

Exposure Limits for Radiofrequency Energy: Three Models

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Introduction

This Conference is entitled “Criteria for EMF Standards Harmonization”. Harmonization, used in the present context, is the process of reducing the large discrepancies in EMF exposure standards that are in effect throughout the world.

For many years, these differences were most apparent between limits of Russia and most of Eastern Europe (which originated in the days of the Soviet Union and the Warsaw Pact) and those of the United States and West Europe. This situation has become even more complicated with the recent adoption of “precautionary” limits by Switzerland, Italy, and a few other countries. Behind these differences are large differences in perception of science and health protection.

Before any “harmonization” can succeed, it is necessary first to understand the differences among these approaches. I focus on exposure guidelines to radiofrequency (RF) energy in the range around 1-2 GHz, which is used by mobile telephones (and a host of other applications).

Science-Based vs. Precautionary Limits

The Table below compares five different exposure limits for RF energy at 2000 MHz (similar to that used by many cellular telephones throughout the world). The limits are for long-term exposure to the general population.

Country	Limit for general public exposure to RF fields (2000 MHz) for extended periods of exposure, W/m ² (applies to far-field exposure, extended duration)	Basis
ICNIRP (adopted in numerous countries worldwide)	10	Science-based
U.S. Federal Communications Commission (FCC) Bulletin 65, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, Washington DC 1997. Generally follows IEEE C95.1-1999 with some modifications	10	Science-based
China	0.1	Science-based

Russia	0.1	Science-based
Sanitary Norms and Regulations 2.2.4/2.1.8.055-96		
Switzerland	0.1	Precautionary
Ordinance on Protection from Non-ionising Radiation (NISV) of 23 December 1999		
Typical Maximum Exposure from Cellular Base Station Mounted on 50 m tower (assuming a total effective radiated power of 2500 watts in each sector, summed over all channels)	0.01	

Limits in the United States, most Western European countries, and many countries in other parts of the world follow IEEE C95.1-1999¹ or the (quite similar) ICNIRP limits.² Those in the Russian Federation, (together with most of its former Warsaw Pact allies), China, Switzerland, and a few other countries are as much as a hundred times lower. I identify these limits as “science-based” and “precautionary”, reflecting major differences in philosophy and approach.

Science-based limits are based on expert evaluation of the scientific literature to identify potential adverse effects of exposure. The resulting limits are designed to exclude identified hazards with an appropriate margin of safety. I have identified three of the limits in the Table as science-based, in this sense.

- US and most Western European limits (IEEE C95.1-1999 and ICNIRP). The rationale for these limits has been spelled out at length in the documentation accompanying the standards. These limits were based on an extensive review of the scientific literature to identify potentially hazardous effects and their thresholds. For example, in designing IEEE C95.1, “the most sensitive measures of potentially harmful biological effects were based on the disruption of ongoing behavior associated with an increase of body temperature in the presence of electromagnetic fields.” Because of the “paucity of reliable data on chronic exposures”, most of the literature concerned short-term (hours or less) exposure to RF energy. The hazards that are identified in the documentation are, for the most part, thermal in nature. The “averaging times” in the limits are short (6 to 20 minutes) and reflect thermal considerations.³
- Russian, Chinese, and most East European limits The Table shows a major Russian limit (Sanitary Norms and Regulations 2.2.4/2.1.8.055-96). The rationale for these limits is not described in the standard itself.¹ There is, however, a considerable body of commentary about the Russian and Eastern European standards by scientists who have been professionally involved in RF health and safety studies, including some by Russian and East European scientists (e.g. ^{4 5 6 7 8 9}).

¹ I thank Dr. A.G. Pakhomov for providing an English translation of the present Russian standard (SanPin 2.2.4/2.1.8.055-96).

The Russian (and several Eastern European) limits are clearly not designed principally to protect against thermal hazards. Their limits are far below thermally significant levels. More strikingly (from the perspective of Western limits) they embody the concept of dose, i.e. the incident power density multiplied by time, in a way that is unrelated to any conceivable thermal hazard. One Russian authority indicated that the limits of the Russian Federation for RF exposure at the frequencies used by wireless communications were set on the basis of biological experiments that found that a 3-hr daily exposure at $250 \mu\text{W}/\text{cm}^2$ (950 MHz) could be regarded as a threshold for harmful physiological effects in experimental animals.¹⁰

Thus, Russian (and Eastern European) limits clearly reflect the conviction that long-term (hours or more) exposures at levels far below Western limits result in adverse health effects. Indeed, the Russian and Eastern European medical literature contains many reports of health effects from low-level exposure to RF energy. These include, for example, nonspecific problems (such as headaches, fatigability, irritability, sleep disorders, and dizziness) in workers in radio factories, who are exposed to RF energy at undetermined levels^{11 12}. The Chinese literature contains similar reports.¹³ The Russian literature contains references to a “microwave disease” characterized by “asthenic, asthenovegetative, and hypothalamic syndromes”¹⁴ The disease is not recognized in Western medicine, and its diagnostic criteria would undoubtedly strike many Western physicians as vague and nonfalsifiable. Even some Eastern European physicians have complained about the nonspecificity of these criteria as well.^{15 16}

The large difference, between Russian and Eastern European exposure limits and those in the U.S. and most of Western Europe, is of longstanding duration. The latest Russian exposure standards (1996, 1997) are essentially identical to previous ones (1976, 1978, 1984). While IEEE C95.1 has evolved over the years, this has largely been a result of engineering calculations and a desire to provide a higher level of protection to nonoccupational groups, and not as a result of changes in the scientific understanding of the hazards involved.

Precautionary limits. Recently, Italy, Switzerland, and a few other countries have instituted exposure limits that are based on a totally different approach, the precautionary measures. Unlike science-based standards such as IEEE C95.1-1999, the ICNIRP limits, or the Russian limits (which are designed to avoid identified hazards), the Swiss limits were, in the words of the explanatory document accompanying the limits, “specifically intended to minimise the yet unknown risks” of RF and power-frequency electromagnetic fields.

The Swiss exposure guidelines were set at the lowest levels that were felt to be technically and economically feasible. In practice, that meant reducing the ICNIRP limits by a factor of 10 (in field strength) or 100 (in power density). (The law, however, is quite complex, with distinctions between “immissions” and “emissions”, identification of places of sensitive use, new and old installations, etc. The limits in the table above would apply to most residential areas and near schools and hospitals.)

The Swiss law appears to result, at least in part, from concerns of the public about the safety of mobile telephone base stations. Its limits are somewhat above the levels of RF energy exposure from typical base stations mounted on towers at conventional heights, but might exclude base stations mounted at lower elevations on buildings (not to mention many broadcast facilities, airport radars, and other high-powered transmitters). The Swiss limits do not apply to wireless handsets, or to medical or industrial exposures – all potential sources of far exposures than wireless base stations.

“Harmonization” – Can It Be Done?

“Harmonizing” RF exposure limits has long been a perceived need among standards setting committees, and is one major goal of the World Health Organization’s EMF Project. Such harmonization would help meet a variety of needs. It addresses the desire of the World Health Organization to provide a consistent level of health protection to different people around the world (WHO). It would also minimize some practical problems in implementing the limit. Not least, bringing exposure limits around the world into line would help reduce some of the political controversy connected with RF fields.

However, given the very large differences in different national guidelines, “harmonization” will be a difficult task – if it can be accomplished at all. At least two separate issues can be identified:

1. Harmonization of Science-Based Limits.

The most longstanding and best documented issue related to “harmonization” is the large difference between the groups of exposure limits of the West (such as ICNIRP and IEEE C95.1-1999) and those of the Russian Federation and Eastern Europe. The comments below are offered from a Western perspective.

Evaluating the Russian and East European scientific literature in this field has posed great problems for Western scientists, for at least two reasons apart from the obvious language issue.

One problem is the brevity of the descriptions of many reports of the studies. The research reports often lack crucial information such as the frequency and intensity of exposure, SAR, or descriptions of aspects of experimental design that would be needed to ensure the validity of the findings. Western health agencies and standards setting bodies generally consider only studies that meet minimum standards of reporting and methodology. For example, IEEE C95.1-1999 says that “only peer-reviewed reports of studies at SAR = 10 W/kg, which had received favorable engineering and biological validation, should be considered relevant to the assessment of risk from exposure to electromagnetic fields.” Thus, whatever the quality of the original studies may have been, many Russian and Eastern European studies would be excluded from consideration in the Western risk assessment process by virtue of inadequate documentation.

But also, many of the Russian and Eastern European studies appear to suffer from serious flaws and for that reason would carry little weight in the Western risk assessment process. For example, many of the Russian occupational health studies involving EMF are little more than case reports, as opposed to well-controlled studies that tested specific hypotheses. Many more suffer from extensive use of post hoc data analysis. That is, the investigators applied large batteries of tests to their subjects, and assumed that any variation in the results between the “exposed” and “control” individuals was a direct effect of RF exposure. (That may or not may be the case, depending on a host of considerations.) Of course, many Western studies contain similar flaws, and also have carried little weight in standards setting processes. But the combination of uncertain quality, together with inadequate reporting, is an impossible barrier.

Finally, many of the Russian and East European studies employ concepts that are unusual in Western medicine. For example, Vasilevskii et al¹¹ conclude, on the basis of EEG (electroencephalogram) and other tests, that workers exhaust the “functional reserves” of their central nervous system after 14 years of work with microwaves and other electromagnetic fields. The document that promulgates the Russian standard lists asthenic, astheno-vegetative, and hypothalamic syndromes as “clinical disorders resulting

from EMR [electromagnetic radiation] RF exposure”.¹⁷ Most Western health agencies would undoubtedly consider a “temporary disturbance in the homeostasis” of an individual to be vague and unquantifiable, and the criteria that have been used to diagnose it (eg. subtle changes in heart rate variability or EEG) to be nonspecific and having no clear health significance. But such concepts are familiar in Russian medicine, and the Russian and Eastern European literature on health effects of RF energy abounds with such concepts. Such differences stem in part from very different views about health and medicine.

Clearly, “harmonizing” Russian and US limits (for example) will be far more than a technocratic exercise. The differences between these science-based standards involve different medical traditions with different concepts of health and disease, and different standards of proof.

One useful first step would for different standards groups to sit down and decide on a uniform set of criteria for accepting scientific reports (publication in peer reviewed journals, appropriate exposure assessment, blinded study design, etc.), and then evaluate specific reports for inclusion or exclusion from consideration. Achieving convergence even in this preliminary step would be a worthwhile accomplishment.

A second useful step would be to identify Russian (and Chinese and other) studies that scientists involved with national standards setting process regard as demonstrating health effects of RF energy. These studies (which might be unpersuasive to Western risk assessors) should then be followed up by stronger studies with appropriate design and standards of reporting. Followup studies with superior design would be needed for any study, wherever in the world it was conducted, that suggested the existence of health hazards. Such studies, in the case of Russia, would probably have to be funded by Western health agencies, but should meet internationally accepted standards of design and reporting. Everybody would benefit from such studies.

Even more difficult will be reconciling “precautionary” limits in Switzerland and other countries, with science-based limits. The precautionary principle is well established in international law and enjoys widespread political support. However, it remains elusive in meaning and easily misused.¹⁸ . And by their very nature, precautionary policies are set in the absence of scientific knowledge, not on the basis of such knowledge.

In a “Backgrounder” on the precautionary principle¹⁹, the World Health Organization recommended that precautionary policies “be adopted only under the condition that scientific assessments of risk and science-based exposure limits should not be undermined by the adoption of arbitrary cautionary approaches. That would occur, for example, if limit values were lowered to levels that bear no relationship to the established hazards or have inappropriate arbitrary adjustments to the limit values to account for the extent of scientific uncertainty.”

WHO noted that a variety of “precautionary” approaches (such as improved risk communication) can be taken to EMF regulation, apart from setting mandatory limits. WHO also noted that some European “precautionary” policies about EMF field regulation would seem to be inconsistent with recent commentary by the European Commission on the proper use of the principle.²⁰

In the end, harmonization may come about from political and economic pressures rather than from scientific data. Recently, the Czech Republic revised its limits upwards, to those of ICNIRP, as part of the process of integration into the European Union. Other Eastern European nations, in their bids to join the EU, are considering similar changes.

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