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U. S. Department of Defense Limits for Human Exposure to RFR: An Approach to Standards Harmonization

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1. Introduction

The United States Department of Defense (DoD) is one of the world's largest developers and users of radio frequency radiation (RFR) emitting systems, with an estimated 8000 different types in the current inventory and new systems on the way[1]. Because of their heavy exploitation of RFR, the DoD and the U. S. military services have been studying and controlling the potential hazards of RFR exposure since shortly after World War II. To meet its requirements today, the DoD conducts extensive RFR bioeffects research (and supporting research in RFR measurement, dosimetry, and modeling), writes, adopts, and promulgates RFR human exposure standards, and implements procedures to assure compliance[2]. This paper focuses on DoD support of RFR human exposure standards.

Because RFR health and safety is important to all military services, RFR military research, standard setting, and compliance procedures have long been coordinated through a DoD chartered group named the "Tri-Service Electromagnetic Radiation Panel" (TERP). The TERP consists of three members each from the Army, Navy, and Air Force, with one member from each service representing the research, medical, and operational communities, plus one member from the U. S. Marine Corps.

The TERP reviews and coordinates all military activities relating to the development and use of RFR safety standards.

2. Research on RFR Bioeffects and Dosimetry

The most important activity in setting RFR safety standards is innovative bioeffects research, backed by accurate RFR dosimetry. The U.S. military services have been a significant contributor to the RFR bioeffects database since 1956, when the four year "Tri-Service Program" on RFR biological effects was started.[3,] More information on U.S. military research on RFR bioeffects and dosimetry may be obtained in the articles "Historical Perspective of the Dosimetry Handbook: Yesterday, Today, and Tomorrow" by John C. Mitchell[4] and "United States Air Force Support of Radio Frequency Radiation Health and Safety: Bioeffects, Dosimetry, and Safety Standards" by Michael. R. Murphy[2].

3. Writing Standards for Novel Military Systems or Applications

The research and involvement of the U.S. military services has long been important in the setting of scientifically based RFR exposure standards. The frequency independent $10mW/cm^2$ standard was initially established on the basis of the data obtained from Tri-Service Program[3] and the work at the Air Force School of Aerospace Medicine in the early 1970's led to the first frequency dependent standard in the U.S. in 1975[5]. In 1966, the U. S. Navy teamed with the Institute of Electrical and Electronic Engineers to publish the first edition of the C95.1 standard for RFR frequencies[6,7]. The military services developed the first exposure standards for pulsed RF fields, commonly used in radar, and for the electromagnetic pulse (EMP), associated with nuclear explosions or EMP simulators. Both of these standards were later transitioned to the ANSI/IEEE C95.1 standards series[7].

Today, when the requirements of the military services are military unique, the TERP develops an "interim guidance" for exposure limitations. Such was the case in 1995 when the TERP issued an "Interim Guidance for Exposure to Ultrawideband Radiation (UWB)".[8] This guidance and new research findings have been reviewed and re-endorsed by the TERP each year since. When sufficient data exist, the

UWB Interim Guidance will be transferred to the DoD Instruction on RFR Safety,[9] and when UWB exposures become more common in the civilian community, the military bioeffects data will be transitioned to the IEEE Standards Coordinating Committee 28 (SC28) for consideration.

4. Military Adoption of Non-Military, Consensus Standards

Except for cases of novel or military-unique systems, such as high power UWB systems, the DoD and the TERP prefer to adopt non-governmental, consensus standards rather than set original standards of their own. Through an Office of Management and Budget Directive (OMB-119)[10] and the National Technology Transfer Act of 1995[11], U. S. government employees are encouraged to participate in civilian and international non-governmental, consensus-based standard-setting bodies rather than draft government-specific standards. The military services, working through the TERP, are fully supporting this policy.

For most DoD RFR emitting systems, health and safety issues are addressed in a Department of Defense Instruction (DoDI 6055.11), "Protection of DoD Personnel from Exposure to Radio Frequency Radiation and Military Exempt Lasers,"[9] issued by the Undersecretary of Defense for Acquisition and Technology, on the recommendation of the Deputy Undersecretary of Defense for Environmental Security. This instruction is written by the TERP based on the exposure standard developed by the Institute of Electrical and Electronic Engineers (IEEE C95.1 - 1991)[8], an open, consensus standard. Individual military services promulgate the DoD Instruction in specific service publications, namely, the Army "Technical Bulletin, Control of Hazards to Health from Microwave and Radio Frequency Radiation and Ultrasound" (TBMED- 1980)[12], the "Navy Occupational Safety and Health Program Manual", Chapter 22 "Nonionizing Radiation"[13], the "Marine Corps Radiofrequency Electromagnetic Field Personnel Protection Program",[14] and the "Air Force Occupational Safety and Health Standard" (AFOSH) Std 48-9,[15] which are used by safety officers and field engineers in evaluating RFR health and safety conditions and ensuring compliance.

When new relevant health and safety data are developed for existing systems or unusual health issues arise, rather than issue military modifications or exemptions, it is the preference of the TERP to bring these issues to the IEEE Standards Coordinating Committee 28 for

consideration, consensus processing, and issuance as a supplement to the IEEE standard. This approach was recently used successfully to address an issue concerning the limits and averaging time for exposure to RFR-induced currents.[16]

5. Providing Service and Support to Other Standard Setting Bodies

Because of the many expert engineers and scientists employed by the U. S. military to investigate and control the potential hazards of RFR exposure, it is not unexpected that U. S. military employees, as independent professionals, would be involved in other standard setting bodies. Many DoD personnel provide service on the IEEE Standards Coordinating Committee 28 and its several subcommittees. Many DoD experts participate actively as RFR literature reviewers for scientific papers to be included in the next revision of ANSI/IEEE C95.1-1991. The U. S. Air Force also has contributed to developing a computer database for the RFR literature review. Two military employees, Dr Eleanor Adair (Air Force) and Dr John D'Andrea (Navy), serve on the RFR section of the National Council on Radiation Protection (NCRP) and one military employee, Dr David Sliney (Army), serves on the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

During the period 1993-1997, the TERP took the leadership in revising the NATO Standardization Agreement (STANAG) "Control and Evaluation of Personnel Exposure to Radio Frequency Fields - 3 kHz to 300 GHz"[17,18,19]. This agreement, STANAG 2345, is based on both the IEEE/ANSI C95.1 standard and DoDI 6055.11. As a consequence of the expertise and service provided during the revision of STANAG 2345, Dr B. Jon Klauenberg, of the U.S. Air Force Radio Frequency Radiation Branch, was designated Technical Representative to the NATO General Medical Working Group and liaison to the Radio and Radar Hazards Working Group.

6. Facilitating Harmonization of RFR Standards

For the DoD, standards harmonization begins with the three military services through the TERP, as described earlier. The TERP also coordinates with representatives from other U. S. government agencies

concerned with RFR health and safety in order to further the consistency of standards within the United States.

Because the U. S. military services operate globally and with many different national partners, harmonization of RFR exposure standards is a desirable international goal. This goal is furthered through increasing communication and providing service in support of standards harmonization. During the process of revising STANAG 2345, the U. S. Air Force co-organized a NATO Advanced Research Workshop titled "Developing a New Standardization Agreement (STANAG) for Radio Frequency Radiation", to which many Army, Navy, and Air Force scientists contributed, and which resulted in the publication of the most complete work yet on RFR standard setting.[20] The Air Force is now using the World Wide Web to increase RFR communication by making the RFR Dosimetry Handbook, 4th Edition,[21] Camila Gabriel's monograph on the dielectric proprieties of body tissues,[22] and other Air Force publications available internationally on the INTERNET.

Scientists in military RFR research programs and members of the TERP generally facilitate and support world-wide standards harmonization. In addition to international presentations by U. S. military RFR specialists at scientific meetings, the U. S. Air Force organizes a special RFR workshop at the Annual Meetings of the Bioelectromagnetics Society. The NATO Technical Representative to the General Medical Working Group, Dr B. Jon Klauenberg, and the Chair of the TERP, Dr Michael R. Murphy, both from the DoD research programs, participate actively in the International Advisory Committee of the World Health Organization Nine Year EMF program, which also pursues a goal of international RFR standards harmonization. Furthermore, the U. S. Air Force Research Laboratory contributes to the WHO EMF program as a Collaborating Center. The Air Force recently helped the WHO EMF program with the first concerted effort to promote standards harmonization between the Russian and the European/American standards setting communities and is arranging the translation into English of current Russian EMF standards.

7. Summary

The United States DoD has the need and obligation to evaluate the potential health and safety impact of human exposure to the emissions of the RFR systems that it develops and uses. The military services have

appropriate equipment, trained specialists, and well established procedures to measure RFR fields and assure that DoD personnel or nearby civilian populations are not overexposed to military RFR emitting systems; however, day-to-day practical RFR safety procedures rely greatly on the permissible exposure limits found in promulgated exposure standards. The effectiveness of protection against existing systems and controls on future systems, therefore depends on the validity and appropriateness of the standards being applied. The US DoD addresses the issue of RFR health and safety in a multifaceted approach, by conducting standards-oriented research on RFR dosimetry and bioeffects, writing military specific standards for novel emissions, adopting non-governmental, consensus standards whenever possible, providing service and support to national and international standard setting bodies, and facilitating the world harmonization of RFR standards.

8. Disclaimer

The opinions expressed in this paper are those of the author and should not be interpreted as an official position of the United States Air Force, Department of Defense, or Government.

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