Committee on Man and Radiation (COMAR): Update on 5G

Dan Hoolihan, EMC Society Liaison to COMAR

Introduction

The Committee on Man and Radiation (COMAR) is a technical committee of the IEEE Engineering in Medicine and Biology Society (EMBS) and has been part of that organization since 1997.

The EMC Society has had a liaison relationship with COMAR since its inception as an IEEE Committee in 1972.

Most recently, the individual in the EMC Society with a formal liaison status with COMAR has been Dan Hoolihan (actually since 1988)! Because of that relationship, the EMC Magazine occasionally publishes short articles on COMAR to inform our members of their latest activities.

Technical Information Statements

COMAR produces Technical Information Statements (TIS) on a periodic basis to reflect an accurate and objective perspective on Electromagnetic (EM) Fields and their impact on the human body. These are published, in general, after unverified reports of hazards to human health from electromagnetic energy, radio waves, and other non-ionizing electromagnetic sources surface in the popular press.

At the present time, COMAR is diligently working on developing a TIS on 5G wireless devices.

Non-Technical Audiences

Oftentimes, COMAR members and other electrical/EMC engineers are asked to talk about EM Fields and their effects on human beings. This is a difficult assignment because the technically-trained presenter must discuss the issues with people who, at best, may have a high-school physics course education or, worse (such as a ninth-grade general science background or less). To help the common person understand modern-day technology without inundating them with technical terms and descriptions is a major challenge for the technical spokesperson.

Bob Olsen

Bob Olsen, the EMC Magazine's Book Review editor, was asked to give a presentation to a local organization on 5G and its effects. He developed an introductory lecture for a general audience on the topic of 5G and Radio Frequency Safety Regulations. The slides for this talk can be requested by writing to Bob at bgolsen@wsu.edu.

One part of the lecture was a discussion of the origin of and rationale for these regulations as well as the expert committees behind them. An article that summarizes this part of the lecture follows this brief introduction to COMAR and health issues due to EM Fields. **EMC**

RF Safety Regulation Background Relevant to 5G

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Introduction and Purpose

Recently, there has been quite a bit of discussion about the safety of newer 5G wireless communication systems [1]. It is not uncommon to find articles that compare RF safety standards developed by different organizations and accept the validity of each without comment [2] or dismiss the validity of a given standard by claiming a conflict of interest [3]. Given this, it is reasonable to ask about the legitimacy of the standards setting process. In regulating human RF exposure, most countries in the world refer to standards generated by either the International Committee on Electromagnetic Safety (IEEE/ICES) and its Committee on Man and Radiation (COMAR) or the International Commission on Non-ionizing Radiation (ICNIRP). Hence, it is reasonable to discuss the processes by which these bodies arrive at their standards or guidelines for human exposure to RF electromagnetic fields. That is the purpose of this document. Prior to equating the validity of any alternative standard to those of COMAR or ICNIRP, a similar analysis of the alternative should be done. One example of such an analysis is presented in [4].

Standards, Guideline and Health Agency Committees

Committees involved in setting standards and guidelines for human exposure to radio frequency (RF) electromagnetic fields have certain characteristics. First, they consist of multiple individuals with recognized expertise spanning the range of scientific background necessary to evaluate multidisciplinary literature in the areas of bioelectromagnetics relevant to the proposed standard. The disciplines represented on the committee generally will include medicine, epidemiology, biology, biophysics, physics, risk assessment, risk communications, and engineering. Such expertise is necessary to evaluate literature in areas that include epidemiology and other human studies and animal, in-vitro, biophysical, dosimetric and engineering studies. Second, committee members will be charged to evaluate the entire body of relevant literature. In part to ensure that no relevant portion of the literature is omitted, committee members will have a balance of perspectives and be screened for conflict of interest. Third, the committee members will hold their discussions in well-advertised, open meetings and operate under established, publically available rules. A good discussion of how such scientific study committees should be formed can be found in a publication of the US National Academies entitled, "The National Academies Study Process, Ensuring Independent, Objective Advice [5]."

Evaluation of Studies

The body of bioelectromagnetics literature consists of more than 30,000 publications [6]. Further, it is well known that not all peer reviewed studies are of equal value. This has been well described by Foster who is quoted (with permission) at some length here [7]

"The studies vary widely in quality, biological endpoint, and relevance to health. The literature is filled with low-quality fishing expeditions in search of effects (as opposed to studies that tested hypotheses). Many of these studies were one-shot experiments that were not followed up or even repeated by the investigators themselves. Many studies have obvious technical flaws, typically poor dosimetry (determining how much exposure the preparation actually received in an experiment) or poor temperature control (heating is a necessary consequence of RF exposure and most biological reactions are sensitive to temperature). Many of the reported effects were small, close to the level of background variability and small compared to potential artifacts (and hence difficult to identify reliably), with no particular relevance to health. The literature suffers badly from publication bias - researchers are more likely to report having found an "effect" and less likely to publish no effect studies. As might be expected, the literature abounds with reports of "effects", many of which are simply artifacts from poorly conducted experiments.

At the opposite end of the quality spectrum are a number of well-done, massively funded studies that follow the lines of standard toxicological assays or epidemiology studies, which were designed to provide reliable evidence in assessing possible risks from extremely low frequency[1] (ELF) or RF fields. The results of these studies have been overwhelmingly negative, failing to document adverse (or any) effects of exposures at levels below current safety limits that are in effect throughout most of the world."

Given the variation of quality within the body of literature, the World Health Organization has published a set of guidelines for its assessment of the literature in order to identify the health risks of electromagnetic fields [8]. They state

"All studies, with either positive or negative effects, need to be evaluated and judged on their own merit, and then all together in a weight-of-evidence approach. It is important to determine how much a set of evidence changes the probability that exposure causes an outcome. Generally, studies must be replicated or be in agreement with similar studies. The evidence for an effect is further strengthened if the results from different types of studies (epidemiology or laboratory) point to the same conclusion".

Rationale for the Existing Standards and Guidelines

The most important RF exposure standards or guideline setting committees are the IEEE International Committee on Electromagnetic Safety (IEEE/ICES) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [9, 10]. Both of these committees are constituted and operate according to the principles outlined earlier in this section [5].

Some concern has been expressed about whether these committees are independent of the industry to which the standards apply. In response, it can be noted that the 128 member IEEE/ICES committee that developed the 2019 revision to the standard (i.e., IEEE C95.1-2019) represented a very broad range of expertise, including physicians, basic scientists, and engineers. Further, only a minority (16.4%) of its members were from industry while the largest group was from academia. More information about the specific processes followed by the IEEE/ICES can be found in [11]. Similarly, the present Science Expert Group of ICNIRP has 28 members, of which 16 are academics, 11 are from government laboratories and one from a (non-5G) industry. Each of these has filed a conflict of interest statement that can be found at the ICNIRP website.

The first task of each committee was to identify well documented, adverse health effects caused by exposure to RF electromagnetic fields and the dosimetric and related exposure conditions under which these effects occur. These effects and the conditions that cause them form the basis of for the proposed standards or guidelines. More specifically, each committee found that these well-documented, adverse health effects can be related to thermal heating of human tissue. Hence, the "dosimetric reference limit" (sometimes called the "basic restriction") set by each committee is related to absorbed power in the body, which can be related to temperature rise. This limit is given in terms of the specific absorption rate (SAR) defined as power (in watts) absorbed per kilogram of body

[1] The definition of ELF added for completeness.

mass since this can be related to temperature rise. The standards/guidelines then define an electromagnetic field exposure level called the "exposure reference level" (previously the "maximum permissible exposure") by the IEEE or 'reference level" by ICNIRP which ensures that the dosimetric reference limit is not exceeded. This level is convenient to measure because it is measured in the absence of a human body. In all cases, safety (or reduction) factors are set between the threshold at which these effects occur and the exposure standards. These factors are different for individuals who have received training and are aware of their exposure and the general public. In the former case, the safety factor is 10, while for the general public it is 50.

Worldwide, most government RF exposure limits are based on guidance developed by these two groups. In order that recent research be considered, both sets of limits are periodically reviewed. More specifically, both sets of limits were revised and updated in 2019 [12, 13]. It is noteworthy that changes from the previous versions of these standards/guidelines were minimal. Further, over the frequency range occupied by 5G systems, the standards/guidelines developed by both groups are in agreement.

Given some concern about whether non-thermal effects have been considered in setting their 2019 guidelines, ICNIRP has stated [10]

> *"Acute and long-term effects of HF exposure below the thermal threshold have been studied extensively without showing any conclusive evidence of adverse health effects.*
>
> *A considerable amount of research has been conducted on the relationship between HF fields and health outcomes such as headaches, concentration difficulty, sleep quality, cognitive function, cardiovascular effects, etc. This research to date has not shown any such health effects. The only consistently observed finding is a small effect on brain activity measured by electroencephalography (EEG). The biological implication of these small changes is, however, unclear. For example, they have not been shown to affect sleep quality or be associated with any other adverse effects."*

A similar statement about the IEEE/ICES position on this can be found in [11]. This specific statement is reproduced here as

> *"Some investigators have reported effects at much lower exposure levels, which are sometimes called "nonthermal" effects. Each version of the IEEE standard has acknowledged the existence of such reports, while at the same time indicating that they were insufficient to be considered a health hazard or to be used as a basis to develop exposure guidelines. For example, the 1991 standard states that "research on the effects of chronic exposure and speculations on the biological significance of nonthermal interactions have not yet resulted in any meaningful basis for alteration of the standard. It remains to be seen what future research may produce for consideration at the time of the next revision of this standard". Other organizations have independently reached this same conclusion."*

In the United States, the Federal Communications Commission (FCC) has adopted the IEEE/ICES standards with the following statement [14],

> *"The FCC guidelines for human exposure to RF electromagnetic fields were derived from the recommendations of two expert organizations, the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE). Both the NCRP exposure criteria and the IEEE standard were developed by expert scientists and engineers after extensive reviews of the scientific literature related to RF biological effects. The exposure guidelines are based on thresholds for known adverse effects, and they incorporate prudent margins of safety. In adopting the current RF exposure guidelines, the FCC consulted with the EPA, FDA, OSHA and NIOSH, and obtained their support for the guidelines that the FCC is using."*

The 2019 versions of the IEEE and ICNIRP whole body exposure limits for the general public at frequencies relevant to 5G are listed below in Table I [12, 13]. It is clear that these are identical. A specific reference to the FCC standards can be found at [15].

Table I. Whole Body RF Exposure Limits for the General Public[2] in ICNIRP and IEEE

	Frequency Range	Incident Power Density	Averaging Time
IEEE C95.1 (2019)	2-300 GHz	10 W/m2	30 minutes
ICNIRP (2019)	2-300 GHz	10 W/m2	30 minutes

References

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[2] Limits for trained workers in restricted environments are a factor of 5 higher.

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