

## BOOK REVIEWS



by Jim Hill, EMXX Corporation.

In this issue we will get back to the serious business of book reviewing. There are two reviews that have come our way. One, prepared by Herman Garlan, is a review of the proceedings of the Seventh International Symposium on EMC recently held in Wroclaw, Poland. This symposium is held biennially on even numbered years. The output is a two-volume set in 17 by 24 cm. format with a total of 1069 pages, part in English and part in the Russian Cyrillic. Through the exchange program between the EMC Society and the Polish EMC group we have copies available for sale here in the USA.

The second book review was borrowed from the IEEE Antenna and Propagation Society Newsletter of August 1984. It is one of the IEEE Press books, a compilation of papers taken from IEEE Transactions, Symposium Records, and various IEEE sources over a period of years. This collection of papers on "Biological Effects of Electromagnetic Radiation" is of current concern now that the old exposure limits are undergoing an adjustment based on a limited research data base. The credentials of the reviewers are impressive and their review comments and additional bibliography are worthwhile.

### *PROCEEDINGS OF THE SEVENTH INTERNATIONAL WROCLAW SYMPOSIUM ON EMC, JUNE 1984*

Organized by Wroclaw Technical Institute, Wroclaw, Poland. Copies available from the EMC Proceedings Editor, Technical University of Wroclaw, Wybrzeze Wyspainskego 27, 50-370 Wroclaw, Poland. In the USA, copies are available from EMXX Corp., 6706 Deland Drive, Springfield, VA. 22152, telephone (703) 451-4619 at a cost of \$30.00 for the two volumes.

The papers of the Wroclaw Symposium (EMC'84) are contained in two volumes. A total of 101 are presented: 56 in English, 45 in Russian. A feature of the presentation is the abstract that follows each paper. The abstract is in Russian if the paper is in English and in English if the paper is in Russian. In most cases, the abstract is very short (5-10 lines) although in a few cases it runs to a full page. It is to be regretted that so many papers are in Russian, since many of the abstracts indicate that the subject matter of the paper would be of interest to engineers in the Western World very few of whom can read Russian. To list just a few:

- One paper deals with forecasting reception quality in the mobile radio services.
- One paper deals with the design of cellular mobile radio systems.
- One paper deals with the use of spread spectrum techniques by mobile radio communication systems.
- One paper sets out parameters for digital transmission of TV systems.

Two keynote addresses were presented. Professor Stumpers of Netherlands discussed the work of URSI (International Union of Radio Science) in the EMC field and then spoke briefly about lightning in EMC and in particular about discharges to towers and buildings. Professor Seidler of the Polish Academy of Science presented an interesting paper describing a system for improving compatibility by incorporating subsystems to evaluate the state of the EM environment which he defines as getting current information about other users of the environment. The paper presents the fundamental relationships between the quality of performance of the communication system and the size of the state identification subsystem and cautions that the cost of subsystem rises rapidly with the sophistication thereof.

(Continued...)

The papers are divided into 20 sections (chapters) covering the entire gamut of EMC technology. In addition to covering subjects such as measurement, spectrum management, EM environment, antennas, etc., the Wroclaw Symposium presented subjects seldom highlighted in the EMC Symposia in the Western World. The subject of EMC in wire line communications is treated at some length in sessions sponsored by Study Group V of the CCITT. After a brief review of CCITT studies in this field, subsequent papers discuss the behaviour of voltage limiting components, the suppression of magnetically induced interfering voltages in four-wire and three-wire circuits, etc.

Another unusual section was devoted to EMC and the Radio Amateur Service which included a paper from New Zealand describing the procedures used in that country. Of particular interest were the two appendices: "A Code of Practice for Broadcast and Television Interference" — a pamphlet distributed by the New Zealand radio amateurs; and, "Radio Interference to Audio Devices" — a pamphlet published by the New Zealand Post Office.

It is not possible to discuss or even mention each paper individually and only a few of the English language papers are highlighted below.

Under measurements, a German paper addresses the difficulties being experienced when meaningful EMI tests are to be performed. This is of particular concern when testing equipment that can be operated in differing combinations, such as large computing systems.

An Italian paper describes a system for frequency assignments in broadcast networks using computers.

Some highly specialized studies are presented by Russian and Polish authors (papers in English) on the effect of RF energy on seedlings, the differences of biological effects of simple and combined fields, etc. This chapter also included a paper from Taiwan on the use of RF energy to treat bone fractures. The EMC problems in mobile communications are treated basically in Russian papers, three of which have already been mentioned.

A number of papers are presented dealing with immunity. One paper describes the West German regulations and their method of measuring immunity. A paper in Russian discusses the basic principles of immunity control in domestic frequency equipment in the band 20 Hz to 30 MHz. An Italian paper (in the last section — Late Papers) discusses the generation of EM fields for immunity testing and the associated problems.

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### **BIOLOGICAL EFFECTS OF ELECTROMAGNETIC RADIATION**

*Edited by John M. Osepchuk*

*Published by the IEEE Press*

*The IEEE Service Center*

*445 Hoes Lane, Piscataway, NJ 08854*

*608 pages, Copyright 1983*

*Member price \$47.95*

#### **INTRODUCTION**

This IEEE Press book is a collection of about 100 papers on the physical, biological, medical, health, and safety-standards aspects of RF/microwave biological effects. It consists of reprints of papers written by engineers, physicists, and medical and biological professionals. There are seven sections, each compiled by an associate editor who has written a short overview, with its own list of references covering significant papers not reprinted in the book. The book was prepared by some members of the IEEE Committee on Man and Radiation (COMAR). All of the associate editors were on the committee. While the title uses the term "electromagnetic radiation," this book only

considers the RF portion of the EM spectrum.

A critical point that is made in the foreword of the book is the fact that while the book has a publication date of 1983, almost all materials were incorporated in the text in 1979, so the articles in the book are somewhat dated. In this rapidly-changing field, a delay of five years can seriously affect the relevance of this kind of a book. An attempt was made to solve this problem by breaking the book into sections, and having each section's associate editor incorporate an updated summary/bibliography of the literature on that section's subtopic, emphasizing more recent developments. This was only partially effective, as will be mentioned later.

### Section I: QUANTITATION OF ELECTROMAGNETIC FIELDS IN BIOLOGICAL SYSTEMS by A. W. Guy

This section provides a good but somewhat incomplete coverage of RF/microwave dosimetry (measurement and theoretical prediction of fields inside biological bodies) via several "overview" papers, and several original works on theoretical and experimental dosimetry. The lack of authoritative overview papers on the important experimental tools for modern dosimetry weakens this section. These tools are the non-perturbing temperature probe, electric and magnetic field survey instruments, and the implantable E-field probe. While one short paper by Bowman is presented on the design of one particular temperature probe, the state of the art, as it now exists, is not covered adequately for any of these tools. Well-written overview papers such as those on thermometry (Cetas, *Med. Phys.* 5, 1978), on survey instruments (Aslan, *IEEE MTT-21*, 1972) and on implantable E-field probes (Bassen, *Radio Science* (6S) 1979), should have been included or at least cited in the section's summary/bibliography.

Persons interested in the state of the art of EM biological-effects measurements should read the comprehensive book from the National Council on Radiation Protection (NCRP Report 67, Washington, DC, 1981) on radiofrequency electromagnetic fields, properties, quantities and units, and biophysical interaction and measurements. This NCRP book can provide important contemporary material on the state of the art of EM bioeffects dosimetry.

### Section II: BIOPHYSICAL CHEMICAL BASIS OF RF FIELD INTERACTIONS by J. W. Frazer

This section covers the complex and interdisciplinary area of the biophysical interaction of RF energy with molecular, cellular, and biological micro-systems. Frazer concludes that most effects of RF and microwave radiation in biological systems seem adequately explained as a direct response to a temperature rise. This is a questionable conclusion in light of many recent findings and theories. In situations where the temperature dependence is carefully controlled, nonthermal, quantum-mechanical explanations are necessary, as in the work by Olcerst, quoted by Frazer. Persons interested in this subject should read the publication by Olcerst, et al. (*Radiation Research* 82, 2, 1980). Also, the excellent collection of papers on mechanisms of interaction entitled "Biological Effects of Nonionizing Radiation," edited by K. H. Illinger (American Chemical Society symposium series No. 157, Washington, DC, 1981) should be read by anyone

delving into this subject. It is surprising that in the review paper by Frazer, no mention is made of the Frohlich theory, nor is any of K. H. Illinger's work quoted. An interesting inclusion in this section is a collection of papers entitled "Summaries of Selected Papers from USSR Academy of Sciences." It represents a school of thought on RF bioeffects that believes effects are induced by levels of RF radiation that are considered insignificant by a majority of Western scientists in this field.

One important new area of RF biophysical interaction was not included in this section. Research on the basis of interactions of pulsed, extremely low frequency (ELF) magnetic fields and pulse-modulated RF fields with biological tissues has become a very active area in the past five years. Of key importance in this area is the concept of electro-chemical information transfer and the interference of electromagnetic fields with this process. Actually, the basic papers on this subject of Basset et al., Chiabrera et al., Pilla et al., span the period from late sixties to the present, and as such should have been cited. Those interested in this subject should read some or all of the following:

- Pilla A. A., *J. Biol. Physics* 11, 51, 1983
- Pilla A. A., *Advances in Chemistry Series* 188, 126, 1980
- Pilla A. A., in *Mechanism of Growth Control*, R. D. Becher ed., C. C. Thomas, Springfield
- Beltrame et al., *Alta Frequenza* 49, 101, 1980
- Bassett, C. A. et al., *Annals of the N.Y. Academy of Sciences* 238, (1974) (242-262).

### Section III: EFFECTS OF RADIO FIELDS ON THE CENTRAL NERVOUS SYSTEM AND BEHAVIOR by D. R. Justesen

The associate editor's overview of radiofrequency effects on the central nervous system and behavior is a well-written, concise presentation of most of the available information. Despite some obvious oversights, such as the lack of mention of microwave-drug interactions on behavior, this section's summary/bibliography covers most of the important topic areas and can serve as a starting point for those who wish to pursue specific areas more thoroughly.

The eight papers following this overview do not serve to fully represent the present state of the art on the central nervous system (CNS) and behavioral effects of RF. For example, two of the eight papers deal with the subject of the "microwave hearing effect." It should be noted that recently this

phenomenon has been shown to be associated with thermo-elastic pressure waves generated in the ear, and thus appears to represent a purely mechanical effect, rather than a direct CNS interaction, as was previously assumed. Another paper deals with dosimetric considerations in two RF exposure systems. While these latter three papers are interesting, one must question the wisdom of including many marginally-related papers in a section on central nervous system and behavioral effects. Because of the delay in the publication of this book, a significant portion of the CNS/behavioral papers presented in it were published in the early 1970's. Although such material may have served as a basis for subsequent work, today it is primarily of historical interest. It does not adequately represent the most current information in this critical area of research, nor does it reflect the current state of knowledge of the central nervous system and behavioral effects of RF.

#### Section IV: PATHOPHYSIOLOGIC ASPECTS OF MICROWAVE/RADIOFREQUENCY ENERGY EXPOSURE by S. M. Michaelson

This section deals with the harmful whole-body effects of RF energy. This is a vast area, so it is almost impossible to select a few papers and obtain an adequate collection. The brief introduction by S. M. Michaelson consists almost exclusively of caveats concerning the proper design and execution of experiments, and would apply to any area of biomedical research. One is left with the impression that very few, if any solid data on RF/MW bioeffects are available. This associate editor even states that in the appended bibliography, papers were included which "do not meet the criteria of sound scientific publications." It would be desirable for the associate editor to substantiate his opinion that "most of the experimental data support the concept that the effects of microwave exposure are primarily if not only, a response to hyperthermia or altered thermal gradients in the body." We noted that the conclusion of one of the reprints (Imig et al.) in this book is that in experiments on testicular degeneration "damage may result in part from factors other than heat." The important aspect of thermoregulatory responses is represented by a paper of peripheral vasodilation in the squirrel monkey by Adair, while the paper by Ely et al. has only historical interest. Recent papers by Way et al. (*Bioelectromagnetics* 2, 341, 1981) and Spiegel et al. (*Bioelectromagnetics* 1, 253, 1980) should be read for a more complete

coverage of this area. To fully appreciate the subject, the papers on cataracts in this section should be supplemented by reading the excellent review of microwave cataractogenesis by Cleary (*Proc. IEEE*, 68, 49, 1980). In conclusion, this section contains a collection of papers of mixed quality and relevance, which do not provide a coherent representation of the present state of knowledge on the pathophysiologic aspects of RF energy.

#### Section V: MEDICAL APPLICATIONS OF ELECTROMAGNETIC FIELDS by O. P. Gandhi

This section includes papers on the classical medical application of RF fields — diathermy (the therapeutic heating of the musculature, tendons, etc. for physical therapy), and papers on most of the new, important areas such as Nuclear Magnetic Resonance (NMR) imaging (which may soon challenge the most sophisticated, computerized X-ray imaging modalities such as Computerized Tomography (CT), and RF hyperthermia for the treatment of cancer. Most of the areas of medical applications of RF are discussed adequately, but the coverage of the rapidly changing field of cancer hyperthermia does not present a comprehensive overview of the state of the art of hyperthermia applicators. Those interested in the subject should read Kantor (*J. Microwave Power* 16 (2) 1981).

One significant flaw in this section is the lack of almost any mention of the subject of bone and wound healing that is induced through the application of strong, pulsed magnetic fields or pulse-modulated RF carrier signals. Recently a new technical society was formed (Biological Repair and Growth Society) to cover this area. Also, the book gives no indication that there has been a steady history of clinical practice in which Basset and others have been active for over 20 years. Many thousands of patients suffering from bone fractures that would not heal normally have been successfully treated by physicians with long-term, pulsed magnetic fields. In light of this, the Food and Drug Administration has recently approved one bone-healing device as being clinically safe and effective. Therefore, the lack of any mention of such interactions of EM fields with biological systems is a significant oversight in this and the other sections of the book. A reference to the papers by Basset et al. and Becker et al. (see section II) should have been made, and at least one reprint included in this section.

#### Section VI: SAFETY STANDARDS by J. M. Osepchuk

This section contains papers dealing with personnel exposure standards and guidelines, and the physical basis for such standards. A paper that covers the prevalent personnel exposure and product-emission standards in 1980 by S. Michaelson was included. It is brief and somewhat incomplete. We assume that this paper was included as an up-to-the-minute summary of the status of RF safety standards at the time of publication of the book (since it was reproduced directly from a typed and photocopied, rather than typeset, manuscript). Because of its "timeliness" it has a rough physical appearance and is difficult to read, with the tops of virtually each character clipped off. Papers on the occupational exposure of personnel, and standards for control of such exposures were not included in this book. A paper, such as one by Conover (Proc. IEEE 68(1), 1980) or other knowledgeable regulatory agency professionals should have been included in this section's summary/bibliography.

#### Section VII: INTERFERENCE EFFECTS: ELECTROMAGNETIC COMPATIBILITY OF CARDIAC PACEMAKERS by J. C. Mitchell

Electronic cardiac pacemakers are the only medical devices covered in this section on interference effects. Mr. Mitchell and his group at the U.S. Air Force School of Aerospace Medicine are world experts in the area of pacemaker interference. Although this paper represented the state of the art at the time of its publication, effects on the new generation of "programmable" pacemakers were not mentioned. These new devices actually contain radiofrequency receivers or other means to obtain instructions for their operational adjustment after implantation in the patient, and can be susceptible to certain kinds of RF interference. A shortcom-

ing of this section on RF interference in biomedical systems is the lack of any attempt to cover any other medical-device EM-interference problems, such as interference with critical, life-support and monitoring devices. The FDA's Bureau of Medical Devices (now part of CDRH) published a proposed final draft standard on electromagnetic compatibility for medical devices several years ago. This document (Medical Device Standard MDS 201 0004, 1979) should be read by anyone who is concerned with RF interference effects on medical electronics.

#### CONCLUSIONS

This book and its collection of papers provides relatively good, but somewhat outdated, coverage of the engineering and physical aspects of RF fields and their interaction with biological systems, plus the biomedical applications of electromagnetic fields. The coverage of the "biological" areas of this subject (the biophysical, pathological, and behavioral/central nervous system effects of EM fields) lacks a discussion of some of the most important scientific information on this subject, including the important area of pulsed-magnetic and RF field biological effects, their biophysical basis, and medical application to bone and wound healing. An overall view of this book is that it provides an extensive but incomplete set of references for this complex, controversial, and rapidly-changing field. Due to the changes that have occurred since this book went to press, it does not provide a complete overview of the present state of knowledge in this area.

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