Radio Frequency Radiation Dosimetry

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Series 3. High Technology – Vol. 82

Radio Frequency Radiation Dosimetry

and Its Relationship to the Biological Effects of Electromagnetic Fields

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Proceedings of the NATO Advanced Research Workshop on
Radio Frequency Radiation Dosimetry and Its Relationship to the Biological
Effects of Electromagnetic Fields
Gozd Martuljek, Slovenia
12-16 October 1998

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 978-0-7923-6405-4 ISBN 978-94-011-4191-8 (eBook)
DOI 10.1007/978-94-011-4191-8

Printed on acid-free paper

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PREFACE

The North Atlantic Treaty Organization (NATO) has sponsored research supporting development of personnel safety standards for exposure to Radio Frequency Radiation (RFR) for over a quarter century. NATO previously recognized that one of the most important tools used in the RFR effects research laboratory is accurate dosimetry when it supported a NATO Advanced Studies Institute (ASI) on *Advances in Biological Effects and Dosimetry of Low Energy Electromagnetic Fields* held in 1981, in Erice, Sicily. That meeting resulted in a NATO ASI publication; *Biological Effects and Dosimetry of Non-ionizing Radiation: Radio frequency and Microwave Energies*[1].

The most recent NATO sponsored program on RFR was an Advanced Research Workshop (ARW) on "Developing a New Standardization Agreement (STANAG) for Radio frequency Radiation" held May 1993, at the Pratica di Mare Italian Air Force Base, Pomezia (Rome) Italy. That ARW produced an ASI proceedings, published in 1995: *Radio frequency Radiation Standards, Biological Effects, Dosimetry, Epidemiology, and Public Health Policy*[2]. The Rome ARW and the Proceedings served as a springboard to the much needed revision of the NATO Standardization Agreement (STANAG) 2345 MED *"Evaluation and Control of Personnel Exposure to Radio Frequency Fields - 3 kHz to 300 GHz"*[3], which was subsequently promulgated in October 1998. One of the published recommendations developed by the Rome ARW was to hold this second ARW focusing on dosimetry and measurements.

The NATO Research and Technology Organization (R&T O) Human Factors and Medicine Panel-026, Task Group 002 "Health Effects of Non-ionizing Radiation in the Military Setting" in 1998 identified Dosimetry and Measurements as a high priority topic needing review and update. Additionally, the two NATO Military Agency for Standardization (MAS) Working Groups dealing with RFR personnel safety (General Medical WG and Radio and Radar Radiation Hazards WG) both endorsed the need for further review of RFR Dosimetry.

The most cited reference on dosimetry is the *Radio Frequency Radiation Dosimetry Handbook*[4-7]. The impetus for the *Handbook* was to bring together dosimetric data to guide researchers in dealing with the complex processes of absorption of RFR in biological tissue. The dosimetric data in the first *Handbook*[4], published in 1976, was limited to the frequency range 10 kHz to 1.5 GHz. The only data provided was for homogeneous spheroidal and ellipsoidal models. Subsequent editions expanded the frequency range and added data on absorption in models irradiated by plane-waves in free space and on or near ground planes. Empirical relations for calculating the rate of energy absorption, some rules of thumb, and data from the literature summarizing metabolic rates, dielectric constants, and conductivities were also included. The 3rd Edition[6] contained a section on dosimetric techniques, including qualitative near-field dosimetry. The 4th Edition[7] was published in October 1986 and updated much of these data to provide convenient access to the information contained in the previous editions. These *Handbooks* have been among the most cited references in scientific reports

concerning the biological effects of electromagnetic radiation, indicating their usefulness to the health effects community. There have been many advances in the state-of-knowledge since 1986, as researchers have begun to understand the complexities of tissue absorption of RFR. If biological effects of exposure are to be understood, accurate dosimetry is required in the assessment of exposure to this kind of radiation. New advances in theory, technology, and computation must now be applied to the development of a new edition of the *Handbook.*

The expansion of NATO provides new opportunities for collaborative research and information exchange. Harmonization and alignment of standards for safety are necessary within NATO to ensure interoperability during NATO exercises. Safety standards within NATO and worldwide should be based upon the same scientific data. However, significant differences are seen between the major standards. One of the probable factors for these differences is that the variability in research results upon which standards are based is frequently due to inconsistency in measurement and dosimetry. The output of a transmitter is usually easily established, and energy densities around it can be predicted and, in free field conditions, be measured with some precision. The introduction of animals and support equipment into the field perturbs it, so that measurements or calculations of energy density become very difficult. Power deposition levels within the whole animal and in small areas of the animal are required for meaningful bioeffects research. Until laboratories adopt more standard forms of animal exposure, methods of making density measurements, and reporting experimental results, comparison between different experiments will be impossible. Continuing work is needed on phantom and animal exposure studies aimed at measuring, and then predicting power deposition in individual organs. If dosimetry is not reliable and valid, then the data upon which standards are based should be questioned. A consensus needs to be obtained on a uniform/standardized dosimetry methodology.

The five day Slovenian ARW had four major objectives: (1) Provide an international forum to identify and discuss new technological advances in dosimetry and measurements (2) establish working groups to evaluate these advances; (3) develop a consensus on which advances should be applied to an update of the standard reference *Radiofrequency Radiation Dosimetry Handbook* (Ed 4)[7]; and (4) provide a foundation for a series of lectures to disseminate findings and train scientists. Papers were followed by round-table discussion sessions for comment on presentations and to develop consensus recommendations. The final day consisted of a specialized session of working groups to plan activities to begin revision of the *Radio Frequency Radiation Dosimetry Handbook.*

Our experience with international research and development programs designed to foster consensus on scientific issues has shown that inclusion and involvement are the critical to success. While a significant portion of expertise in the field of RFR research is found in the western world and is concentrated in military establishments, the expansion of NATO requires that experts worldwide be included. The exchange of ideas and information benefited all participants. The directors are especially grateful that scientists from Cooperation Partner and Partner for Peace countries were able to participate as key speakers, working group participants, or as observers. There is a need for international cooperation and a requirement for achieving commonality, compatibility, interchangeability, and interoperability within NATO.

In keeping with NATO objectives for ARWs, this working meeting was designed to assess the state-of-the-art in a given scientific area (RFR dosimetry) and to formulate recommendations for future. Several recommendations were issued by the ARW working groups and are attached as the Appendix. This ARW continues the NATO program goal to enhance security through scientific dialogue and to encourage peaceful exploitation of scientific skills and discoveries. We believe that the NATO Science Program objective of enhancing scientific and technological capabilities of Partner for Peace countries was fulfilled. We hope that this proceedings will stimulate interest and support coordinated research and development in RFR Dosimetry. This ARW proceedings is expected to be a valued resource for developing wider international consensus. No single nation can provide the overarching framework necessary. The consensus developed should be as multi-national as possible including Partner for Peace and other nations as well as NATO member nations. The International EMF Dosimetry Project first organized at this ARW is expected to bring a multinational effort to bear on this topic. We hope that this proceedings will stimulate this effort.

Directors and Editors

B. Jon Klauenberg, Damijan Miklavčič

Organizing Committee

Peter Gajsek, Paolo Vecchia, Stanislaw Szmigielski, Laszlo Szabo

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ACKNOWLEDGEMENTS

This NATO Advanced Research Workshop would not have been possible without the personal commitment and attention of numerous organizations and individuals. We are indebted to the following sponsoring organizations: NATO Scientific Affairs Division, High Technology Area; NATO Research and Technology Organization, United States Air Force Research Laboratory; United States Air Force Security Assistance Command; United States Air Force European Office of Aerospace Research and Development; the European BioElectromagnetics Association, the Bioelectromagnetics Society, Elletra 2000, Holaday Industries Inc., the University of Ljubljana and the Agricultural Institute of Slovenia. The support and participation of the following Republic of Slovenia Ministries is gratefully acknowledged: the Ministry of Science and Technology; the Ministry Foreign Affairs; the Ministry of Defense; the Institute of Public Health; the, Ministry of Health; and the Ministry of Environment . The beautiful facilities at the Hotel Spik, Gozd Martuljek, Slovenia, made the conference extremely pleasant and the long working days enjoyable. The directors and the participants of this ARW are deeply indebted to numerous individuals for their outstanding contributions that made the ARW such a success. Similarly, the contributions of the local arrangements committee headed by Peter Gajsek of the Institute of Public Health, and technical assistants Marko Puc, David Cukjati, Mojca Pavlin, and Natasa Kitak are greatly acknowledged. The social events and tours are memories of "The Slovene miracle" and "The Land of Green Tourism" that will be treasured. The meeting would not have occurred had not Ms Nancy Schulte, Program Director, High Technology Program given personal attention to our proposal. Her support was invaluable. Two individuals should be singled out for particular thanks for their untiring work before, during, and after the ARW. Ms Debra Jurek, Veridian, for her tireless efforts as executive secretary, ensuring all the many administrative details were accomplished smoothly, especially registration, travel, and accommodations arrangements. All in attendance will fondly remember her personal attention to each individuals needs. Ms Stephanie Miller, Radio Frequency Branch, USAF Research Laboratory, for cheerfully and diplomatically obtaining all the required paper work from the authors, reformatting and editing grammar and syntax of each paper (a gargantuan task) and "coaxing" the senior editor to finish his editorial tasks. Each of the session chairs provided valuable editing suggestions to the papers in their sessions and prepared a summary of the session. Lastly, the careful and scholarly efforts of each of the participants is recognized, appreciated, and clearly evidenced in the Proceedings.