleum Products
21. Chlorine and Hydrogen Chloride

This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of either the World Health Organization, the United Nations Environment Programme, or the International Radiation Protection Association.

Environmental Health Criteria 22

ULTRASOUND

Published under the joint sponsorship of
the United Nations Environment Programme,
the World Health Organization, and the
International Radiation Protection



25

INVENTARIO N. _____



World Health Organization
Geneva, 1982

CONTENTS

	page
ENVIRONMENTAL HEALTH CRITERIA FOR ULTRASOUND	10
1. SUMMARY AND RECOMMENDATIONS FOR FURTHER STUDIES	13
1.1 Summary	13
1.1.1 Scope and purpose	13
1.1.2 Introduction	13
1.1.3 Mechanisms of action	14
1.1.4 Biological effects	15
1.1.4.1 Airborne ultrasound	15
1.1.4.2 Biological molecules	16
1.1.4.3 Cells in suspension	16
1.1.4.4 Organs and tissues	16
1.1.4.5 Animal studies	17
1.1.4.6 Epidemiology and health risk evaluation	17
1.1.5 Exposure limits and emission standards	17
1.1.5.1 Occupational exposure to airborne ultrasound	17
1.1.5.2 Therapeutic use	18
1.1.5.3 Diagnostic use	18
1.1.5.4 General population exposure	18
1.2 Recommendations for further studies	18
1.2.1 Measurement of ultrasonic fields	18
1.2.2 Exposure of patients to diagnostic ultrasound	19
1.2.3 Biological studies	19
1.2.4 Training and education	22
1.2.5 Regulations and safety guidelines for equipment	22
2. PHYSICAL CHARACTERISTICS OF ULTRASOUND	24
2.1 Continuous, gated, and pulsed waves	26
2.2 Intensity distribution in ultrasound fields	28
2.2.1 Progressive wave fields	28
2.2.2 Standing waves	31
2.3 Speed of sound	32
2.4 Refraction and reflection	32
2.5 Characteristic acoustic impedance	33
2.6 Attenuation and absorption	34
2.7 Finite amplitude effects	36

ISBN 92 4 154082 6

© World Health Organization 1982

Publications of the World Health Organization enjoy copyright protection in accordance with the provisions of Protocol 2 of the Universal Copyright Convention. For rights of reproduction or translation of WHO publications, in part or *in toto*, application should be made to the Office of Publications, World Health Organization, Geneva, Switzerland. The World Health Organization welcomes such applications.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

PRINTED IN FINLAND

83/5631 - VAMMALA - 7000