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[illegible] OF [illegible] BIOLOGICAL [illegible] ([illegible]) AND CLINICAL
[illegible] ASSOCIATED WITH [illegible] ARE [illegible] RADIATION

[illegible]

[illegible]

[illegible]
[illegible]
[illegible]

BIBLIOGRAPHY OF SOMATIC ECOLOGICAL EFFECTS (EFFECTS) AND CULTURAL HAZARDS RELATED TO NONIONIZING AND RADIO-FREQUENCY RADIATION

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Research Report

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Corrections, and Additions: 23 April 1973
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[illegible]

[illegible] 2003 references on the biological [illegible] to radio [illegible] and electromagnetic radiation, published up to June 1993, are included in the bibliography. Particular [illegible] on the effects of non-ionizing radiation [illegible]. The references are arranged alphabetically by [illegible], and contain as much information as possible [illegible] of the original documents. An index of the [illegible] to radio frequency and microwave radiation is also [illegible] in this report.

Where supplementary IdentiDoc [illegible] the number of references to [illegible] than 2003.

Ken [illegible]

Electromagnetic [illegible]
Non-ionizing Radiation
Laser [illegible]
Radio Frequency Radiation
Microwave Radiation
[illegible]
Epidemiology
Electromagnetic Radiation Injury

DOCUMENT CONTROL DATA - R & D

NAVAL MEDICAL RESEARCH INSTITUTE NATIONAL NAVAL MEDICAL CENTER BETHESDA, MARYLAND 20014	UNCLASSIFIED

BIBLIOGRAPHY OF REPORTED BIOLOGICAL PHENOMENA ('EFFECTS') AND CLINICAL MANIFESTATIONS ATTRIBUTED TO MICROWAVE AND RADIO-FREQUENCY RADIATION

Medical Research Interim Report, Bibliography (Current to April 1972)

Zorach R. Glaser, Ph.D.
LT, MSC, USN

Revised 20 April 1972 (2nd Edition - [illegible], Supplement)	Aug [illegible]
	MF12.524.015-0004B, Report No. 2, Revised

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BUREAU OF MEDICINE AND SURGERY (NAVY)
WASHINGTON, D.C. 20390

More than 2300 citations on the biological responses to radio frequency and microwave radiation, published up to April 1972, are included in this bibliography of the world literature. Particular attention has been paid to the effects on man of non-ionizing radiation at these frequencies. The citations are arranged alphabetically by author, and contain as much information as available to us to assure efficient retrieval of the original documents. Soviet and East European literature is included in detail. A tabulation of the effects which have been attributed to radio frequency and microwave radiation is included as Chapter 1. The second edition, (which supersedes NMRI report AD/734391) is updated with the inclusion of three supplementary listings, and has incorporated many corrections and additions to the original 2100 citations.

UNCLASSIFIED
Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Biological effects						
Non-ionizing radiation						
Radar [illegible]						
Radio frequency [illegible]						
Microwave radiation						
Health hazards						
Thermography						
[illegible] radiation injury						
[illegible]						

TABLE OF CONTENTS

Preface

It is the hope of the author that this bibliography will provide guidance to the diffuse and conflicting literature on the biological consequences of electromagnetic radiation at radio- and microwave-frequencies, with particular reference to the effects of concern on man. Such guidance is needed in the formulation and appraisal of criteria and limits of human exposure to "non-ionizing" radiation, and in the planning and conduct of future research.

The original plan was to categorize and key the literature citations to the "outline of biological and clinical effects" (Chapter 1). This proved to be a much more difficult and time-consuming task than anticipated, and was actually completed only for about 600 papers. Thus, the lower-number combinations given in square brackets for some of the "A" through "V" citations refer to the outline. [0] indicates the citation was "not verified".

The standard format used throughout the bibliography for authors, (date), journal, volume, (issue): page, "title". The authors are alphabetized, and in chronological order. Multiple authors are also alphabetized, and in chronological order according to the second, third, etc., author. Indexing pagination is given where possible, as in the original language of the citation. Report accession and translation numbers (some of which are given in Appendix A), and alternate sources are listed when known. The title of books is underlined. Where the title of the report was not available (or not given), a short (one line) description of the paper is listed whenever possible. Reports in which the name of the author was not given are listed chronologically using the format, "title", reference, source, (date). In many cases the citation was obtained from secondary (and tertiary) sources. For this reason it was impossible to put every citation into a consistent format.

In the text, papers have been cited which were presented as symposia or meetings devoted to the present topic, even when the report title suggests that it does not pertain directly to the topic. This has been done to show the wide range of items considered relevant (at least at the time of the meeting, and by the organizing chairman! In most years, an example is "Electromagnetic".

A few citations of marginal and/or peripheral relevance have also been included so that the reader may judge the applicability to his individual research needs. Examples are reports dealing with the biological effects of acoustic and electrostatic magnetic fields, experimental techniques using radio frequency and microwave radiation (e.g., electron spin resonance, and nuclear magnetic resonance spectroscopy), and microwave exposure limits, regulations, and standards.

A bibliography for a few literature-listings for prescribed exposure are available upon request.

The author welcomes information which will correct errors and omissions, both of which no doubt exist. Copies of new papers would be greatly appreciated, and would encourage updating and revising the bibliography periodically.

ACKNOWLEDGMENTS

The assistance and support received during the preparation of this bibliography have been considerable, and I am happy to acknowledge my indebtedness to a number of people. Drs. John Fenner and Dorothy Fellers, former and present Heads of the Biophysics Division, and Dr. Seymour Polman, Director of the Environmental Biophysics Department of the Naval Medical Research Institute, provided me the opportunity to work on the bibliography, and offered frequent encouragement.

Acknowledgment is also due to many friends and associates for their helpful suggestions, questions, and items, and/or gifts of papers or other material, which have been invaluable in the course of the work. Mr. Glenn Brown of the Naval Ship Engineering Center contributed an extensive collection of government reports and documents, some of which had not previously been cited in the open literature.

Special help in tracing and in the acquisition of reference papers has been received from the librarians and staff members of the NMRI Library: Mrs. Thelma Robbins, Mrs. Annette Goodman, Mrs. Eleanor Capps, and Miss Yolanda Gomez. Their willingness and resourcefulness in tracing and obtaining copies of a large number of papers and reports, often in spite of incomplete and/or inaccurate citations given in other sources, resulted in a bibliography including many reference items in the bibliography.

Mr. Christopher Lodge of the Scientific and Technical Center, Department of the Navy, provided each of the Soviet Bibliography, linguistic and other technical assistance, and in addition offered valuable comments and encouragement throughout the preparation of this report. Especially commendable were the corrections and improvements suggested by Mr. Lodge following his reading of the entire manuscript.

Additional advice in locating some of the Soviet literature was Mr. R. S. Brychkovskiy, of the Foreign and Technology Division, The Library of Congress.

Credit is due Mrs. Rose Bost (Ohio State University) for translating many of the German papers; to Dr. Dallie Melvin, who translated from the Italian, and to Mrs. Edith Engel who typed many "Slavic texts"; also to Mrs. Rosie Glover for her help in many aspects of the work.

Mrs. Pamela Epstein Jeffrey deserves special mention for her outstanding editorial assistance, and especially for the heroic typing, organization, and checking of the entire report.

The [illegible] of Reported Biological Effects ("Effects") and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation, in pattern after that given by R. Farrar, et al., in an article entitled, "How safe are microwaves?", which appeared in Nonionizing Radiation 1(1):7-8 (1981). Some of the "effects" were listed in the report by S. V. Cheney and W. T. Kaye, Jr., entitled, "Considerations in the evaluation of the biological effects of exposure to microwave radiation", (Analysis Report), Dec. 1, 1969, for the Task Force on Research Planning in Environmental Health, National Panel on Physical Factors in the Environment. The discussions and suggestions offered by Bruce McCaig, Edward Finch, Earle Gerkman, and Christopher Sabin relative to the Outline are also gratefully acknowledged.

Preparation of the bibliography was supported by the Bureau of Medicine [illegible], Department of the Navy, under work unit M012,[illegible], 005-6[illegible].

[illegible]

[illegible]

[illegible]

A. "Marking of Impact" (Cryptic Clues - Sterility, Electromagnetic Phenomena, Electrokinetics, Electrochemistry, Electrobiology)

1. Whole Body Concentration Gradient (Cancer), Lymphomas
2. Skin
3. Cornea and Lens Arrays
4. (a) Loss of Lens (Cataractogenic Devices - [illegible]
   (b) [illegible]
5. Deafness (Possible [illegible])
6. [illegible]
7. Fingers
8. [illegible] Implants (Bone [illegible], etc.)

The effects are [illegible] to adapt for us.

B. Changes in [illegible]

1. [illegible]
2. Alteration of Chemicals in Blood Vessels (Increased [illegible] Clumping), Allergies
3. Changes in the Oxidative Processes in Tissues and Organs
4. Silver Interpenetration
5. Altered Sensitivity to Drug Schedule
6. Decreased Thermoregulation (Increased Sweating, [illegible])
7. Altered Sex Ratio of Births (Boys [illegible])
8. Altered Neuromuscular Sensitivity
9. Altered Tonal Development
10. Increased Character in Tonal Sections
11. Interaction in Surrounds (Air Molecules, [illegible])
12. Altered Metal Function (Increased Silicon [illegible])
13. Changes in [illegible]
14. [illegible]
15. Changes in the Sensitivity of Skin Receptors of the (a) [illegible], and (b) [illegible]
16. Altered Blood Viscosity

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* In [illegible] the [illegible] of identification produces a positive effect - "[illegible]".

Note: These effects are listed in [illegible] of [illegible] [illegible] Hierarchies should with [illegible] [illegible] regarding as "effect" [illegible] or [illegible] may have been drawn from a [illegible] [illegible]

17. Alterations in the Microcirculation (BBB) of the Cerebral Cortex [in rabbits]
18. Changes in the Rate of Clearance of Tagged Ions from Tissue
19. Reversible Structural Changes in the Cerebral Cortex and the Hippocampus
20. Electroencephalographic (EEG) Changes
21. Alterations in Susceptibility to Light, Sound, and Olfactory Stimuli
22. Functional (a) and Pathological (b) Changes in the Eyes: (a) decrease in color of blind spots, altered color recognition, changes in intraocular pressure, lacrimation, swelling of eyelids; (b) lens opacity and cataracts, altered vision conditions, and altered reactions-to-light processes
23. Myocardial Necrosis
24. Hemorrhage in Lungs, Liver, Fat, and Brain] Ar Fatal Levels
25. Generalized Degeneration of all Body Tissue] of Radiation
26. Loss of Acoustical Tests
27. Death
28. Teleprotection
29. Altered Rate of Rehabilitation of Damaged Tissue

C. Central Nervous System Effects

1. Radiation
2. Tumors
3. Hallucinations (Strobe and Dancing Flame)
4. Electroencephalographic (EEG) Changes
5. Cranial Nerve Disorders
6. Pyramidal Tract Lesions
7. Conditioned Reflex Disorders
8. Vasomotor Action of the Hypothalamic Junction
9. Balance, Coordination

D. Autonomic Nervous System Effects

1. Neuro-endocrine Disorders (e.g., alteration of hunt rhythm)
2. Fatigue
3. Physiological disruptions in the Response of the Vagus Nerve
4. Stimulation of Parasympathetic Nervous System (Bradycardia), and Inhibition of the Sympathetic Nervous System

E. Peripheral Nervous System Effects

Effects on Locomotor Reflex

E. Psychological Disorders ("Brain Schizoid Syndrome") - [illegible] "Neuropsychologic Load [Psychosomatic] Relationship"

1. Paranoidness - [illegible] "Bad" [illegible]
2. Depression
3. Impulsivity
4. Anxiety
5. Lack of Concentration
6. Hypersomnia
7. Fatigue
8. Hallucinations
9. Sleepiness
10. Insomnia
11. Increased Irritability
12. Increased Aggressive
13. Lack of Desire
14. Sexual Dysfunction
15. Increased Fatigability
16. Short Fuse
17. Loss of Memory

II. Biochemical Disorders (Serious Disorders)

Deficiency, Dysfunction, Imbalance, and Hyperactivity Disorders

III. Blood Disorders

$$\frac{\text{Hb g/dl}}{\text{Hct \%}}$$

Examples:

1. [illegible]
2. Hypercoagulation (Hypercoagulation and Intravascular Coagulation of [illegible])
3. Hemolysis (Hemolysis), [illegible]
4. Polycythemia (Hematocrit), [illegible] levels or amount of Fibrinogen (FI)
5. Number of Erythrocytes (Increased), [illegible]
6. Blood Glucose Concentration (Increased)
7. Blood [illegible]
8. Abnormal [illegible]
9. [illegible] and [illegible], and Total Protein Concentration
10. Number of Leukocytes
11. Albumin/Globulin Ratio Increased
12. Hemoglobin (Loss of Saturation of Blood Corpuscles)

13. Erythrocyte Sedimentation Rate (Number of Red Blood Cells), and Leukocytosis
14. Polycythemia

V. Vascular Disorders

1. Thrombosis
2. Hypertension

A. Oxygen and Other Biochemical Changes

Changes in activity of:
1. Dehydrogenase [illegible]
2. Phosphatase [illegible]
3. [illegible] [illegible]
4. [illegible] [illegible]
5. [illegible]

6. Insulin Concentration
7. Total, Free, and Final Transduction (as high molecular [illegible] levels), Concentration [illegible]
8. Tissue Deficient Glucose
9. Alteration in Rate of Cell Division
10. Increased Concentration of RNA in Lymphocytes, and Decreased Concentration in Brain, Liver, and Spleen
11. Changes in Pyruvic Acid, Succinic Acid, and Cholesterol Concentration
12. Changes in Concentration of Glycogen in Liver (Hepatocytes)
13. Alteration in Concentration of [illegible] Concentration in Urine

B. Metabolic Disorders

1. Alteration of [illegible] [illegible] in Blood Serum
2. [illegible] in Urinary Mineral [illegible]
3. Alteration of Rate of Metabolic Degradation [illegible]
4. Altered Carbohydrate Metabolism

C. Neuro-Muscular Disorders

1. [illegible] [illegible]
2. Hypotonic [illegible]
3. Convulsions
4. Altered Secretion of Stomach, "Hypertonic Juices"

D. Endocrine Gland Changes

1. Altered Pituitary Function
2. Hyperadrenalism
3. Hypothyroidism
4. [illegible] Rate of Radioactive Iodine in Thyroid Gland
5. Altered Adrenal Cortex Activity
6. [illegible] in Blood
7. [illegible] Thyroid Activity
8. Hypoparathyroidism (Probably Decreased Parathyroid Hormone)

E. Reproductive Changes

1. Changes in Tubular Epithelium of Testicles
2. Ovum Changes

5. Genetic and Chromosomal Changes

   1. Chromosome Aberrations (e.g., linear chromosomes, acentrics, ring and dicentrics, acentric fragments, [illegible])
   2. Mutations
   3. Hemoglobin
   4. Somatic aberrations (changes in cell rate [illegible] nuclear or chromosomal, cellular transformation)
   5. Mutations [illegible]

6. Heat Shock Effect (Disruption [illegible] of precipitation [illegible] and coagulation of cellular and other [illegible] particles)

   Also, deterioration of [illegible], [illegible], and [illegible] in electromagnetic fields

9. Miscellaneous Effects

   1. Spacing Between Sexual Offspring
   2. Cellular metabolic rates in [illegible]
   3. Changes in Typical Activity of Individual Colonies
   5. Treatment for Hydatids, Photosensitivity, Skin Diseases
   5. Loss of Hair
   6. Arrhythmia of [illegible]
   7. Sensitivity of Hearing, Vibration, [illegible], and [illegible] [illegible] the [illegible] and [illegible]
   8. Oxygen Precipitation, Hydrolysis, and Oxygen [illegible] of Decay
   9. Changes in the Operation of Implanted Cardiac Pacemakers
   10. Changes in Circadian Rhythms

[illegible]

[illegible]

1. [illegible]

2. [illegible]

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4. [illegible]

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16. [illegible]

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APPENDIX A

ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Agency Acronym, Meaning
[illegible]	Defense Technical Information Center (DTIC), Formerly Armed Services Technical Information Agency (ASTIA)
[illegible]	[illegible]
[illegible]	Library of Congress - Aerospace Technology Division
[illegible]	National Technical Information Service (NTIS), U. S. Dept. of Commerce
[illegible]	[illegible]
OTS	Office of Technical Services, U. S. Dept. of Commerce
[illegible]	Department of the Army
[illegible]	[illegible]
[illegible]	Headquarters Chief of Staff for Intelligence Army, Washington, D. C.
[illegible]	National Aeronautics and Space Administration
[illegible]	Scientific & Technical Information Office (STIO) of NASA
[illegible]	[illegible]
[illegible]	Classified Data Document Center [illegible]
[illegible]	National Library for Science & Technology, Denton [illegible]

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