WHO/SDE/OEH 99.4
Original: English
Distr. Limited

COVER PAGE

Inaugural Round Table on World EMF Standards Harmonization
Minutes of Meeting, 18 November 1998
University of Zagreb, Zagreb, Croatia

Occupational and Environmental Health
Protection of the Human Environment
Sustainable Development and Healthy Environments
World Health Organization, Geneva, 1999

MINUTES:

WHO Round Table on Harmonization of World Standards for EMF Exposure
University of Zagreb, Zagreb, Croatia, 18 November 1998

Introduction

The International EMF Project was established by WHO in 1996 in order to address concerns about possible health effects from EMFs. It is collaborating with the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the International Agency for Research on Cancer (IARC), the International Electrotechnical Commission (IEC), the International Labour Office (ILO), the International Telecommunications Union (ITU), the United Nations Environment Programme (UNEP), the North Atlantic Treaty Organization (NATO), the European Commission (EC), over 40 governmental agencies and the following WHO Collaborating Centres: the National Radiological Protection Board, UK; the Bundesamt für Strahelnschutz, Germany; the Karolinska Institute, Institute of Environmental Medicine, Sweden; the Food and Drug Administration, USA; the National Institute of Environmental Health Sciences, USA; the National Institute of Occupational Safety and Health, USA; and the National Institute for Environment studies, Japan.

The International EMF Project is assessing health effects of exposure to static and time varying electric and magnetic fields in the frequency range 0 - 300 GHz. This range is divided into: static (0 Hz), extremely low frequency (ELF > 0 - 300 Hz), intermediate frequency (300 Hz - 10 kHz) and radiofreqquency (10 kHz - 300 GHz) fields. The Project was established to:

a) provide a co-ordinated international response to the concerns about possible health effects of exposure to EMF,
b) assess the scientific literature and make status reports on health effects,
c) identify gaps in knowledge needing further research to make better health risk assessments,
d) encourage a focused research programme to fill important gaps in knowledge,
e) incorporate research results into WHO Environmental Health Criteria monographs, in which formal health risk assessments of exposure to EMF will be made,
f) provide information on risk perception, risk communication and risk management as they apply to EMF,
g) provide advice and publications to national authorities on EMF issues, and
h) facilitate the development of internationally acceptable standards for EMF exposure.

It had become evident that since the late 1950s and early 1960s when the first standards and guidelines began to be discussed there has developed an increasing variety in the approaches taken by various national and international authorities and agencies to the drafting of standards and guidelines. In order to facilitate the harmonization of EMF standards, the International EMF Project initiated this activity at its inaugural meeting in Zagreb. At this first meeting, the purpose was to assess points of similarity and difference and identify steps to be taken to resolve any apparent or substantive differences.

Opening

The meeting was called to order by Dr MH Repacholi at 1500 h. After greeting participants, he reported briefly on the press conference that had been held at 1200 h to launch the WHO effort to harmonize EMF (Electric and Magnetic or Electromagnetic Field) exposure standards world wide (see Appendix "A").

Dr Repacholi expressed his intention to maintain a relatively informal atmosphere during the meeting to ensure there would be ample opportunity for discussion and feedback. These he considered essential to the successful completion of harmonization efforts.

The basic goal of the present and future meetings is to facilitate the working together of various national and international agencies charged with formulating standards for EMF exposure to establish a framework for world wide harmonization. WHO does not set standards. Standards development is the responsibility of national authorities, or national and international standards-setting institutions. The International EMF Project has over 45 national authorities and 8 international involved in its activities. With such a large base of committed authorities, the EMF Project has a unique opportunity for providing a framework for establishing overall EMF standards harmonization world-wide.

Appendix "B" provides a summary of standards or guidelines current within each country's or agency's jurisdiction. In establishing the framework for harmonization of EMF standards, numerous questions will have to be addressed. For example:

- What criteria should be used to evaluate research results?
- What should be the detailed requirements for a scientific rationale to support limits?
- What is the best model for developing standards? Methods for determining compliance should not be overlooked.
- What is to be made of isolated data points at specific frequencies?
- How and with what degree of confidence can results be extrapolated to other frequencies or intensities?
- How should similar concerns about the applicability and extrapolation of animal or cellular studies to humans be dealt with?
- Should one standard cover the whole frequency range from 0 to 300 GHz?
- What about safety factors? Do they or should they address scientific uncertainties in the fundamental research or imprecisions in the techniques used for exposure assessment? Should they also allow for gaps in knowledge?
- Should standards be one or two tiered - i.e. differentiate between occupational or controlled exposure and general population or uncontrolled exposure?
- What account should standards take of social and economic impacts?

Dr Repacholi opened the floor to brief presentations by each of the national and agency representatives.

1. Dr David Black indicated that New Zealand and Australia had harmonized their approach to EMF exposure standards some time ago. New Zealand had adopted, in 1985, the standards established in Australia in 1975. Subsequently a two part draft had been discussed based on the guidelines promulgated by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) but which deviated from them at the high frequency end of the range. The most recent draft, of less than a month ago, is intended to follow the ICNIRP Guidelines as closely as possible adopting the spatial averaging, reference levels and look up tables, for example, but recognizing that there is a mandatory requirement that a 'cautionary' principle be incorporated. After discussions, both ALARA and 'prudent avoidance' had been found wanting and had been supplanted by a 'precautionary' principle.

In response to a query about the differences between the 'precautionary principle' and 'prudent avoidance' or ALARA, Dr Black noted that ALARA could not be applied consistently without running into conflict with its application in the context of ionizing radiation. On the other hand, 'prudent avoidance' had been found to be too loosely defined and widely misunderstood and misused to be useful. The 'precautionary principle' was similar to 'prudent avoidance' but incorporated a distinct cost element.

In further discussion about how the high frequency range was to be treated it became apparent that there was still some discussion of whether or not to follow the ICNIRP guideline to be expected before the latest draft would finally be accepted.

2. Dr John Leonowich followed with information about standards activities of the IEEE (Institute of Electrical and Electronic Engineers). The Standards Co-ordinating Committee, C28, had held a meeting recently in San Antonio, Texas where its Chairman, Dr John Osepchuk, had underscored the international nature of the IEEE by virtue of its extensive international membership base. The C95.1 Committee is actively pursuing its updating programme and is currently about 1/3 the way through reviewing the current literature. It is anticipated that a new draft will be available by the end of 1998. The C95.2 Committee's work on warning signs has been completed and the corresponding standard is to be published early in 1999. A supplement on induced currents is also due early in 1999. Future activities are expected to focus on questions associated with tiering the standard, clarifying spatial averaging and elaborating the concept of contact current.

Dr Allen (NRPB) noted that despite its claim of being international by virtue of its having members in countries around the world, IEEE did not appear to be accepted outside the US or mandated even within the US Dr Leonowich noted that first, the ANSI/IEEE standard had been adopted by the US DoD and is thereby mandatory among the armed services. Second, the US FCC is required to follow some parts. And third, the occupational exposure guidelines embodied in the TLVs of the ACGIH were derived from the ANSI/IEEE standard. However, in the end, there is not actually a mandated standard over all of the US

Dr Cleveland from the US Federal Communications Commission (FCC) added further clarification noting that the FCC is the licensing authority for RF devices exclusive of federal sources. The FCC also takes into account the non-occupational impact of the sources and exposures associated with them. They have adopted the recommendations of the National Council on Radiation Protection and Measurements (NCRP) which, in part, are similar to the

ANSI/IEEE standard and also takes into account SAR limits which for practical applications are defined in terms of electric field strength, magnetic field strength or power density, as appropriate. It was noted that extensive information was widely available on their web site and that technical publications for determining compliance have been issued with supplements containing further details related to broadcasting, amateur and mobile radio applications.

3. Dr James Lin spoke on the subject of the NCRP Standard and as Chairman of its Scientific Committee 8-95. He noted that the NCRP is a non-profit corporation chartered by the US Congress in the mid-1960s. Members and participants in NCRP activities work in subgroups of experts but finally all reports have to be approved by the full membership (currently over 100 members and 70 organizations) of the council. NCRP Report 86 published in the mid-1980s for the first time recognized dosimetric methods. It saw the adoption of SA and SAR, included the first two-tier system incorporating a factor of 5 reduction for exposures to members of the public and time averaging recommendations. The ongoing work of Scientific Committee 8-95 had started in 1995 and was still in progress. Among items under review was exposure assessment, particularly related to the eye, the ear, epidemiological studies and medical applications. There was a considerable amount of scientific work on DNA and gene expression, cancer induction and promotion, amplitude, power, or frequency windows, and modulated fields.

In response to a question about the basis for standards in the US and the degree of co-operation between NCRP, ANSI/IEEE and ACGIH, Dr Lin noted that NCRP assembled the basic database from which recommendations were derived by NCRP to assist other US standards setting organizations in establishing their limits.

4. Dr Jürgen Bernhardt, speaking on behalf of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), noted that their recommendations had been published in the April 1998 issue of *Health Physics.* There, a risk assessment had also been carried out, not taking into account social or economic considerations. Such considerations are the responsibility of national governments. The guidelines were based on health risk assessments published in WHO Environmental Health Criteria documents and more recent studies. The guidelines incorporate safety factors varying from about 2 to more than 10, depending on frequency, and flexibility to cover many exposure situations. For practical application of the guidelines, reference levels were provided to determine compliance with the basic restrictions. While recent work may indicate problems associated with near fields or inhomogeneous fields, it is not anticipated that there will be any revision for some 5 to 6 years, probably not until after the conclusion of the WHO EMF Project's health risk assessments.

When asked whether the reference levels were to be used as limits, Dr Bernhardt noted that the reference levels MAY be used for most situations but the basic restrictions may need to be applied to deal with certain specific situations such as cell phones.

It was noted from the floor that the literature suggests cell phones are very near to producing exposures exceeding recommended limits. Consequently, should ICNIRP not be considering an update sooner than in 5 to 6 years? Dr Bernhardt responded that no part of the head was subject to temperature rises in excess of 0.1 or 0.2 C. Further, there is no scientific evidence of other effects not associated with temperature rises. Consequently, there is no need to rush the current review process.

In response to a query as to whether there was any difference between the reference level and investigation level [basic restriction], Dr Bernhardt noted they were effectively the same, except that the reference levels applied to worst case exposure situations and so exceeding the reference level did not necessarily mean that the basic restriction was exceeded.

5. Dr Jon Klauenberg reviewed the standards activities within NATO over the past 20 years. During the past 6 years there had been a great deal of work toward harmonization which had culminated on 13 October 1997 with the promulgation of STANAG 2345 which is the NATO RFR personnel protection guideline. A new edition has the status of a MINIMAL safety standard, meaning any participating nation may have stricter guidelines. The group is looking into new means of incorporating contact currents into the standards and investigating issues of compatibility to allow for operations across international boundaries.

In the context of US federal agencies, Dr Klauenberg noted that the agencies are required to follow newly established Public Law 104-113 known as the National Technology Transfer and Advancement Act of 1995 (NTTAA - 1995). The Office of Management and Budget (OMB) revised its guidance on federal agency standardization practices to emphasize the NTTAA - 1995 requirement that non-governmental consensus standards be used wherever possible. The OMB - A119 also requires that cost/benefit, all stakeholder interests, due process, appeals process and an oversight mechanism all be given due consideration. The National Telecommunications and Information Administration (NTIA) has formed a Working Group, Ad Hoc 189, to revise the RADHAZ section of the NTIA Handbook. While consideration is being given to the FCC guidelines, it probably will not be the only guidance adopted. It is anticipated that several standards/guidances will be adopted by reference.

6. Dr Barnabas Kunsch representing CENELEC noted that it consists of 19 European countries working together to develop standards. Its Technical Committee on Human Exposures to EMFs, CLC/TC 211 has been assigned the task of harmonizing "existing" national standards in Europe. He pointed out that "short-term" in the title does not represent a restriction but rather that the standards are not established as "long-term." There is no overall European standard as yet. It is still in process and is presently in the form of a Pre-Standard with a 2-tier structure addressing occupational and public exposure situations and distinguishing between reference levels and limits. Dr Kunsch presented several tabular comparisons between ICNIRP, IEEE and the CENELEC Pre-Standard. He also noted that the role of CENELEC is being questioned by some countries - notably Denmark and some others which are considering whether standards should be directed at controlling emissions rather than exposures.

Asked whether CENELEC would adopt the ICNIRP Guidelines, Dr Kunsch stated that there is a position indicating that it will.

It was also noted that CENELEC showed some minor differences between the levels for 50/60 Hz fields and it was questioned why there should be any differences, considering that there could hardly be any anticipated differences in bioeffects for such small differences in field frequency. Dr Kunsch pointed out that the differences arise from the fact that the field limits are based on induced current density. Using a fixed value of induced current density gives rise to a frequency dependence in the field strength (specifically a small

difference between the limits at 50 and 60 Hz) that indeed would not be anticipated to have any practical significance.

7. Dr Kunsch continued with a description of European Commission (EC) activities noting that, in June, a draft had been published addressing public exposures to EM fields from 0 to 300 GHz. The basic restrictions and reference levels were taken from ICNIRP as published in the April 1998 *Health Physics* and further clarified in the October and November issues. The standard is not expected to be approved until early 1999. He noted that the EC Presidency currently resides with Austria. While the standard is supported by a majority of delegations, some have concerns. It was his expectation that it will still require some time for all concerns to be addressed.

8. Dr Kunsch concluded with a brief summary of activities in Austria noting that Austria had been the first European country to adopt the International Radiation Protection Association/International Non-Ionizing Radiation Committee (IRPA/INIRC) RF Guidelines published in 1988. Work is progressing on an NIR regulation that will likely follow ICNIRP, but also take into account EC and WHO recommendations.

9. Dr Art Thansandote noted Canada had its first RF guidelines, known as Safety Code - 6, in 1979. SC - 6 was subsequently revised in 1991 and is currently under review for the second time with anticipated publication in 1999. He noted that there had been difficulties in dealing with the SAR limits for the eye. Consequently the recommendations were relegated to the level of suggested exposure limits and would remain so until any risks were more clearly established. Low level RF exposure has been an issue in Canada for some time now, the contention being that SC - 6 is not adequately protective. In response to these criticisms the Canadian government had established a Blue Ribbon panel to investigate and report by March 1999.

10. Dr Paolo Vecchia described standards in Italy noting that the government takes advice from scientific institutions and is consequently developing a framework for a law on NIR that would identify sources, jurisdictions, responsibilities and penalties. The law would then provide a basis for decrees that are then more flexible. At present there are specific laws covering 50 Hz and 100 kHz to 300 GHz public exposures. As regards power frequency, the limits are based on the 1990 IRPA/INIRC guidelines, but there are many difficulties associated with enforcing the limits. It is not clear to the judges who have to deal with claims, how distances should be measured or what constitutes a few hours' exposure. The legal system will not permit application of wording as loose as that found in ICNIRP. In the higher frequency ranges there are great differences compared to ICNIRP and a new idea called "quality of service" has been introduced which incorporates one hour averages. Dr Vecchia expressed concern that, as a consequence of imprecision in wording and political pressures, there is a constant drift to ever lower and lower reference levels to accommodate such pressures.

Dr Vecchia was asked if he knew who had written the technical language for the politicians in Italy. He responded that the initial draft was based on the IRPA/INIRC guidelines, but because of political expediency, the reference levels pushed downward.

11. Dr Peter Gajsek spoke on Slovenia's activities since its independence. The standard in use was established by the Ministry of Science in 1992 and followed CENELEC 5166. More recently there has been work toward preparing an Act addressing radiation

protection that is expected to rely on ICNIRP. They are following with great interest the events currently transpiring in Italy. There is some pressure to introduce a new safety factor of 10 for NEW systems, but that is politically motivated. In summary, there will be established an Act of the Ministry of Health that will cover all NIR. It is clear that the new limits will have to be in harmony with the EU and in the longer term with other countries world wide.

12. Dr Mirjana Moser, in addressing Switzerland's situation, noted that there was no national standard. There are, however, a number of ordinances that relate to various aspects of EMF exposure. In the principal ordinance, ICNIRP is followed, but a prudent avoidance clause is also included. Occupational exposures are not addressed nor are mobile sources - ONLY stationary sources. There are other ordinances that have some connections but there are deficiencies, e.g. cell (mobile) phones cannot be covered. A wish was expressed for more general regulations on exposures for the public, workers and the environment, which will take into account social and economic cost/benefit in a manner somewhat similar to what has been put in place for dealing with ionizing radiations. It is anticipated that the same sort of situation will develop for non-ionizing radiations.

Dr Moser was asked how it would be possible to optimize EMF exposures in the absence of dose/response information. She noted that public risk ACCEPTANCE will be the determining factor. For example, the "optimal" number of cell phone base stations for different networks is still to be determined - when there are too many, the public will react.

13. Dr Chiyoji Ohkubo discussed activities and concerns in Japan. He noted that the Ministry of International Trade and Industry had established a standard for power frequencies in 1976 that has been subsequently reviewed with the conclusion that there is no urgent need to revise the guidelines. Similarly, in dealing with RF exposures, a recent review arising from concerns about cell phones established that there is no need to revise earlier guidelines. However, additional guidelines have been published for the use of sources close to the body, e.g. cell phones. A Rule was passed 01 October 1998, taking effect 01 October 1999, establishing levels as shown in tables presented by Dr Ohkubo, which he characterized as being similar to the reference levels of ICNIRP.

14. Dr Gyorgy Thuroczy described the situation in Hungary. A standard had been issued in 1986 that was modified in 1993 to cover the frequency range from 30 kHz to 300 MHz. Then in 1997 the government issued the European standard but currently the old standards are in effect again. They are based on controlled and uncontrolled areas plus a "no access allowed" area and a "harmless" area. The standard follows fairly closely the levels used in Eastern European countries for some situations, but is basically like ICNIRP. Below 30 kHz there is no standard except for power frequency which a 5 kV/m electric field limit. Where national standards are absent, the ICNIRP limits are used.

15. Dr Axel Böttger, in speaking about activities in Germany, said that they seemed to be having the same sorts of problems on risk perception and risk communication as everyone else. The act that is currently in force addresses industrial and commercial uses. It contains requirements for the protection of the public and the neighbourhood from harmful environmental impacts due to electromagnetic fields. For high frequency installations with a transmission power of 10 W equivalent isotropic radiation power or more in certain frequency ranges limits have been established below which there are no restrictions on siting or construction. This follows the pattern of a similar 1000 V limit for power lines. The

government had insisted on the use of peer reviewed information like ICNIRP in establishing the ordinance which has provided for safe operations and has been accepted by the highest courts. There is every intention to consider and incorporate EU and WHO recommendations as they are developed further.

16. Dr Bernard Veyret stated that France is supporting the CENELEC efforts and will carry through with what develops there.

17. Dr Ulf Bergqvist discussed work going on in Sweden. He noted that there was no ordinance on low frequencies. In the RF area they have an ordinance but a revision - expected to follow ICNIRP - is under consideration. There will likely be a statement specifying a precautionary principle should be incorporated.

18. Dr Nina Rubtsova addressed power frequency activities in Russia. For ELF frequencies, 50 Hz in particular, their standards were the strictest in the world. The levels were based on hygiene research and medical, physical and experimental studies. Electric and magnetic fields were tested separately. They dealt with not only the field strengths but also the whole complex of protective measures involving time, distance and personal protective devices. For electric fields, the occupational limit is 5 kV/m. Different levels are specified for different zones, e.g. occupied zones in residential buildings are stricter than those in unoccupied zones where higher levels are permitted. Control is also achieved through the establishment of rights of way. Magnetic field limits vary depending on whether exposure is to the whole body, partial body or the extremities. In the case of live line maintenance the limits are further relaxed because the workers use protective clothing.

19. Dr Yuri Grigoriev continued addressing Russian standards in the high frequency range. The first EMF standard for the frequency range 300 MHz to 300 GHz was established 40 years ago in 1958. GOST standards apply over the whole Russian territory. A committee for NIR was established in Russia in 1998. It will influence implementation of standards in future years. In the low RF frequency range, permitted levels of occupational exposure are time dependent and have been the same since 1976. Some regional variations exist. For example Moscow has different exposure limits but work is under way to standardize over all of Russia. The underlying principle is not to produce any disruption in human homeostasis. Therefore levels are set to ensure no effects occur among exposed humans.

20. Mr Arwel Barrett spoke on behalf of the Health and Safety Executive of the UK NRPB which recommends guidelines in the UK and was the first agency in the world to cover the whole frequency range. In addition he pointed out that while international non-governmental bodies can offer guidance, national organizations and governments have the responsibility of taking into account social, economic and political requirements in setting legal limits. He made mention of "special" exposure situations where scientific knowledge supported different restrictions for sections of the population, e.g. children, because of their size, leading to modified guidelines. UK law is based upon assessment of risks and the provision of healthy and safe places of work so far as is reasonably practicable. The meaning of "reasonably practicable" is well established in UK case law. Overall the UK was satisfied that the UK population was well protected when its guidelines were complied with.

21. Dr Eric van Rongen summarized standards in the Netherlands noting that none were legally binding. Several ministries have issued brochures on how to deal with various

exposure situations. The 1988 IRPA/INIRC guideline is referenced with regard to broadcast stations. The new guide has a two tier guidance that follows ICNIRP including the April revisions except for the upper frequency range where the 100 W/m^2 limit is retained. There is thus a reduced differential between occupational and public limits at the upper frequencies. However it is still not legally binding. In the ELF region there is another brochure based on a Health Council report which followed the 1992 IRPA/ICNIRP recommendations. Work is under way to update in the ELF range along the lines of ICNIRP, but not so strict.

22. Dr Maila Hietanen noted that Finland has had a national ordinance since 1991 for the frequency range from 10 kHz to 300 GHz based on the 1988 IRPA/INIRC guides. Subsequently they have become actively involved with CENELEC. For the time being there is no official position in Finland. They are also involved in the EC recommendations to the Council of Ministers where there is an expectation that this will be concluded during the Finnish Presidency of the EC. Preparation of regulations is under consideration by authorities following ICNIRP but with variations in the area of pulsed ELF magnetic fields and ELF fields in general. Regulations specific to RF induction systems have been in place for some 10 years but they are being updated.

23. Dr Michel Israel spoke on the situation in Bulgaria. He stated that there are several ordinances dealing with EMFs. They address occupational and public situations separately. In the occupational area, the old standards were in close conformity with the COMECON guidelines for power, RF and microwave frequencies. In 1995 all of NIR was covered following the guidance of the 1989 EC directive. Ordinance #41 addresses ELF exposures based on the TLVs of the ACGIH. In the public area the issue of electromagnetic radiation in residential areas is addressed. Norms exist for electric fields and power densities plus how to calculate safety zones. Ordinance #9 covers VDUs used by students and ordinance #7 deals with health protection in residential areas defining safety zones for high voltage lines and power stations. During the past two years, the ICNIRP and EC guidlines have been translated and another committee has been established to consider the issues.

24. Dr Stanislaw Smigielski addressed standards in Poland. He noted that, in general, all Eastern European standards were similarly based on doses and the establishment of safety zones, where initial levels are very low and gradually progress to dangerous zones where levels are closer to those of the CENELEC and ICNIRP standards. Consideration is being given to revisions in the future, including prospects for harmonization. He presented charts showing the relationships between the various guidelines.

25. Dr Jocelyn Leal commented briefly on the situation in Spain noting that there are no specific laws.

Appendix "B" includes all the contributions received.

Open Discussion

Dr Repacholi noted that the preceding portion could well have been billed as an introduction to diversity. The task now at hand was to begin the process of working toward a common basis.

What could be derived as a basis for commonality? There did appear to be some common areas among the criteria chosen for evaluating the science, models and safety factors. However, what about risk perception/risk acceptance? Should these concepts be a part of the framework for standards or kept aside to be included with social and economic considerations, the latter having implications with regard to differences in the processes that take place within various countries. Perhaps there was a broad consensus on the "form" of a framework insofar as there appeared to be rather broad agreement on the basic restrictions. However, problems arising from "action", "reference" or "investigation" levels would need to be resolved. Furthermore, close attention needs to be paid to the practical implementation of the guidelines not only from the point of view of levels and quantities measured but also looseness or lack of clarity in wording.

It was noted from the floor that there were problems with the Eastern European standards having adopted an approach using zone controls rather than the West's one or two tier approach. In response it was suggested that it did not appear difficult to add zones to the tier approach.

A plea from the floor that there be no form of prudent avoidance incorporated was met with broad acceptance and no further comment.

Dr Leonowich questioned whether there was any other physical agent where risk perception was considered in setting standards. No example was offered. He also pointed out that procedures for assessing compliance would have to be incorporated as they are in some other standards. Consideration would need to be given to safety factors and how other factors interact with them plus the broader issues of electromagnetic compatibility (EMC). Dr Repacholi noted that EMC should not be included inasmuch as it is an engineering rather than a health/bioeffects issue. Dr Leonowich resumed stressing the issue of wording with regard to legalities and how such problems can become substantially exacerbated as a result of inadequate translations into other languages.

A plea for simplicity was made by Dr Hubert Trzaska. He noted that the originally derived bioeffect limit of 4 W/kg is, at best, ±6 dB. None of the theoretical models predicted anything to better than a factor of 10. Arbitrary "safety" factors of 10 (occupational) or 50 (public) were commonly used. And yet values are tabulated to four figure accuracy! Similarly frequencies are specified to many figures. Dependencies are specified for different frequency ranges to say nothing of the arbitrary frequency boundaries themselves. Equally, the concept of power density is nonsensical below 300 MHz. All this indicates that values should be maximally simplified - ONE value for LOW frequencies and ONE value for HIGH frequencies. That would establish the most logical and easiest to use standard.

The plea for simplicity sparked a number of responses. Dr Lin pointed out that the objective should not be simplicity but rather to protect humans from deleterious effects. In that context, a clear distinction has to be maintained between bioeffects and hazards. Many of the apparently arbitrary numbers arise from biological data with all its variability. On the

other hand Dr Klauenberg stated that he was not aware of anyplace else where no account has been taken of confidence intervals. The variabilities do need to be taken into account. Dr Repacholi noted that, in part, the frequency variations arose from the body's varying ability to absorb as frequency changes. Dr Ghandi pointed out that, in fact, an enveloping curve had been used. Dr Leonowich interjected with the observation that the investigation levels are the most significant aspect of the issue. Recognizing the consensus on the main levels there would appear to be some hope for harmonization. Dr Greenebaum noted that body resonance has to be clearly and prominently discussed to ensure there are no misunderstandings.

Dr Bernhardt noted that ICNIRP based its hazard assessment on the available science and used safety factors to deal with the uncertainties left by gaps in knowledge. By contrast, IEEE uses safety factors in an entirely different way. Exposure-duration-based Eastern European standards had much larger safety factors.

In a comment from the floor it was pointed out that laws have a great deal of inertia associated with them. The flexibility inherent in standards is an important feature to retain in any framework that might be developed.

Dr Vecchia called for simple and clear standards. He said the public is not comfortable with the imprecisions of science and that a standard should be chosen that follows the lower bound of the confidence limits. There is a need to have public confidence and to ensure that only simple, concise and clear messages are issued to the public.

Dr Klauenberg cautioned that the involvement of as many stakeholders as possible was very important to ensure that it did not appear that vested interests control or dominate the outcomes and that conflicting interests are resolved by consensus.

A final caution from the floor drew attention to the futility of issuing numbers to the public without making provision for the public to measure and evaluate their own situations.

APPENDIX "A"

Press Conference

On 18 November 1998 at 1200 h a press conference was held at the Faculty of Electrical Engineering and Computer Science, University of Zagreb to inaugurate the WHO Project on Harmonization of Standards for EMF Exposure.

In addition to Dr Michael H Repacholi representing WHO, the following officials were in attendance:

- Professor Zeljko Reiner, Minister of Health, Croatia
- Professor Dina Šimunic, Faculty of Electrical Engineering and Computer Science, University of Zagreb
- Professor Jürgen Bernhardt, International Commission on Non-Ionizing Radiation Protection (ICNIRP)

Professor Reiner outlined Croatia's ongoing concerns about and involvement in standards for non-ionizing radiation and its resolve to participate actively in establishing standards in Cupertino with other national, regional and international agencies. He expressed his personal pleasure and satisfaction at having the WHO's inaugural harmonization meeting in Zagreb.

Professor Bernhardt emphasized the role of ICNIRP as the scientific arm of WHO's NIR activities. The Commission is the formally recognized non-governmental Organization in NIR protection for the WHO, the ILO and for the European Union. ICNIRP works together with the WHO to assess health effects of exposure to NIR on the basis of internationally accepted quality criteria, free of vested interest. The Commission uses the results of this assessment to draft health based exposure guidelines. Recently the ICNIRP adopted guidelines on limits of EMF exposure for frequencies up to 300 GHz. Compared with these guidelines there are large differences in the EMF exposure limits in standards of some Eastern European countries. ICNIRP therefore welcomes WHO's initiative to harmonize EMF standards world wide on the basis of world wide accepted quality and assessment criteria.

Professor Šimunic expressed her satisfaction at the WHO initiative and stressed the importance of world wide standards harmonization in the field of bioelectromagnetics. As a member of the group of scientists responsible for the development of the Croatian law on non-ionizing radiation, she outlined the importance of this meeting for Croatia, because the law is in the last development stage.

Text of the Press Release that was issued

WHO launches an initiative to harmonize electromagnetic field standards world-wide.

Globalization of trade and the rapid introduction of mobile telecommunications world-wide, have focused attention on the large differences existing in standards limiting exposure to electromagnetic fields.

Differences in the EMF exposure limit values in standards in some Eastern European and Western countries are, in some cases, over 100 times. This has raised concerns about their safety and has led to public anxiety about increasing EMF exposures from the introduction of new technologies.

WHO established the International EMF Project to review scientific studies relating possible health effects from exposure to EMF to identify research that will allow improved health risk assessments to be made. Health risk assessments from the International EMF Project will provide the basis for future EMF exposure standards. Dr MH Repacholi, manager of WHO's International EMF Project said that "Facilitation of harmonized EMF standards world-wide is a logical extension of the WHO's International EMF Project. However, agreement may take some years to achieve and much hard work since there are large differences between national standards."

With many countries from the former Soviet Union and elsewhere, now considering new EMF standards, the WHO's EMF Project is launching an initiative during the Fourth European BioElectromagnetics Association (EBEA) congress in Zagreb, Croatia, 18-22 November 1998, to develop a framework for internationally-acceptable EMF standards. The Croatian Minister for Health, Professor Zeljko Reiner said that "This WHO initiative comes at a very opportune time because Croatia wants to update its EMF standards to those accepted internationally so Croatian citizens will have the same level of health protection as other countries in the world."

Over 20 countries will have representatives to participate in the initial meeting to identify a process for developing a framework for an international standard. These include: Australia, Austria, Canada, Croatia, Czech Republic, Finland, France, Germany, Hungary, India, Italy, Netherlands, New Zealand, Poland, Russian Federation, Slovenia, Sweden, Switzerland, United Kingdom, United States of America.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP), a formally recognized NGO of WHO, that drafts international EMF standards will also participate in this initiative. Professor J Bernhardt, Chairman ICNIRP said that "ICNIRP relies on health risk assessments from WHO to draft EMF safety guidelines. WHO's initiative to develop a framework for internationally acceptable standards will greatly assist ICNIRP in drafting its next EMF guidelines on exposure limits."

APPENDIX "B"

EMF Exposure Standards from around the World
(in alphabetic order)

Except for changes in format to standardize the appearance of the present document, the information provided in this appendix is as submitted by the various country or agency representatives.

AUSTRALIA

Australasian Standards Committee

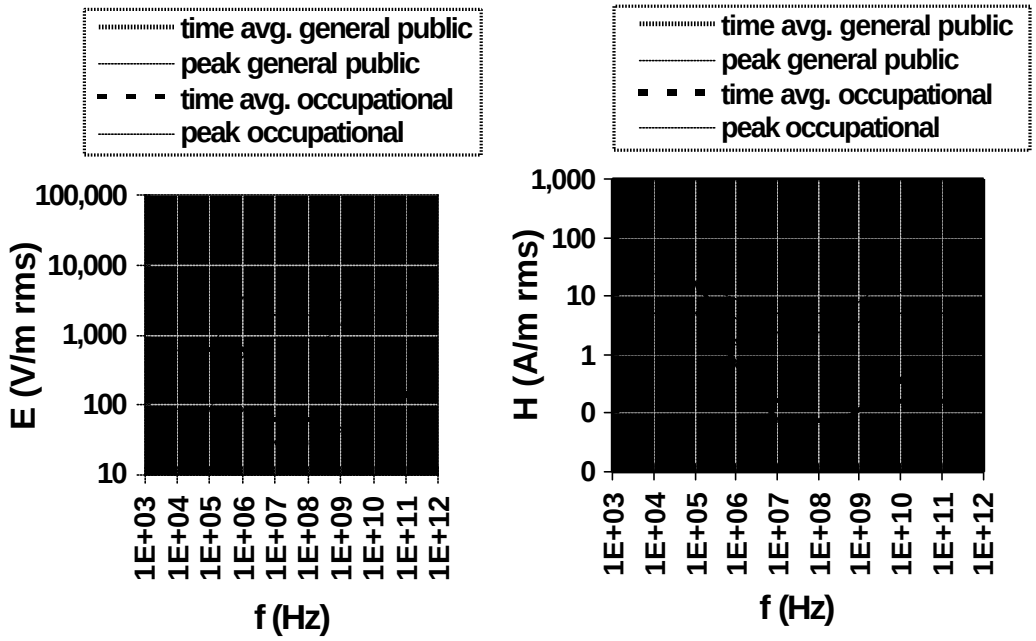
Australia first developed a standard for radiofrequency exposure in 1985. The standard was developed in something of a political environment, and drew on previous published work by ANSI and IRPA. The standard used the dosimetric approach with an SAR basic restriction level of 0.4 W/kg for occupationally exposed workers and 0.08 W/kg for general public. A notable difference compared to the IRPA guidelines of the day was the lack of any relaxation of power flux density levels at ultra high frequencies.

New Zealand had no RF standard until 1989 at which time controversy surrounding a large broadcasting site caused a government directive to develop a standard quickly. The ruling Australian standard (from 1985) was adopted as a draft, and a new committee set up to establish a definitive New Zealand Standard. Within a few years, an agreement was made to harmonize standards as far as possible between Australia and New Zealand, and so the work of the Australian and New Zealand Standards Committee was combined to create a joint standard.

By 1994, the proliferation of mobile telephone base station sites in New Zealand had created a significant amount of public interest in the question of RF safety resulting in new pressures on the Standards Committee. The issue of following the IRPA curve in allowing power flux density to rise at ultra high frequencies was particularly controversial and proved one of several difficulties in agreement of a draft. On several occasions, final drafts were submitted to the committee, however in every case there was insufficient agreement, on the basis of Standards Association rules to go ahead and publish the draft. The process used in the Standards Institutes of Australia and New Zealand is to require an 80% consensus and then attempt to resolve any other matters to achieve as near consensus as possible in the committee. By 1998, the need for a standard had become urgent and a decision was taken by the Standards Associations to release an interim document that included some compromizes particularly on controversial issues such as the problem about ultra high frequencies.

Another major issue causing argument was that the 1985 document had explicitly included a requirement for environmental RF levels to be kept *as low as reasonably achievable* (ALARA). Most members of the committee, particularly those with wider responsibilities in radiobiology had a particular aversion to using this term, which was originally devised to convey the unarguable importance of dose reduction for ionizing radiation. Several members of the committee wished to keep a term that was just as powerful, whereas others preferred a more general expression of a precautionary approach. There has therefore been considerable discussion regarding the exact wording for the precautionary approach. In the previous drafts, the term "prudent avoidance" was referred to, however the committee has now decided to move away from this phrase as it is difficult to characterize the definition properly in the presence of several interpretations but little definitive literature.

This Interim Standard (NZS/AS2772 Part 1) was released at about the same time as the 1998 ICNIRP guidelines were published in Health Physics (April) and the document expires in March 1999. At present the UHF reference levels remain capped at 200 $\mu W/cm^2$, so that for example at 900 MHz AS/NZS 2772 is much more conservative than ICNIRP which allows 450 $\mu W/cm^2$ and the Australasian Standard 200 $\mu W/cm^2$.



Basic Restrictions and Reference Levels for the November 1998 Draft of AS/NZ2772

basic restriction	**relevant reference levels**
Whole body average SAR (100 kHz–10 GHz)	time averaged E &/or H (100 kHz–10 GHz)
Localised SAR in head & torso (100 kHz–10 GHz)	time averaged E &/or H (100 kHz–10 GHz)
Localised SAR in limbs (100 kHz–10 GHz)	time averaged E &/or H (100 kHz–10 GHz) &/or limb currents for the legs and arms (10–110 MHz)
Power density (10 GHz–300 GHz)	time averaged E or H (10–300 GHz)
Current density (3 kHz–10 MHz)	peak rms E &/or H (3 kHz–10 MHz) and contact currents (3 kHz–10 MHz)
Specific absorption per pulse (0.3–10 GHz)	peak pulse E &/or H (0.3–10 GHz)

The Australian and New Zealand Standards have always been in two parts, part one deals with exposure levels and part two deals with measurement principles and techniques. There is considerable merit in this approach so it is proposed to continue.

There remains a substantial public requirement in Australasia for a precautionary approach to be included in the new document, and this is reflected in the make up of the Standards Committee. This has been made much easier by the deliberate inclusion on the committee of several general public representatives. In the past there had been inordinate public pressure on one or two members of the committee. Now this is spread more evenly but still with an overriding requirement to achieve a workable and generally acceptable document.

Since the publication of the draft standard, there have been two further committee meetings, the last of which was on the 4 and 5 November 1998. There is a new draft for part one of the Standard which now closely follows the ICNIRP approach and is an attempt to harmonize the local requirements of Australasia, with the scientific imperatives determined by ICNIRP.

At the time of writing this document (13 November 1998) a revised draft of AS2772 is being proof read, with a view to publication for public comment in early December, and return to a final meeting of the committee in February 1999. The Standard could be finally published as early as March 1999 if all goes well.

Dr David Black MBChB FAFOM MARPS New Zealand Institute of Occupational & Environmental Medicine

AUSTRIA 1

The Austrian EMF Standards Situation

Barnabas Kunsch

On request of the Austrian health authorities as well as of the Austrian power industry the Austrian Standards Institute together with the Austrian Electrotechnical Association developed the pre-standards ÖNORM S 1119 and ÖNORM S 1120 in 1994 and 1992, respectively. The two pre-standards set exposure limits for the protection of people against electromagnetic fields in the low (0 Hz to 30 kHz) and high frequency range (30 kHz to 3 THz).

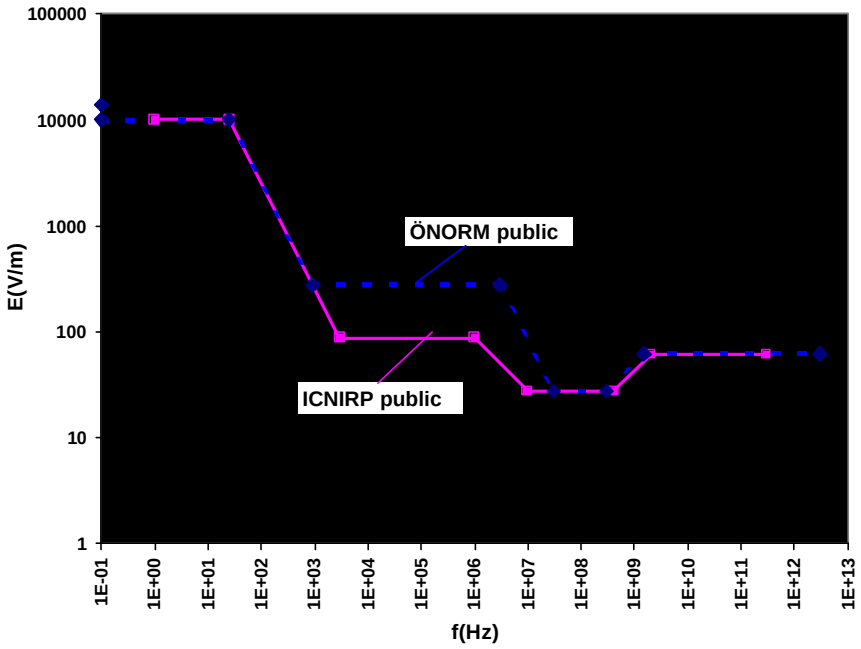
As the European Committee for Electrotechnical Standardization CENELEC is currently working on a European Standard, national committees are prevented from issuing standards during this standstill period.

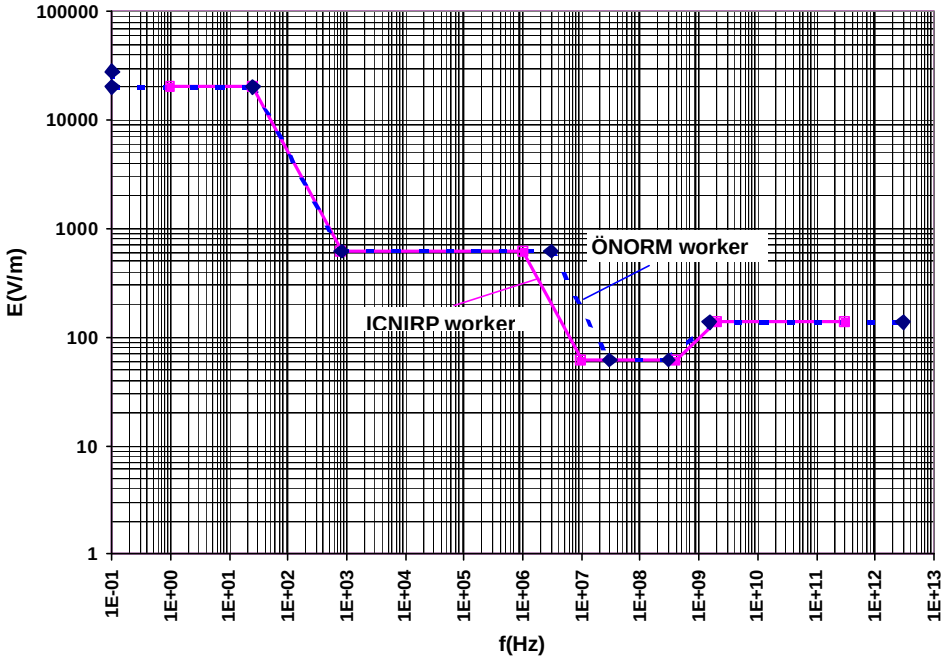
The pre-standards do not apply to intentional medical application but as a rule to medical personnel. Hazards due to interference of fields with cardiac pacemakers are not taken into account.

General characteristics:

- The limits are based on well established or predicted health effects (stimulation and heating).
- For the general public lower limit values are set than for occupational exposure.
- Higher limit values correspond to exposures of short duration and of extremities rather than the whole body.
- Limits are given for quantities which are readily measurable, i.e. electric and magnetic field strengths and power flux density.
- At 50 Hz the limit values are identical to the INIRC/IRPA limits of 1990.
- The SAR limit value for the general public is 0.08 W/kg. The occupational exposure limit value is five times higher. For extremities there are special limit values.

Attached are diagrams comparing the reference levels of the new ICNIRP Guidelines for unlimited exposure time. The main differences are at intermediate frequencies where the ICNIRP Guidelines apparently consider indirect effects more important than the Austrian pre-standards.


100000
10000
1000
100
10
1
E(V/m)
ÖNORM public
ICNIRP public
1E-01
1E+00
1E+01
1E+02
1E+03
1E+04
1E+05
1E+06
1E+07
1E+08
1E+09
1E+10
1E+11
1E+12
1E+13
f(Hz)


100000
10000
1000
100
10
1
E(V/m)
ÖNORM worker
ICNIRP worker
1E-01
1E+00
1E+01
1E+02
1E+03
1E+04
1E+05
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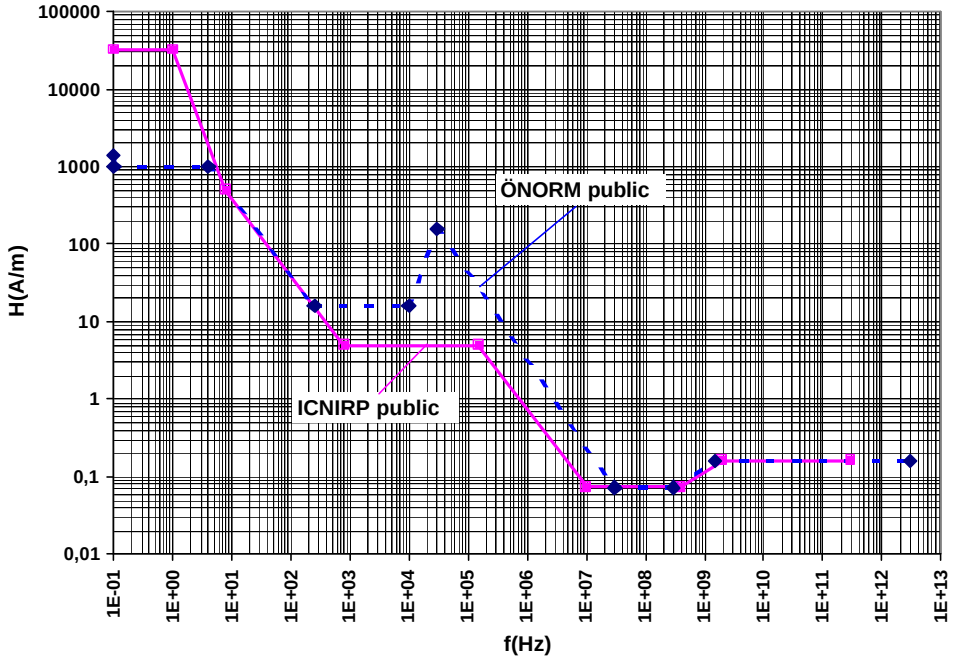
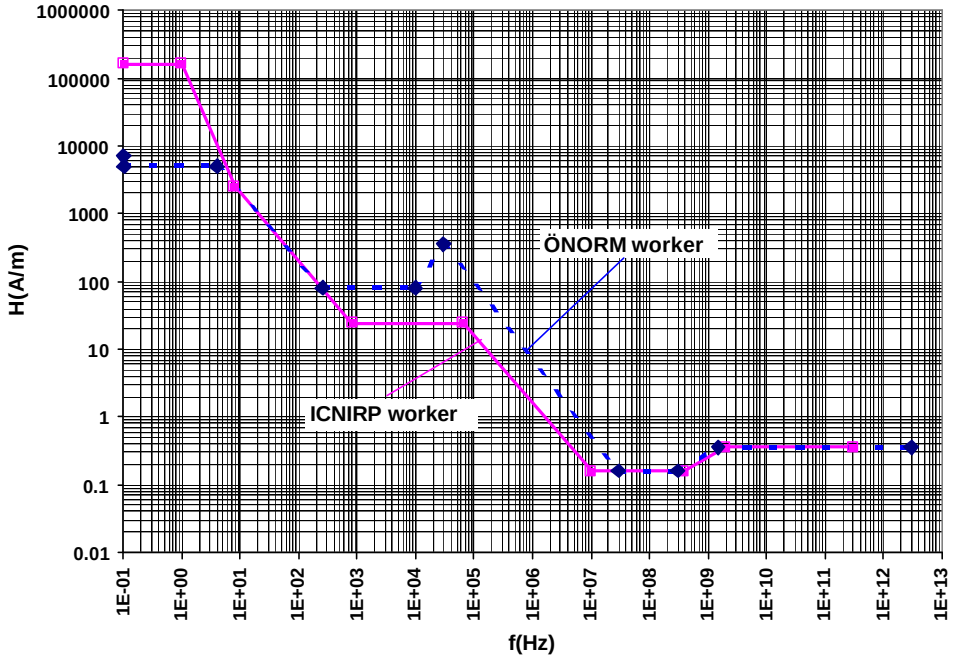
1E+07
1E+08
1E+09
1E+10
1E+11
1E+12
1E+13
f(Hz)


100000
10000
1000
100
10
1
0,1
0,01
H(A/m)
ÖNORM public
ICNIRP public
1E-01
1E+00
1E+01
1E+02
1E+03
1E+04
1E+05
1E+06
1E+07
1E+08
1E+09
1E+10
1E+11
1E+12
1E+13
f(Hz)


1000000
100000
10000
1000
100
10
1
0.1
0.01
H(A/m)
ÖNORM worker
ICNIRP worker
1E-01
1E+00
1E+01
1E+02
1E+03
1E+04
1E+05
1E+06
1E+07
1E+08
1E+09
1E+10
1E+11
1E+12
1E+13
f(Hz)

AUSTRIA 2

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Federal Chancellery
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A-1031 Wien

The Austrian Government accepts the necessity not only to introduce but also to carefully assess new technologies. Therefore, it took responsibility by different actions in the field of Non-ionizing Radiation already early. It took and takes care for continuing observation and assessment of the scientific results in this field and especially of Electromagnetic Fields. In this context in the early eighties the former Ministry of Health and Environment ordered by the Austrian Research Center Seibersdorf a Study about the typical sources used in Austria, which emit Non-ionizing Radiation, about the amount of their emission, about their possible health risks and about available radiation protection acts, guidelines and limits all over the world.

The results of this study led to the decision that the IRPA INIRC guidelines in discussion seemed to be the most applicable recommendations as a basis for an Austrian regulation. This decision was mainly based on the fact, that the former IRPA INIRC Committee was an international, scientific and economically independent organization. At this time it seemed to be too early to implement exposure limits, such as the IRPA INIRC recommendations, in Austria by law, although the Austrian Government is convinced, that the setting of health relevant exposure limits is a governmental duty. Because of the many years lasting excellent co-operation with the Austrian Standard Institute in the field of Ionizing Radiation it was decided that Austrian Standards could be the solution until this field would be regulated by law and the Austrian Standard Institute was asked to develop Standards on the basis of the above mentioned recommendations.

Therefore Austria was the first European country that adopted the IRPA INIRC recommendations for exposure limits already in 1986 and even more than this - had extended the exposure limits over the whole frequency range from static fields up to microwaves by 1994 in its standards ÖNORM S 1120 and ÖNORM S 1119, respectively.

Furthermore, the radiation protection group in the Federal Chancellery is going to elaborate a wide scope document from the protection on Non-ionizing Radiation. A first draft of this document can be expected by the end of this year. Basis for limiting exposure to electric, magnetic and electromagnetic fields will be, as far as it can envisaged at present, the ICNIRP 1998 guidelines, taking into account the decision of the Council of Ministers of the European Community and, if available, recommendations of the World Health Organization.

BULGARIA

A SHORT REPORT ABOUT EMF STANDARDS IN BULGARIA

There are several ordinances and standards dealing with EMR in Bulgaria. The whole legislation is divided into occupational exposures, and exposures to the general population.

1. Standards and regulations for occupational exposures

We have the following standards, norms and regulations (ordinances) in the field of electromagnetic radiation for occupational exposures:

a) Regulations:

Ordinance No. 41 (27 October 1995) - Common Regulations for Providing Healthy Work Conditions, Gov. News No. 100/1995.

This ordinance includes hygienic norms for *static electric and magnetic fields, ELF fields (electric and magnetic), radiofrequency and microwave radiation, light and laser radiation.* It is based on Directive 89/654/EEC; 89/391/EEC.

Ordinance No. 8 (26 March 1996) - Hygienic Requirements for *Working Places with VDUs*.

Here all requirements (ergonomic, physical factors - EMR, microclimate, light, etc.) for working places with VDUs are included. It is based on Directive 90/270/EEC.

Standards:

BNS (Bulgarian National Standard) 12.1.002-78. *Electric Fields* near High Voltage Substations and Lines with Voltage 400 kV and more.

The standard is connected with exposures only to the electric field of personnel working in power substations and lines.

BNS 14525-90. *Radiofrequency Electromagnetic Fields.* Permissible Levels and Control Requirements.

This BNS is for RF fields in the frequency range 60 kHz to 300 MHz.

BNS 17137-90. *Microwave Electromagnetic Fields.* Permissible Levels and Control Requirements.

The standard is for exposures to microwave radiation.

2. Standards and regulations for EMR exposure of the general population

In Bulgaria, the following standards, norms and regulations (ordinances) in the field of EMR exposure to the general population are in use:

a) Regulations:

Ordinance No. 9 (14 May 1991) - TLVs for electromagnetic Radiation in *Residential Areas* and for Determining *Safety Zones Around Electromagnetic Sources*, Governmental News No. 35/1991.

In this ordinance there are norms for E [V/m] and for S [$\mu W/cm^2$], also method for calculating the safety zones around EMR sources in the environment.

Ordinance No. 9 (28 May 1994) - Hygienic and Health Requirements for Use of *VDU's* by Students - *in Schools* and Outside, Gov. News No. 46/1994.

This regulation includes norms for electric and magnetic fields emitting from the VDU's, on the base of the technical emitting Swedish standard MPR II.

Ordinance No. 7, Gov. News No. 46/1992 - Hygienic Requirements for Health Protection of the Residential Areas. Here there are defined *safety zones around power stations and high voltage lines.*

The cited standards and regulations are presented on tables below.

The standards for occupational exposures are based on a criteria of adverse irreversible health effects on man, outside the physiological norms.

Most of the laws and regulations in the country are based on European Directives and Standards: Directive 89/654/EEC; 89/391/EEC; 90/269/EEC; 90/270/EEC, etc.

Especially Ordinance No.41/1995, is based on the TLVs (ACGIH), on the cited above three BNS for occupational exposures, and on European standard for laser radiation. The parameters used in the occupational standards are close to these used in VDE and ICNIRP standards for the reference levels.

Many regulations not cited here are dealing with the health surveillance (before working and temporary) of personnel in the field of EMR; with the possible emission levels of microwave ovens, VDUs, industrial sources; with the safe use of lasers, etc.

3. Nowadays activities in the field of standardization

In the last 2 years the ICNIRP standard, also the European pre-standards ENV50166 - 1 and ENV50166-2 were translated in Bulgarian language, and were distributed to the users for an opinion.

A special Technical Committee (TC) on electromagnetic compatibility introduce the whole series of European standards in the field of EMC. Also, TC on Ergonomics is dealing with the environmental health standards of EMR.

A series of methods for measurement and exposure assessment of EMR have been standardized over the country.

STANDARDS FOR EMR IN BULGARIA - PARAMETERS and PURPOSE

STANDARD	FREQUENCY RANGE	PARAMETERS	PURPOSE
Ordinance No. 41/1995	0 Hz - 60 kHz	E [kV/m], B [mT]	Occupational
BNS 12.1.002-78	50 Hz	E [kV/m]	Occupational
BNS 14525-90	60 kHz - 300 MHz	E [V/m], H [A/m], Energetic value W_E, W_H	Occupational
BNS 17137-90	300 MHz - 300 GHz	Power density S [$\mu W/cm^2$], energetic value W_S	Occupational
Ordinance No. 9/1991	30 kHz - 300 MHz	E [V/m]	Population
	300 MHz - 30 GHz	S[$\mu W/cm^2$]	Population
Ordinance No. 8/1996	0 - 300 MHz	E [V/m], B [T]	VDUs - Occupational
Ordinance No. 9/1994	20 Hz - 400 kHz	E [V/m], B [T]	VDUs - children
Ordinance No. 7/1996	50 Hz	E [V/m], Safety zones	Population

STANDARDS FOR EMR IN BULGARIA - PARAMETERS AND EXPOSURE LIMITS

STAN-DARD	FREQUENCY RANGE	E_{max}, V/m	H_{max}, A/m, mT	S_{max}, $\mu W/cm^2$	$W_E = E^2.T$ $(V/m)^2.h$	$W_H = H^2.T$ $(A/m)^2.h$	Ws = S.T ($\mu W.h/cm^2$)
Ordinance No. 41/1995	0 Hz	25 kV/m	60 mT	-	-	-	-
	0 Hz - 100 Hz	25 kV/m	60/f, mT	-	-	-	-
	100 Hz - 4 kHz	$2.5x10^6/f$	60/f, mT	-	-	-	-
	4 kHz - 60 kHz	625 V/m	60/f, mT	-	-	-	-
BNS 14525-90	60 kHz - 3 MHz	500 V/m	50 A/m	-	20000	200	-
	3 MHz - 30 MHz	200 V/m	50 A/m	-	3200	200	-
	30 MHz - 300 MHz	60 V/m	-	-	800	-	-
Ordinance No. 9/1991	30 - 300 kHz	25 V/m	-	-	-	-	-
	0.3 - 3 MHz	15 V/m	-	-	-	-	-
	3 - 30 MHz	10 V/m	-	-	-	-	-
	30 - 300 MHz	3 V/m	-	-	-	-	-
	0.3 Hz - 30 GHz	-	-	10	-	-	-
BNS 17137-90	300 MHz - 300 GHz	-	-	1000	-	-	200

CANADA

RF Exposure Standards in Canada: An Update{PRIVATE }

Art Thansandote, Greg Gajda, Dave Lecuyer and James McNamee

In 1979, the Federal Department of Health in Canada issued a document titled Safety Code 6, recommending the limits of occupational and general public exposures to radiofrequency (RF) fields at frequencies between 10 MHz and 300 GHz. The safety procedures and installation guidelines given in this Code were for instructing and guiding employees of federal public service departments and agencies and for those coming under the jurisdiction of the Canada Labour Code. Safety Code 6 has been adopted or referenced by Canadian Provinces and Territories. This Code has become a *de facto* standard as it applies to broadcasting and radiocommunications through the regulations imposed by the Federal Department of Industry Canada.

Safety Code 6 has been reviewed and revised periodically in order to take into account new scientific information as well as other national and international exposure standards. The first revision was proposed as a journal article titled “Proposed Revision of the Canadian Recommendations on Radiofrequency - Exposure Protection” which was published in Health Physics, Vol. 53, pp. 649-665, 1987. This revision was later published by Health Canada in 1991 and reprinted in 1994 under the title "Limits of Exposure to Radiofrequency Fields at Frequencies from 10 kHz - 300 GHz." The field strength limits, specific absorption rate (SAR) limits and contact current limits are specified for both occupational exposures and exposure of persons other than RF workers. The basic SAR restrictions as given in the Code are as follows:

{PRIVATE }Condition	Occupational Exposure	General Population
The SAR averaged over any 0.2 of the body mass	0.4 W/kg	0.2 W/kg
The local SAR in the eye	0.4 W/kg	0.2 W/kg
The local SAR averaged over any 1 g of tissue, except the body surface and the limbs	8 W/kg	4 W/kg
The SAR at the body surface and in the limbs (averaged over 10 g of tissue)	25 W/kg	12 W/kg

Safety Code 6 is available on the world wide web page of Health Canada at <*http://www.hc-sc.gc.ca/rpb*>.

The Safety Code is currently undergoing another revision. Copies of the draft were distributed for review and comment to other federal departments and agencies, provinces and territories, industry as well as interested parties in Canada and the US. The consultation process has been completed and the final editing of the text is under way. The publication of this revision is expected in the first quarter of 1999. To take into account new scientific information, induced current limits have been incorporated and the basic SAR restrictions in the previous table replaced by the following:

{PRIVATE }Condition	Occupational Exposure	General Population
The SAR averaged over the whole body mass	0.4 W/kg	0.08 W/kg
The local SAR for head, neck and trunk, averaged over any one gram (g) of tissue*	8 W/kg	1.6 W/kg
The SAR in the limbs, as averaged over 10 g of tissue*	20 W/kg	4 W/kg

*Defined as a tissue volume in the shape of a cube.

Due to limited scientific information about possible harmful effects on the eye for low-level RF exposure, the SAR limits for the eye given in the current Safety Code 6 will be relegated to the status of suggested exposure levels as opposed to required exposure limits. These suggested levels shall remain in the Code until sufficient scientific information is available to more accurately assess the health effects of RF exposure on the eye.

During the past decade, the rapid growth of cellular phone industry has resulted in the installation of numerous base stations or radio transmitters to relay phone calls. The base station antennas are either mounted on free-standing towers or placed on roof-tops or sides of buildings. Many communities across Canada are concerned about the possible health risks associated with the emission of RF fields from these antennas. As these concerns are becoming an increasingly important public health issue, there is a belief by the public that the exposure limits set by Health Canada and international organizations do not adequately address the effects of RF fields on population health. In response to this concern, Health Canada requested that the Royal Society of Canada form an Expert Panel on RF fields to look into this matter. This panel will independently assess the scientific literature and advise Health Canada on the potential harmful effects of RF fields and will address the public concern over the adequacy of Safety Code 6. The report from the expert panel will be completed and submitted to Health Canada in March 1999. At that time, the Royal Society of Canada will also hold a press conference to release the report to the public. This report will be reviewed by Health Canada and any suggestions by the Royal Society of Canada will be considered.

CENELEC

ON CENELEC'S ROLE IN PROTECTION FROM EMF

B KUNSCH, CHAIRMAN OF TC 211

The European Committee for Electrotechnical Standardization CENELEC started its work on harmonizing European standards in the field of exposure to electromagnetic fields in 1990/1991, based on the initiative of Germany. CENELEC's members are the national electrotechnical committees of 19 European countries. The harmonization work was assigned to the Technical Committee TC 111 which was renumbered TC 211 in 1996, and carried out by its two Subcommittees SC 211A (low frequency electromagnetic fields) and SC 211B (high frequency electromagnetic fields). The result was accepted with a weighted vote as the European Pre-standard ENV 50166[1] in a voting meeting which was carried out according to CENELEC rules at the end of November 1994.

ENV 50166 was issued as a prospective standard for provisional application for a period of three years. Conflicting national standards might be kept in force parallel to the ENV during this time. According to general CENELEC rules the national electrotechnical committees had to decide after about two years how to proceed further. In Nov 1997 it was decided to extend the lifetime of the ENVs by another two years and to use this period of time for:

- further evaluating the various national electrotechnical committees' point of views
- analysing the experiences in the member states with the adoption of the ENVs
- observing the developments within ICNIRP
- trying to establish a document which is not in conflict with ICNIRP-guidelines and the European Commission's opinion about CENELEC's role.

The European Commission (EC) prepared a draft directive[2] on the protection of workers from physical agents in 1994 which, among others, included electromagnetic fields. Furthermore, the EC is about to issue a Council recommendation on the protection of the public[3]. This recommendation is largely based on the new ICNIRP-guidelines which were published in April 1998[4]. It is clear that these documents will have a significant bearing on European standardization once they are endorsed by the member states.

My personal view is that the Council recommendation will be approved at the Council meeting scheduled for 12 November 1998. Furthermore, I expect that in due course the draft directive will be brought in line with the ICNIRP guidelines for EMF. This will provide for a consistent set of European restrictions for the exposure of people to EMF and shift the scope of TC 211's work from harmonizing national European EMF standards to developing procedures to check and ensure compliance with EC's regulations.

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2. CEU, Commission of the European Communities, Amended proposal for a council directive on minimum requirements for the protection of workers from harmful physical agents, Official Journal of EC 37:115 (1994)

3. EC, Proposal for a Council recommendation on the limitation of exposure of the general public to electromagnetic fields 0 Hz – 300 GHz, COM (1998) 268 final

4. ICNIRP, Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 74, 4, 494-522, 1998

THE EUROPEAN PRE-STANDARD ENV 50166 "HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS" IN CONTEXT

Camelia Gabriel,[1] Bernard Hutzler,[2] Norbert Krause,[3] Barnabas Kunsch,[4]
Brian J Maddock,[5] Gianni Mariutti[6]

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INTRODUCTION

The European Committee on Electrotechnical Standardization CENELEC started its work on harmonizing European standards in the field of exposure to electromagnetic fields in 1990/1991, based on the initiative of Germany. CENELEC's members are the national electrotechnical committees of 18 European countries. The harmonization work was assigned to the Technical Committee TC 111 which was renumbered TC 211 in 1996, and carried out by its two subcommittees SC 211A (low frequency electric and magnetic fields) and SC 211B (high frequency electromagnetic fields). The result was accepted with a majority vote as the European Pre-Standard ENV 50166[1] in a voting meeting which was carried out according to CENELEC rules at the end of November 1994.

ENV 50166 was issued as a prospective standard for provisional application for a period of three years. Conflicting national standards may be kept in force parallel to the ENV during this time. According to general CENELEC rules the national electrotechnical committees (NEC) have to decide after about two years how to proceed further. There are three possibilities: Converting the ENV into a European Standard (EN), extension as an ENV for two more years or complete withdrawal. The related enquiry is currently under way, soliciting national opinions. It is expected that the decision will fall on schedule, by the end of 1997.

MAIN CHARACTERISTICS

The ENV is divided into two parts: low frequency electric and magnetic fields in the frequency range 0-10 kHz (ENV 50166-1) and high frequency electromagnetic radiation from 10 kHz to 300 GHz (ENV 50166-2). At low frequencies the stimulation of nerves and muscle tissue and at high frequencies heating were considered as established effects. As regards reports on long term effects such as the induction or promotion of certain types of cancer this literature, as well as the views of relevant national and international bodies, was scrutinized and it was found that the evidence currently available had not established a connection.

Basic restrictions are set to prevent the established effects from causing any adverse consequences. They are specified in terms of biologically relevant quantities, typically induced current density at low, and specific absorption rate at high frequencies. As these quantities cannot be measured directly, the standard specifies a set of more readily measurable reference levels in terms of external electric and magnetic field strengths and power density.

Reference levels as limits for the electric and magnetic field strengths are derived from the basic restrictions using worst case assumption. Compliance with reference levels automatically ensures compliance with the basic restrictions. Reference levels may be exceeded if the basic restrictions are met.

It should be noted that the pre-standard does not apply to the deliberate exposure of persons during medical research, diagnosis or treatment. Furthermore, safety hazards associated with the ignition of flammable materials or the triggering of explosive devices are not covered, and the interference of permissible fields with implants cannot be excluded. This problem is being dealt with by a specific CENELEC standard currently in preparation.

Low frequencies

The ENV sets 10 mA/m^2 as the basic restriction for occupational exposure within the frequency range 4 Hz-1000 Hz. The current density restriction is set inversely proportional to the frequency below 4 Hz and directly proportional to the frequency above 1000 Hz. For the general population a precautionary factor of 2.5 was chosen, resulting in 4 mA/m^2 at power frequencies. Harmful indirect effects are prevented by limiting the contact current, to 3.5 mA over the entire low frequency range for workers and to 1.5 mA for the general population.

To prevent annoyance by surface effects a basic restriction is set for electric fields at 30 kV/m above 0.1 Hz (42 kV/m at 0 Hz). A basic restriction for static magnetic fields at 2 T prevents vertigo and nausea.

High frequencies

In the high frequency range the ENV uses the following quantities as basic restrictions: Induced current density and contact current at frequencies up to 10 MHz and 3 MHz respectively, the specific absorption rate SAR with different values for whole body, limbs, local heating and the specific absorption SA for pulses of a duration of less than 30 µs at frequencies above 300 MHz.

The current density is set for workers at f/100 mA/m^2, whereas the precautionary factor of 2.5 is maintained for the general public. Between 10 kHz and 100 kHz the contact current limit increases proportionally to the frequency and, between 100 kHz and 3 MHz, remains constant at 35 mA and 20 mA for workers and the general population, respectively.

The threshold for effects which are considered detrimental to health is observed at SAR of 4 W/kg, averaged over a 6 minute time interval and over the whole body. This corresponds to a systemic temperature increase of less than 1^o C at normal conditions. To derive the basic restriction for workers a safety factor of 10 is applied which gives an SAR of 0.4 W/kg. For the general public 0.08 W/kg was chosen. In the high frequency range both rms and peak values are set for the reference levels. Above 10 MHz, reference levels are also given for the mean power density.

REGULATIONS WORLD-WIDE

Some European countries have already developed national standards or guidelines for the protection of the population from electromagnetic fields. Problems to overcome in harmonization were whether a one tier or a two tier structure of the standard should be adopted and how to define the two levels of protection. For example Great Britain's NRPB guidelines[2] give one set of limits which are valid for everyone whereas Germany's DIN/VDE Standard[3] and Austria's ÖVE Standards[4,5] distinguish between controlled/uncontrolled areas and workers/general public, respectively.

Table 1a,b. Limit values of CENELEC ENV 50166[1], IRPA guidelines[6-8] and CEU draft Directive[9] for exposure of workers over a full working day. The SA limit refers to pulses of duration less than 30 µs at a frequency above 300 MHz.

(a) power frequency 50/60 Hz	**CENELEC**	**IRPA**	**CEU**
Induced current density , head and trunk [mA/m^2]	10	10	10
Electric field strength [kV/m]	10	10	19.6;12.3;6.1
Magnetic flux density [mT]	1.6	0.5	0.64;0.4; 0.2
Contact current [mA]	3.5		1.5

(b) high frequencies	**CENELEC**	**IRPA**	**CEU**
Frequency range [Hz]	$1.0x10^4$-$3.0x10^{11}$	$1.0x10^7$-$3.0x10^{11}$	$1.0x10^5$-$3.0x10^{11}$
Specific absorption rate SAR [W/kg]			
Whole body	0.4	0.4	0.4
Extremities (averaged over 10 g tissue)	20	20	20
Head and trunk (av. Over 10 g)	10	10	10
Peak specific absorption rate SA [mJ/kg]	10		10
Contact current (0.1 - 3 (100) MHz) [mA]	35	(50)	50

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) and, previously, the International Non-Ionizing Radiation Protection Committee (INIRC) of the International Radiation Protection Association (IRPA) developed guidelines at 0 Hz, 50/60 Hz and in the high frequency range from 100 kHz to 300 GHz in 1994[6], 1990[7], and 1988[8], respectively. (Subsequently reference is made to all these institutions as IRPA.). Guidelines over the entire frequency range are currently under preparation.

In August 1994 the Commission of the European Communities (CEU) published an amended proposal for a council directive on the minimum safety and health requirements regarding the exposure of workers to the risks arising from physical agents[9]. Noise, vibration, optical radiation and electromagnetic fields and waves are covered. In addition to exposure limits the draft directive sets 3 action levels for the external field strengths requiring specific actions, when exceeded. Included in Figures 1 and 2 is action level 2 (denoted by CEU AL2) as well as the limits of the ANSI/IEEE standard[10] and the ACGIH threshold limit values (TLV)[11].

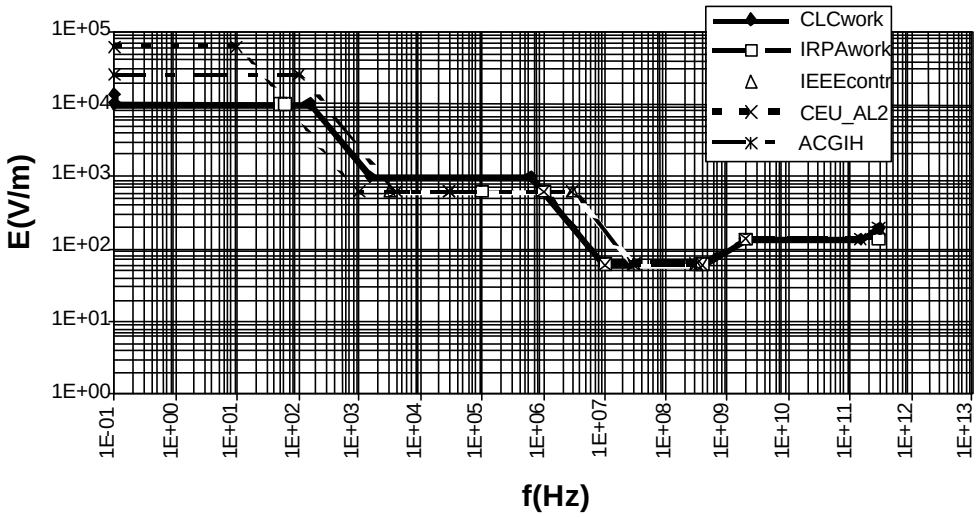

Figure 1. Comparison of electric field strength limit values for workers and continuous exposure over a full working day (for notations see box). CENELEC set reference levels over the entire frequency range. IRPA limit values exist at 50/60 Hz and in the frequency range 100 kHz to 300 GHz. The medium action level of CEU is denoted by CEU AL2. The IEEE limit values are defined in the frequency range from 3 kHz to 300 MHz and refer to controlled areas. They coincide with ACGIH's threshold limit values for workers which extend to lower frequencies. For higher frequencies power density limit values are set by these American institutions.

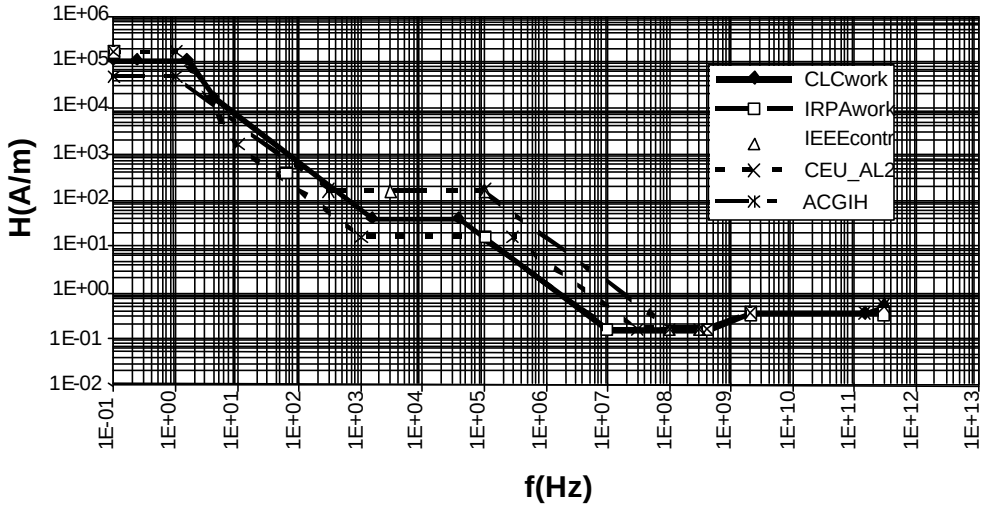

Figure 2. Comparison of magnetic field strength limit values for workers and continuous exposure over a full working day (for notations see box). Details as in Figure 1.

CONCLUSIONS

When comparing the various regulations the different definitions of the limits need to be taken into account. The ENV has adopted the view of IRPA in distinguishing between occupational exposure and the exposure of the general public which has proved a useful distinction in ionizing radiation protection for many years. The lower limits for the general public make sense because this consists of people of all ages and health status. Workers enjoy regular health examinations. Furthermore, public exposure is not restricted to working hours and the period of working life. In many countries different authorities are in charge of public and working health matters.

However, there are also limits to this concept which show the merits of the distinction between different areas, e.g. controlled and uncontrolled areas, instead of two different human groups. It is expected that, in the long run, elements of the second concept will be incorporated into the standard.

When talking about convergence of international regulations it should be noted that there already is far reaching agreement. Generally the regulations of CENELEC, IRPA/ICNIRP and CEU are based on the same criteria. For workers there is full agreement between the basic restrictions of CENELEC, the basic criteria of IRPA/ICNIRP and the exposure limits of CEU for the induced current density and SAR, which are the starting points for deriving the respective field strengths (e.g. Tab.1). For the general public IRPA uses a safety factor of 5 for the current density limit value at 50/60 Hz as well as for SAR at high frequencies. CENELEC also uses 5 at high frequencies but 2.5 at power frequency which leads to different reference levels for the public.

Because exposure to strong electric fields cause discomfort and stress the reference level E is set inversely proportional to the exposure duration in hours t (h). CENELEC also uses IRPA's formula E (kV/m $\leq$ 80/ t (h)). At 50/60 Hz CENELEC's reference level for the public is 10 kV/m without time restriction whereas IRPA sets 5 kV/m for continuous exposure and allows 10 kV/m for few hours per day. This limit value can be exceeded for few minutes per day provided the basic restriction of 2 mA/m^2 is met.

Taking into account the uncertainties in the biological cause-effect data it seems that the protection provided by these regulations is very similar. The differences between CENELEC and IRPA appear to be larger for the magnetic field reference levels: 1.6 mT and 0.64 mT of CENELEC contrast with IRPA's 0.5 mT and 0.1 mT for occupational and public exposure, respectively. For shorter exposure durations, however, IRPA's limit values for few hours per day of 5 mT (workers) and 1 mT (public) exceed CENELEC's respective reference levels.

There is excellent agreement between CENELEC's high frequency reference levels and IRPA's field limits for workers above 100 kHz and for the public above 10 MHz. It is the frequency range from a few kHz to a few 10 MHz where the differences between the various regulations are largest (Fig. 1 and 2). The reason for the divergent opinions has to be investigated in order to achieve convergence as far as possible.

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CROATIA

REPORT OF EMF ACTIVITIES IN CROATIA

Dina Šimunic

At present there is no Croatian regulation concerning the influence of electromagnetic fields on human health. Therefore, a group of experts appointed by the Minister of Health provided the final version of the "Non-Ionizing Radiation Law." The law is based on ICNIRP guidelines and it is expected to be adopted by the Croatian Assembly by the end of 1999.

The CENELEC TC 111 pre-standards (ENV 50166) are being tested and will be enforced as Croatian norms by the Croatian Office for Standards and Norms. Also, the other specifications and standards, as soon as they are ratified by the European Union, will be adopted by the same Office.

EUROPEAN COMMUNITY

PROGRESS REPORT ON THE PROPOSAL FOR AN EC - COUNCIL RECOMMENDATION ON THE LIMITATION OF EXPOSURE OF THE GENERAL PUBLIC TO ELECTROMAGNETIC FIELDS 0 Hz – 300 GHz

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Herewith I would like to inform you about recent activities concerning electromagnetic fields in the European Community.

The European Commission presented the Council on 11 June 1998 with the proposal for an EC - Council Recommendation on the limitation of exposure of the general public to electromagnetic fields 0 Hz – 300 GHz.

The aim of the proposal for a Council Recommendation is to provide for a commonly agreed framework concerning a high level of protection against established effects from 0 Hz - 300 GHz electromagnetic fields.

The proposal is based on a set of basic restrictions and reference levels for the general public as developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in the „Guidelines for Limiting Exposure to Time – Varying Electric, Magnetic and Electromagnetic Fields“ published in April 1998 and the comments published recently in Health Physics as „questions and answers“ to these ICNIRP Guidelines .

The Council decided on 3 July 1998 to consult, on a facultative basis, the European Parliament on this proposal, taking account of the general interest the Parliament has shown for this subject matter in the past.

The Parliament´s Opinion will not be available before the beginning of next year.

Under the Austrian Presidency the proposal for a Recommendation has repeatedly been examined. The principle of adopting a Recommendation in this area is supported by a large majority of delegations, for some of them, however, subject to further clarification of specific questions concerning the body of the text and/or technical questions related to the annexes. Some delegations still have a general reservation on the text under examination.

Negotiations will continue during the German Presidency.

FRANCE

Exposure standards in France

Bernard Veyret

There are no specific French standards for exposure limits to electromagnetic fields.

At the present time, the CENELEC TC 111 pre-standards (ENV 50166) are being tested.

The French standardization agency (AFNOR) has them registered as C 18-600 (ELF) and C 18-610 (RF).

When ratified, the future European standards, whether or not they are based on these pre-standards, will be enforced in France.

GERMANY

Standards in Germany

Axel Böttger
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At 1 January 1997 the 26th Ordinance Implementing the Federal Emission Control Act (EMF Ordinance) came into force. This ordinance shall apply to the erection and operation of high frequency installations and low frequency installations which serve commercial purposes or are used in the course of commercial undertakings and do not require special approval of the Federal Emission Control Act. It contains requirements for the protection of the public and the neighbourhood from harmful environmental impacts due to electromagnetic fields. The ordinance shall not take into account any effects of electromagnetic fields on electrically or electronically driven medical implants. For the purpose of this ordinance high frequency installations shall mean stationary radiofrequency installations with a transmission power of 10 W equivalent isotropic radiation power or more which generate electromagnetic fields in the frequency range from 10 MHz to 300,000 MHz. Low frequency installations shall mean stationary installations for transformation and transmission of electricity including overhead transmission lines and underground cables, traction power trunk lines and traction power overhead lines including transformer and switchgear systems, and electric transformer installations including switchgear units with a voltage of 1,000 Volts or more.

In the interest of protection from harmful environmental impacts, high frequency installations are to be erected and operated such that, at maximum operating capacity and by taking account of emissions by other stationary radiofrequency transmission installations

- the limit values for the relevant frequency range are not exceeded and
- in addition, the peak values of the electric and the magnetic field strength in the case of pulsed electromagnetic fields do not exceed 32 times of the limit values

in buildings or on land for the non-transient presence of humans as are situated within their sphere of influence.

Low frequency installations are to be erected and operated such that, while they operate at maximum capacity and by taking account of emissions by other low frequency installations, the limit values are not exceeded in buildings or land intended for the non-transient presence of humans as are situated within their sphere of influence. The limit values shall be disregarded under very strict conditions by no more than 100 percent for short time.

In the interest of precaution low frequency installations in the vicinity of dwellings, hospitals, schools, kindergartens, crèches, playgrounds or similar facilities the limit values in such buildings or on such land shall also comply with the requirements but without the exceptions mentioned above.

The ordinance does not cover the whole EMF spectrum from the static field up to high radiofrequency fields. It was the intention of the Federal Government that the limit

values of this ordinance are based on international accepted peer reviewed recommendations of the International Radiation Protection Association/INIRC and the World Health Organization as well as on recommendations of the National Radiation Protection Commission. Because of some changes in the new recommendations of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) which were published in April 1998 we did not include the range of 0.1 to 10 MHz on which recommendation existed at the time of implementation of the ordinance.

These are the limit values of the ordinance.

Frequency (f) in Megahertz	Effective field strength value, root-mean-square average over six-minute periods	
	Electric field strength in Volt per Metre (V/m)	Magnetic filed strength in Ampere per Metre (A/m)
10 - 400	27.5	0.073
400 - 2000	$1.375\sqrt{f}$	$0.0037\sqrt{f}$
2000 - 300000	61	0.16

Frequency (f) in Hertz	Effective value of electric field strength and magnetic flux density	
	Electric field strength in Kilovolt per Metre (kV/m)	Magnetic flux density in microtesla (µT)
50 Hz fields	5	100
$16\ ^{2}/_{3}$ Hz fields	10	300

Technical standards have to follow the framework of the ordinance.

The ordinance gave safety to people as well as to companies which run power lines, basis stations etc. as expected. I want to stress that the ordinance was also accepted by the highest courts in Germany. Because of the new ICNIRP guidelines published in April this year we will start the revision of the ordinance next year.

HUNGARY

EXPOSURE STANDARD OF ELECTROMAGNETIC FIELDS IN HUNGARY

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STANDARDS IN HUNGARY

In Hungary the first standard relevant to electromagnetic field and human exposure was released in 1985 by the governmental Hungarian Standard Institution (HSI). The standard covers the frequency range of 30 kHz-300 GHz. The title of standard is "Safety levels of high frequency electromagnetic fields" and issued as MSZ 16260-86 Standard. The standard separated in permissible levels for general public and workers, as defined the controlled and uncontrolled area. A third area was also defined which is not allowed to access for humans (only with safety shielded clothes). The values of permissible levels between 300 MHz - 300 GHz are close to the reference levels of Eastern European countries. In the range of 300 kHz - 300 GHz the standard defines an additional tier as called harmless area. In this frequency range, after a correction of permissible levels in 1993, the reference levels are close to the EU or ICNIRP values (see Table I and II).

Below 30 kHz no National Standard was released relevant to the human exposure. Although a National Standard has been issued in 1986 (MSZ 151/5-86) titled "Overhead lines for power transmission. Approaches and crossing" in which one item deals with the exposure limits to humans but only for electric field and not magnetic. The permissible level of electric field at 50 Hz frequency for the area that is accessible to public is 5 kV/m. No permissible level for exposure to magnetic field. Therefore in Hungary we use in practice the ICNIRP Guidelines for the frequency range below 30 kHz both for electric and magnetic field.

TABLE I: Hungarian MSZ 16260-86 Standard: "Safety levels of high frequency electromagnetic fields" in the frequency range 30 kHz-300 MHz

	Electric field strength (V/m)		
Area	30 kHz-3 MHz	3-30 MHz	30-300 MHz
Harmless	3	3	3
Uncontrolled (general public)	50	30	20
Controlled (occupational)	120	60	40
Restricted in time (for occupational)	960/hours	480/hours	320/hours
Harmful (not allowed)	1000	600	400

TABLE II: Hungarian MSZ 16260-86 Standard: "Safety levels of high frequency electromagnetic fields" in the frequency range 300 MHz-300 GHz

Area	**Power density (mW/cm^2) 300 MHz-300 GHz**	
	Standing source	Rotating source
Uncontrolled (general public)	0.01	0.1
Controlled (occupational)-	0.1	1.0
Restricted in time (for occupational)	$\sqrt{\frac{0.08}{hour}}$	$\sqrt{\frac{8}{hour}}$
Harmful (not allowed)	10	100

In May 1997 the Hungarian Standard Institution released the European Pre-standard (ENV 50166-1/2) as the Hungarian Pre-standard as MSZ ENV 50166-1/2. The Pre-standard has an *Endorsement Notice:* "The European Pre-standard ENV 50166-1/2:1995 "Human Exposure to Electromagnetic Fields. Low Frequency (0 Hz to 10 kHz)/High Frequency (10 kHz-300 GHz)" has been endorsed by the Hungarian Standard Institution as a Hungarian National Pre-standard. The English version of the European Pre-standard shall be considered as the Hungarian National Pre-standard." The Pre-standard also introduced a *National Foreword:* "The relevant Hungarian standard which is valid (is in operation) the MSZ 151/5-86 for low frequency range and the MSZ 16260-86 for high frequency range". According to the general policy accepted by Hungarian Parliament relevant to all EU standards, the EU confirmed standards shall be considered as Hungarian National Standard.

EXPERIENCES IN PUBLIC EXPOSURE AND COMMENTS TO EU PRE-STANDARD

The individuals or citizen's groups feel they need to determine whether they or their children's health will be affected by the increasing exposure to EMF fields. This is especially true for country like Hungary. Therefore discussing about evaluating present EU Pre-standard need to put into the social and economic impact of standards. Our experience is that the permissible reference levels for general public according to the EU Pre-standard are much higher than the exposure to humans where the exposure may occur to general public. Because of this wide gap between the possible exposure to general public and relevant reference levels, many times happens that the human exposure may be *definitely higher than the general environment level but many times lower the permissible reference level*. This exposure condition generally occur over the transformers installed in the basement of a building, where the 50 Hz magnetic field exposure may close to 30-40 μT and the general environmental level in a modern building is typically 0.1-0.3 μT. Hardly can be found any area where the exposure may close or even exceed the EU reference levels for general public in particular the 50 Hz frequency range. Therefore the EU reference level at 50 Hz (and ELF) frequency range should be reduced at least near to ICNIRP Guidelines or more.

ICNIRP

WHO EMF Project Round Table on "Harmonization of EMF Exposure Standards"

The ICNIRP EMF-Guidelines: Criteria, Development and Practical Implementation, Further Needs

JH Bernhardt, Chairman of ICNIRP, D-85764 Munich-Oberschleissheim

Criteria for evaluating scientific studies

The development of exposure guidelines requires a critical, in-depth evaluation of the established scientific literature on the basis of internationally accepted quality criteria. Experimental results can only be accepted for health risk assessment if a complete description of the experimental technique and dosimetry are provided, all data are fully analysed and completely objective, results show a high level of statistical significance, are quantifiable and susceptible to independent confirmation, and the same effects can be reproduced by independent laboratories. It is necessary to identify which EMF-induced biological effects are to be considered a hazard to human health. Criteria that have been widely accepted when evaluating epidemiological studies include the assessment of strength and consistency of the association between EMF exposure and biological effects, evidence of a dose-response relationship, supporting evidence provided by laboratory studies, and plausibility that biological systems exposed to EMF field could likely manifest biological effects.

Development of exposure guidelines

International recommendations of health based guidance to limiting exposure require an assessment of possible adverse health effects using established scientific and medical knowledge. This assessment should be free of vested interest. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent scientific body comprising all essential scientific disciplines, is qualified to carry out the task of the assessment of possible adverse health effects, together with WHO. ICNIRP is the formally recognized non-governmental organization in NIR protection for the WHO, the International Labour Organization (ILO) and the European Union (EU), and maintains a close liaison and working relationship with relevant international bodies such as WHO, IEC and CIE who are engaged in the field of non-Ionizing radiation (NIR) protection. The ICNIRP review process includes Standing Committees of non-members and consultations with the IRPA national bodies and additional experts. ICNIRP works in conjunction with the WHO to assess health effects of exposure to NIR and uses the results of this assessment to draft health-based exposure guidelines.

Recently the ICNIRP adopted guidelines on limits of EMF exposure for frequencies up to 300 GHz. While all the scientific literature were reviewed, the only established effects are short-term, immediate health consequences such as stimulation of peripheral nerves and muscles, functional changes in the nervous system and other tissues, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposures to EMF. Two classes of limiting values are presented. These are basic restrictions and reference levels. Basic restrictions directly relate to established health effects. Appropriate safety factors are included. By using the system of basic restrictions and

derived reference levels, the new ICNIRP guidelines offer flexibility for many exposure situations.

The use of safety factors

It is ICNIRP´s view that safety factors should relate to the precision of the science, reflecting the amount of established information on biological and human health effects of EMF exposure. As with assessment of adverse health effects, setting safety factors should be free from vested interest.

There is no rigorous basis for derivation of safety factors. In the new ICNIRP guidelines safety factors vary from approx. 2 to > 10 depending upon the extent of uncertainty in knowledge of thresholds for health effects for direct and indirect field interaction at various frequencies. In general, threshold field levels for indirect effects (e.g., response to contact currents) are better defined than for direct effects, and hence less conservative safety factors are required. Public guidelines include additional safety factors of 2 to 5 relative to occupational guidelines (depending upon the frequency and the relevant dosimetric parameters), for reasons given in the guidelines.

Practical application of the guidelines

Reference levels are provided for practical exposure assessment purposes, to determine whether the basic restrictions are likely to be exceeded. Reference levels are derived from the basic restrictions by mathematical modelling and extrapolation from the results of laboratory investigations at specific frequencies. They apply for the maximum coupling condition of the field to the exposed person, thereby providing maximum protection. Restrictions are different for workers and the general public. The frequency dependence of the reference field levels is consistent with data on both biological effects and coupling of the fields. ICNIRP recommends the use of the reference levels as a general guidance for EMF limits for workers and the general public.

Special technical advice

ICNIRP recognizes that the reference levels are for maximum coupling conditions and may cause difficulties in some special exposure situations. These include near field exposure or exposure to inhomogeneous fields. In such situations, while the reference levels may be exceeded, there may be compliance with the basic restriction due to the weak coupling of the field with the human body. Examples of typical EM sources with near field exposure are handheld telephones, inductive or dielectric heating equipment, anti-theft devices or electric appliances in homes and workplaces. ICNIRP recognizes the need for technical advice on the translation of biologically justified restrictions on human exposure into practical exposure limitations. This includes numerical modelling of the human body, field coupling to the body, knowledge of the design of devices and the principles and practices of the field measurement. For these reasons the ICNIRP guidelines do not address product performance standards or guidance concerning computational methods or measuring techniques.

ICNIRP considers that international bodies for technical standardization (e.g., IEC, CENELEC) should develop product standards for devices to determine compliance with the basic restrictions.

Social and economic impact

Assessment of adverse health effects of EMF exposure and ICNIRP‘s health based guidance limiting EMF exposure are based on established scientific data and are free of vested interest. They do not take into account political, social and economic considerations. It is ICNIRP´s view that the enforcement of compliance and assessment of the social and economic impact is the responsibility of national governments and their authorities.

Future needs and outlook

Development of EMF standards is an ongoing process. WHO´s International EMF Project includes encouragement of focused, high quality research and incorporation of research results into WHO´s Environmental Health Criteria monographs where formal health risk assessments will be made of EMF exposure. ICNIRP, as the scientific arm of WHO´s NIR activities, will use the results of these assessments to revise the present health based exposure guidelines.

INDIA

EM Radiation Safety Standards in INDIA

VR Singh

The National Physical Laboratory, New Delhi is responsible for maintaining the reference / national standards for INDIA, both for electrical / electronic and physico–mechanical parameters. The EM dosimeters are developed for safety and standardization. Safety limits for various EM media are also discussed. The development and establishment of indigenous EM standards facilities are discussed here in detail.

ITALY

Italian Standards on Protection against Electromagnetic Fields

Paolo Vecchia

At present, a limited number of regulations exist in Italy, part at national and part at regional level. The development of standards has been heavily influenced by controversies and pressure exerted by the public opinion and the media. That is made evident by the much lower attention to the protection of workers, for whom no standard at all exists. The only reference in this area is the European Pre-norm ENV 50166 issued by CENELEC in 1995 and adopted by the Italian Electrotechnical Committee (CEI) in the same year. It has however the value of a voluntary standard, with no force of law.

National standards

Based on a general assignment of responsibilities, establishing exposure limits (to any physical, chemical, or biological agent) for the general public is the responsibility of the Ministry of the Environment, which is assisted by the Ministry of Health. n the contrary, limits for the exposure of workers are established by the Ministry of Health with the assistance of the Ministry of the Environment and the Ministry of Labour.

As regards ELF fields, a decree was issued in 1992 for the safe exposure of the general public to power frequency (50 Hz) electric and magnetic fields. The exposure limits are identical to those recommended by IRPA/INIRC in 1998, both for the electric and the magnetic fields. The norm has however been criticised for internal inconsistencies. Though it applies to any 50-Hz source, an article specially devoted to power lines requires, in addition to compliance with the limits, also minimum distances from the conductors. These equal 28, 18, and 15 m for 380, 220, and 150 kV lines respectively. It is easy to check that the actual values of the fields at such distances are well below limits, which are set in a separate article of the same decree.

In the area of RF/MW fields, a decree was enforced at the beginning of 1999, limited to the exposure of the population to fields radiated from fixed antennae, in the frequency range 100 kHz – 300 GHz. The main characteristics of the standard are the following:

- no basic limits
- exposure limits given by step-functions, namely:
  - 60 V/m and 0.2 A/m in the frequency range 100 kHz - 3 MHz
  - 20 V/m and 0.05 A/m in the frequency range 3 MHz - 3 GHz
  - 40 V/m and 0.1 A/m in the frequency range 3 - 300 GHz
- "precautionary levels": 6 V/m and 0.016 A/m for any frequency
- all limits and quality goals averaged over 6 min.

"Precautionary levels" are intended to protect from possible, although not specified, long-term effects.

Regional standards

For power frequency fields, the Region Veneto issued a Regional law in 1993. It sets much more restrictive limits than the National decree, namely 0.5 kV/m for the electric field and 0.2 mT for the magnetic flux density; in addition, a minimum distance of 150 m from the lines is required for buildings and residential areas. Due to controversies and problems of practical implementation, the enforcement has however been postponed to the year 2000. Similar laws have later been approved by other regions (e.g. Latium and Puglia) but have been suspended due to the opposition of the national government.

A number of regional laws exist regarding exposure to radiofrequency and microwaves. They show relevant differences, which create confusion and mistrust within the public. Limits adopted by the Region Pedmont correspond to an old hypothesis (later abandoned) of IRPA/INIRC, and are characterised by step-function dependencies on frequency. In Abruzzo, a law similar to Pedmont was modified in 1997 to take into account hypothetical long-term effect. In particular, minimum distances from residential buildings are required for any antenna, irrespective of its directivity (i.e. of ERP). This distance is 50 m for power delivered to the antenna between 5 and 350 W, and 1,000 m for power above 350 W. The law applies to any kind of antennas, including base stations for mobile telephony.

Future standards

The Italian Parliament is presently discussing a draft of "framework law" stating basic principles, responsibilities (national vs. regional or local), penalties, control procedures, etc. In the basic principles, a new concept is introduced besides the established scheme of basic limits and reference levels. So-called "quality goals" are in fact defined as additional values which are well below reference levels. They are to be complied with in the case of new installations, and are to be reached within a certain time for existing ones. In theory, quality goals should be different for different technologies, sources, environments, etc. However, even before they are formally introduced with the enforcement of the framework law, their actual implementation seems completely different: in fact, although termed differently, "precautionary levels" established in the recent decree on RF/MW should probably be intended as "quality goals"

It is worth noting that the framework law should logically precede a number of decrees for different frequency ranges, sources, or technologies. However, under the pressure of the public opinion, the Government as already issued the above mentioned decree on RF/MW fields, and has been called upon from the Parliament to issue a similar one for ELF fields (to replace the existing one) in few months.

In summary, the present activity of development of standards seems to take into account the urgent need for harmonisation within the Country (i.e. different regional regulations), but seems to be very far from any effort for an international harmonisation, and insensitive to it.

JAPAN 1

The Standards Situation in Japan

Chiyoji Ohkubo

ELF-EMF

When 500 kV power transmission lines were constructed, a standard for electric field of 3 kV/m was set by Ministry of International Trade and Industry (MITI) in 1976 to prevent perceptible electrostatic induction. In 1993, the MITI's Electromagnetic Field Effects Research Group reported that " there is no evidence at present to indicate the power frequency electromagnetic fields produced in residential environments have harmful effects on human health, and the strength of magnetic fields produced in residential environments was substantially lower than the views represented by the WHO Environmental Health Criteria and the guidelines of similar organizations. It was therefore felt that there is little need at present to take urgent steps to regulate or standardize power frequency magnetic fields based on their effects on human health. However it is important to scientifically clarify the effects of power frequency magnetic fields on human health in order to provide accurate information based on a correct understanding of the issue. It will be important also be crucial to pursue the following activities in order to accumulate further scientific knowledge on this subject"

RF-EMF (Tables 1-6)

The Telecommunication Technology Council (TTC) which belongs to Ministry of Posts and Telecommunications (MPT) published a report entitled "Radio-Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields" in June 1990. This report indicated measures that should be taken to protect the public. The guidelines set out safety factors that were considered to adequate.

Based on the report, the Association of Radio Industries and Businesses (ARIB) set up private guidelines, "Radiofrequency-Exposure Protection ARIB Standard" (ARIB STD-38) in September 1993. This standard has been used a guideline by the radio operators and manufacturers.

The recent rapid growth of mobile telecommunications is due mainly to the development of small handy sized radio equipment such as cellular phone terminals. (At the end of September 1998, the number of cellular service subscribers was 42,807,000 in Japan.) Up until recently mobile telecommunication terminals were used with their antennas of radiation sources not in close proximity to the human body, however, now this is not the case. Therefore, the study group of MPT recommended to protect human body form radio-radiation. The report made a comparison study between Japanese guidelines and various foreign ones, and made the following recommendations. A. It is not necessary to revise the basic part of the current TTC guidelines of 1990. B. It is necessary to establish additional radio-radiation protection guidelines for the radio equipment whose radiation sources are in close proximity to the body.

In April 1997, the TTC published a report titled "Radio-Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields". In this report, A. Additional

guidelines on local absorption are considered concerning the radio equipment which is used in close proximity to the human body, such as cellular phone terminals. B. The introduction of the radio-radiation protection regulations are considered.

In March 1998, the MPT's Panel that Studies on Desirable Application of Radio-Radiation Protection Guidelines for Human Exposure to Electromagnetic Fields made a report favouring a shift toward compulsory standards from private guidelines.

In September 1998, the Radio Regulatory Council submitted a report to MPT stating that an amendment the "Rules for Enforcement of the Radio Law" to establish "Radio-Radiation Protection Regulations for Human Exposure to Electromagnetic Fields" was appropriate. MPT promulgated the revised rules on 1 October 1998. The rules will come into effect on 1 October 1999.

1. Electromagnetic field strength guidelines (Abstract)

Table 1: Electromagnetic field strength guidelines for controlled environment(condition P)
(Average time: 6 minutes)

Frequency f	rms electric field strength E [V/m]	rms magnetic field strength H [A/m]	Power density S [mW/cm^2]
10kHz - 30kHz	614	163	-------
30kHz - 3MHz	614	4.9 f[MHz]$^{-1}$ (163 – 1.63)	-------
3MHz - 30MHz	1.842 f[MHz]$^{-1}$ (614-61.4)	4.9 f[MHz]$^{-1}$ (1.63 – 0.163)	-------
30MHz - 300MHz	61.4	0.163	1
300MHz - 1.5GHz	3.54 f[MHz]$^{1/2}$ (61.4 – 137)	f[MHz]$^{1/2}$/106 (0.163 – 0.365)	f [MHz]/300 (1-5)
1.5GHz - 300GHz	137	0.365	5

Table 2: Electromagnetic field strength guidelines for general condition (condition G)
(Average time: 6 minutes)

Frequency f	rms electric field strength E [V/m]	rms magnetic field strength H [A/m]	Power density S [mW/cm^2]
10kHz - 30kHz	275	72.8	-------
30kHz - 3MHz	275	2.18f[MHz]$^{-1}$ (72.8 – 0.728)	-------
3MHz - 30MHz	824 f[MHz]$^{-1}$ (275 – 27.5)	2.18 f[MHz]$^{-1}$ (0.728 – 0.0728)	-------
30MHz - 300MHz	27.5	0.0728	0.2
300MHz - 1.5GHz	1.585 f[MHz]$^{1/2}$ (27.5 – 61.4)	f[MHz]$^{1/2}$/237.8 (0.0728 – 0.163)	f [MHz]/300 (0.2-1)
1.5GHz - 300GHz	61.4	0.163	1

2. Supplementary guidelines (Abstract)

Table 3: Supplementary guidelines for cases of non uniform or partial body exposure

	10 kHz-300 MHz	300 MHz-1 GHz	1 GHz-3 GHz	3 GHz-300 GHz
Spatial average of Electromagnetic field strength	Controlled environment: Table 1 is applied General environment: Table 2 is applied			
Spatial maximum of electromagnetic field strength	--------	Body excluding extremities: Controlled env.: 20 mW/cm^2 General env.: 4 mW/cm^2		Skin surface: Controlled env.: 50 mW/cm^2 General env.: 10 mW/cm^2
	--------	--------	Head: Controlled env.: 10 mW/cm^2 General env.: 2 mW/cm^2	Eyes: Controlled env.:10 mW/cm^2 General env.: 2 mW/cm^2
Relevant space	*1	Space occupied by a human body separated by more than 10 cm From the electromagnetic radiation source and metallic objects		
Average time	6 minutes			

*1: Space occupied by a human body separated by more than 20 cm from the electromagnetic radiation source and metallic objects

Table 4: Guideline for contact current

Frequency		Contact current
10 kHz - 100 kHz	Controlled environment General environment	10^{-3} f[z] mA (average time < 1 second) 4.5H10^{-4} f[z] mA (average time < 1 second)
100 kHz - 15 MHz	Controlled environment General environment	100 mA (average time: 6 minutes) 45 mA (average time: 6 minutes)

Table 5: Guidelines for induced current at an ankle

Frequency		Induced current at an ankle
3 kHz - 300 kHz	Controlled environment General environment	100 mA (average time: 6 minutes) 45 mA (average time: 6 minutes)

3. Partial-body absorption guidelines (Abstract)

These guidelines are applied to the small radio equipment which is used in close proximity to the human body* at the frequency from 100 kHz to 3 GHz.

Table 6: Partial-body absorption guidelines

	Controlled environment	General environment
Whole-body SAR	0.4 W/kg	0.8 W/kg
Partial-body SAR	For any 10-gram tissue, 10W/kg 20W/kg (extremities)	For any 10-gram tissue, 2W/kg 4 W/kg (extremities)
Contact current	100 mA In cases whereby the contact hazard is not prevented and the frequency is between 100 kHz-100 MHz	45 mA In cases whereby the contact hazard is not prevented and the frequency is between 100 kHz – 100 MHz

(Average time: 6 minutes)

Note: When the contact current comprises multiple frequency components of significant levels with respect to the guideline values, calculate the squared contact current of each frequency component to the square of its corresponding guideline value, and the sum of these fractions must not exceed 1.

JAPAN 2

Regulatory Activities in Japan

The Ministry of Posts and Telecommunications has been involved in the safety issue of radiofrequency EMF exposure. The MPT issued its own guideline for 10 kHz to 300 GHz as a report of the Telecommunications Technology Council (TT Council) in 1990. This guideline was mostly consistent with ANSI/IEEE C95.1-1992 and INIRC/IRPA's 1988 guideline. In 1997 the MPT slightly revised this guideline. The important change was in the restriction for local SARs from 8 W/kg for 1 g tissue to 10 W/kg for 10 g tissue in the case of controlled environment and one fifth of these values for general environment. This revision resulted in more consistency with the current ICNIRP guidelines of 1998.

The MPT has decided to set to mandatory regulation of exposure of general public to environmental RF fields in September 1998 in the framework of the Radio Law. This decision will be effective from October 1999. Any radio stations except mobile stations and those for emergency use will have to make assessment of RF environment in the application of license.

The Agency of Natural Resources and Energy (ANRE) in the Ministry of International Trade and Industries (MITI) is responsible for electric power facilities. Regulation of 3 kV/m electric field strength beneath high voltage power transmission lines was enacted in 1976 by the Ministerial Ordinance of Standards for Electrical Equipment. This clause is not intended to protect human health but to avoid electric shock, which might be caused by electric field. No guidelines on ELF magnetic fields, however, have been recommended by any government organizations.

Recently the Japan Society for Occupational Health has recommended exposure limits on EMF below 300 GHz including static fields. The exposure limits are only applied to occupational exposure. The recommended exposure limits are consistent with the MPT guidelines in RF region and with ICNIRP guidelines in low frequency region. This guidance is of voluntary nature but the occupational hygienists will be likely to utilise this guidance in their surveillance of occupational environment.

NATO

NATO ACTIVITIES TOWARDS HARMONIZATION OF RADIO FREQUENCY RADIATION (RFR) SAFETY STANDARDIZATION*

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*These views and opinions expressed in this paper are those of the author and do not necessarily state or reflect those the United States Air Force, Department of Defence, Department of Energy, US Government, nor the North Atlantic Treaty Organization.

1. Introduction

The North Atlantic Treaty Organization (NATO) has been involved in research and standards setting activities concerning effects of RFR on military personnel, ordinance, and fuel for nearly three decades. The need for assessment and harmonization of RFR safety-guidance continues today, as safety standards are updated throughout the world, and as new RFR systems come on line. The adoption of a scientifically acceptable and defensible standard for human exposure to RFR that is applicable across national boundaries is of significant importance to commanders and operators engaged in multinational exercises and operations. Rapidly expanding technologies require that systems hardware and operations are integrated and compatible within NATO. Accomplishing this requires harmonization of standards.

2. NATO Standardization Programs

NATO has sponsored several programs on RFR that directly support standardization harmonization. These include a NATO Advanced Research Workshop (ARW) on "Developing a New Standardization Agreement (STANAG) for Radiofrequency Radiation" held 16-21 May 1993. The ARW produced a NATO ASI Proceedings with over 40 papers: *Radiofrequency Radiation Standards, Biological Effects, Dosimetry, Epidemiology, and Public Health Policy* [1]. This meeting initiated a successful three-year effort to revise the NATO STANAG 2345 *Evaluation and Control of Personnel Exposure to Radio Frequency Fields - 3 kHz to 300 GHz.* The most recent NATO ARW on *Radio Frequency Radiation Dosimetry, Measurements And The Relationship Between SAR, Power Density And The Biological Effects Of The Electromagnetic Fields* was held in Slovenia 12-16 October 1998.

NATO is the world's largest producer of international standardization agreements. The Military Agency for Standardization (MAS) is the principal military agency for

Standardization within NATO. Its purpose is to facilitate operational, procedural, and materiel Standardization among member nations to enable NATO forces to operate together in the most effective manner. NATO STANAGs allow for establishing co-ordinated minimal standards necessary for achieving the very important goals of commonality, compatibility, interchangeability, and interoperability.

Standardization is voluntary, and is achieved by agreement, not compulsion. Each NATO member has an equal voice. The MAS cannot enforce any agreement; nor can it require national conformity to any policy. MAS authority with regard to Standardization comes only from formal agreement of nations, through their representative, within the rule of consensus.

The 1993 NATO ARW, Developing a New Standardization Agreement (STANAG) for Radio-Frequency Radiation, initiated the process of revising STANAG 2345. The 1993 ARW produced several recommendations for updating the STANAG 2345. Most important was the agreement to use the newly published non-governmental consensus ANSI/IEEE C-95.1-1992 standard [2] as a starting point or straw man for updating STANAG 2345. The international make-up of the IEEE Standards Coordinating Committee-28 (SCC-28) and the relative recency of the standard were factors in selecting the ANSI/IEEE C95.1-1992 as a foundation for the second edition of STANAG 2345. The STANAG 2345 (EDITION 2) [3] is frequency dependent and covers the range from 3 kHz to 300 GHz, taking into account frequency dependency of SAR, and gives advice on limitation of plane-wave field intensity. It is a single-tiered standard that incorporates the controlled values of the ANSI/IEEE C-95.1-1992, in recognition of the military operational circumstances under which it will be implemented. It allows use of protective clothing, if demonstrated to be effective under operational conditions. The STANAG also provides special considerations for induced and contact current guidance. Most important, the STANAG serves as the minimum acceptable standard for NATO operations and will not supersede National Standards that have lower (more restrictive) Permissible Exposure Limits. Member nations of the General Medical Working Group (MED), unanimously recommended ratification of STANAG 2345 (Edition 2) in April 1996 and final promulgation by the MAS was 13 October 1997.

Since STANAGs are supposed to be reviewed and reaffirmed every two years, the 47th MED, in May 1998, directed the Custodial Technical Representative for STANAG 2345 to form an Ad Hoc working group to determine if the STANAG required amendment in the light of recent changes in international standards. This meeting occurred at Brooks Air Force Base in September 1998 and several recent modifications of the ANSI/IEEE C95.1-1992 standard regarding induced and contact currents were proposed. The proposed changes will be circulated to the nations for comment and a state of consensus will be presented by the Custodial Technical Representative to the 48th MED in May 1999.

3. NATO Transition and Expansion Opportunities for Harmonization

A significant initiative at NATO has been establishment of close security links with the states of Central and Eastern Europe and those of the former Soviet Union through the Partnership for Peace (PfP) program. Twenty-six nation states participate.

One of the mechanisms for increasing ties with Partner countries is the inclusion of PfP states in some of the activities of the MED and the Radio and Radar Radiation Hazards (RADHAZ) Working Groups. At these meetings, PfP nations and NATO member nations

have exchanged RFR safety standards in an effort to increase communication, to facilitate scientific information exchange, to facilitate harmonization of standards, and to become more informed on NATO Standardization issues in preparation for possible admittance into NATO.

4. Conclusion

Clearly, NATO has a long history of continuing support for scientific investigation into fundamental biological effects of exposure to RFR necessary for development of sensible and defensible safety standards. This support of research and Standardization contributes significantly to the global approach to Standardization. There is an increased attention at NATO for standardization to provide increased harmonization. With the expansion of NATO and new collaborations with other international organizations concerned with health and safety issues, such as the World Health Organization, NATO has become an important mechanism in facilitating international scientific research, data exchange and global harmonization of RFR standards.

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2. Institute of Electronics and Electrical Engineers (IEEE) C95.1-1991 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 kHz. (1991).

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NEW ZEALAND (see Australia)

POLAND

The Polish standard for occupational and general public exposure

Stanislaw Szmigielski

The Polish standard for occupational and general public exposure is in the process of amendment. The new general public limits were issued in August 1998 but the occupational exposure levels are still under discussion in the national committee established by the Ministry of Health. Therefore the old occupational exposure standard is still effective. This old standard was established in 1972 and 1997 (0.1 – 300 GHz), in 1985 (50 Hz) with extensions added in 1995 (1 – 100 kHz).

In the future a complex of occupational and public exposure standard covering the whole frequency range from 0 Hz to 300 GHz is planned to be issued.

The Polish standard applied to the occupational conditions allows to inhabit for a short period of time in EM field values comparable or even greater than those admitted by CENELEC, IRPA or ANSI standards. The values for workplace are strongly correlated with the exposure time and therefore are 5 – 50 times lower for longer exposure times (for example for 8 hr working shift). Especially in the band of microwaves the permissible exposure time falls quickly down.

The newly issued general public exposure standard (1998) is still set lower than the proposals of CENELEC, IRPA or ANSI for the same frequencz range (0.1 Hz to 300 GHz). This is due to the fact that earlier Polish standard (1980) was set at extremely low levels and it could be difficult to increase the public values too drastically in the future, but it seems rather questionable to achieve the proposed CENELEC, IRPA or ANSI values.

There is a possibility to harmonize Polish exposure standard with the standards proposed by CENELEC, IRPA or ANSI, but first of all the problem of dose and/or the exposure time have to be discussed. It seems a more difficult task would be a trial to harmonize general public exposure standards than occupational standards.

RUSSIA

THE RUSSIAN STANDARDS (EMF RF)

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To underline that 40 years ago, in 1958 in Russia the first EMF standard in the range of 300 MHz - 300 GHz was authorized at the state level.

The first Russia standards were based on the results of clinico-hygienic researches of the 50s, reinforced by the experimental data, having been available provided limitation of two rationed parameters - intensity and time of exposure with the determination of three limits: 10 $\mu W/cm^2$ - for 8 h; 100 $\mu W/cm^2$ - up to 2 h and 1000 $\mu W/cm^2$ - up to 20 minutes for a working day.

These standards for past 40 years were not subjected to essential changes. Besides for the last 25 years the accumulated material has shown the reliability of these standards and, apparently, certain validity.

System of a sanitary-hygienic Standardization of electromagnetic fields in Russia at present.

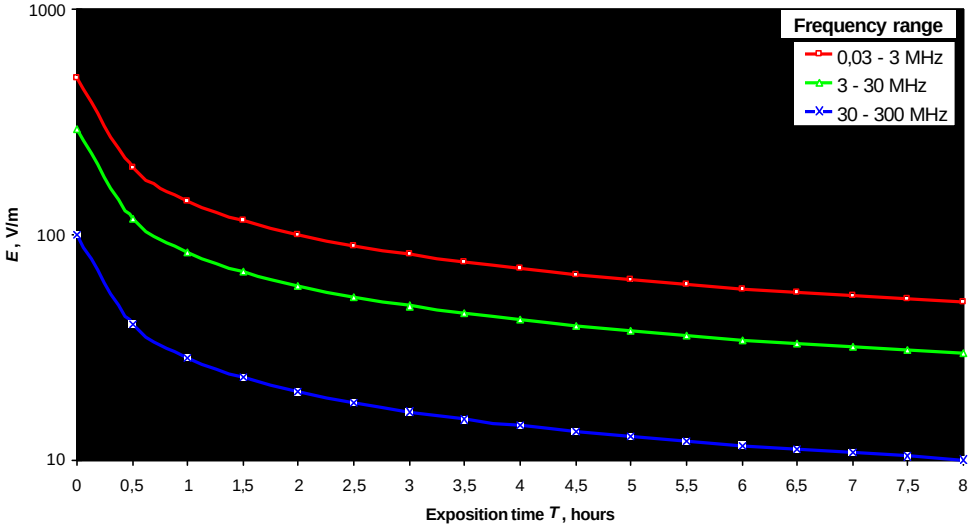
In Russia the system of the standards on electromagnetic safety consists of State Standards (GOST) and Sanitary norms and rules (SanPiN). These interconnected documents are mandatory for performance on the whole territory of Russia.

The commissioning State Standards executes State Committee on Standardization of the Russian Federation.

The Sanitary norms and rules regulate hygienic demands to more particular situations of irradiation and also to separate kinds of production. The Sanitary norms and regulations contain the same main items as the State Standards, however in more detail. As a rule, the sanitary norms and rules are accompanied by the methodical instructions on realization of the control of electromagnetic conditions and protective measures.

The commissioning of the Sanitary norms and rules executes the Ministry of Public Health of the Russian Federation.

Fig. 1 Limit values for electric field strength ***E*** (workplace) according to GOST 12.1.006-84 and SanPiN 2.2.4/2.1.8.055-96



Sanitary norms and rules in Russia at present

There is SanPin 2.2.4/2.1.8.055-96. Fig. 1-4.

Fig. 2**.** Limit values for magnetic field strength ***H*** (workplace) according to GOST 12.1.006-84 and SanPiN 2.2.4/2.1.8.055-96

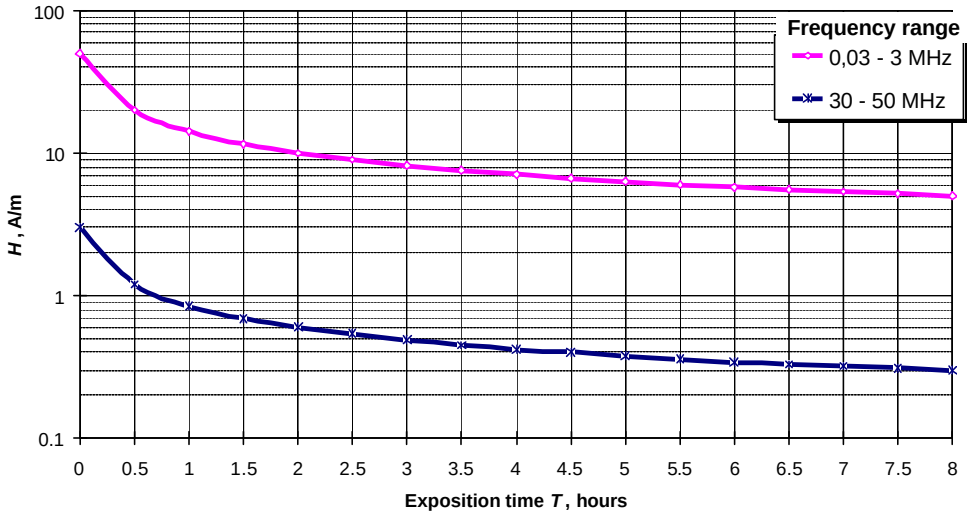


Fig. 3. Limit values for power flux density ***S*** in the frequency range 0,3 - 300 GHz (workplace) according to GOST 12.1.006-84 and SanPiN 2.2.4/2.1.8.055-96

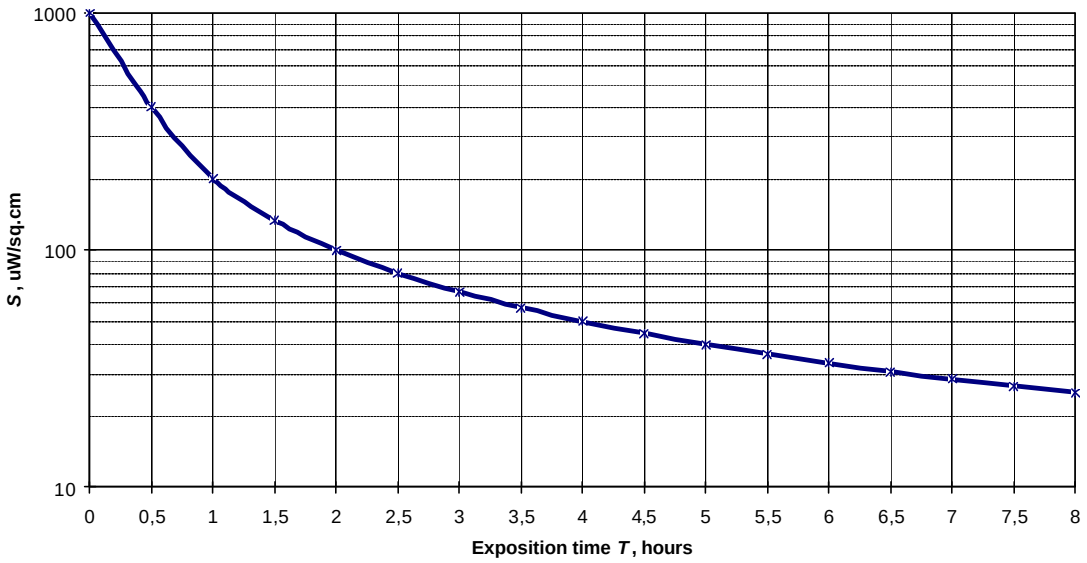
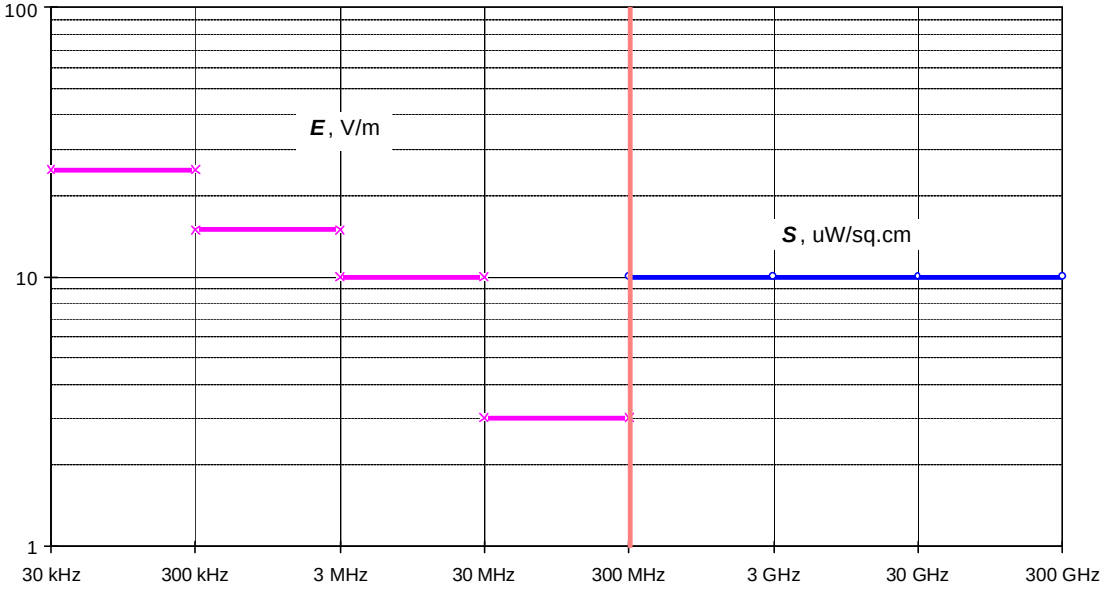


Fig. 4. Limit values for electric field strength ***E*** and power flux density ***S*** (public areas) according to SanPiN 2.2.4/2.1.8.055-96



Unfortunately, regional variations in standards occur in Russia, for example, in Moscow.

General principles to the approach to EMF Standardization in Russia.

The threshold principle of injurious to health is used as the basis of EMF limits

The position "damage-favour" is considered through the concept of risk.

Such EMF permissible value limits are accepted for the certain resources with usual daily EMF irradiation regimes which do not lead to diseases or health deviations among the population (irrespective of age or sex) which can be detected by modern methods during the period of irradiation or long after it was over.

The EMF exposure should not provoke in the person even temporary disturbance of homeostasis including reproductive function, and also the effort protective and adaptation-compensatory mechanisms neither in the nearest, nor in the remote period of time. It means, that EMF limits are the fractional quantity from minimal level of EMF which is capable to provoke some reaction in the human being.

SLOVENIA

CURRENT STATE IN THE FIELD OF EMF IN SLOVENIA

Peter Gajšek

With an increasing range of electromagnetic radiation (EMF) in the working and living environment also the need for dealing with this topic in regard to human protection has grown. The protective standards and recommendations determining the admissible limit values, under which there would be no health risk, are in the foreground. However, the ideas of setting the "safe" limit differ a lot. Thus the wish for uniformity of standpoints for drawing-up the protective standards and recommendations is gaining ground.

In 1992, the Technical Committee for Non-Ionizing Radiation (TC-NIR) at the Standards and Metrology Institute of Slovenia (SMIS) was established within the framework of the Ministry for Science and Technology of the Republic of Slovenia. It consists of 14 members and in 1995 they accepted by method of announcement the Slovenian pre-standard **SIST ENV 50166**, which determines the limit values of electromagnetic radiation in the frequency range from 0 - 300 GHz for professionally exposed people as well as for general public.

According to the new situation in the CENELEC (the main tasks of TC 211 for the future will rather be related to developing procedures and technical norms for implementation of the recommended exposure limits than to standards related to protection of the human health). The new ICNIRP guidelines (ICNIRP 1998) are in fact expected to become the most authoritative EMF exposure standard being referred to in the forthcoming national legislation of many countries. Presumably, this current situation will result in some modification in Slovenia as well.

The ordinance on EMF in living and natural environment, which was prepared by the **Ministry of Environment** of the Republic of Slovenia and implemented in 1996, clearly defines the highest level of EMF exposure allowed and appropriate protective measures. The limit values of maximal field strengths of various frequencies in the environment are based on ICNIRP guidelines and on the SIST ENV 50166.

As a result of the concern about the potential health effects of electromagnetic fields, the government judges that the amount of the total knowledge now accumulating, justifies the application of protective measures in the form of environmental protection. While the scientific database is insufficient in developing limits of exposure, this strategy does not exclude other steps of reducing exposure on new installations.

For new systems and installations of EMF sources in the environment the additional safety factor is introduced to the already valid limit values and represents **only a political decision** which does not rely on a scientific basis. Before choosing the appropriate location for the new installation of any EMF source, the preliminary research calculations must be carried out and the minimum security distances must be determined within the limits of which no objects of special classification should be situated and no other activities allowing longer lingering of people are allowed to take place.

The **Ministry of Health** is preparing an act on radiation protection which will focus of surveillance on the workers and general public being exposed from various non-ionizing sources. Legislation will have to be adopted anew, since it will have to be harmonized with the directives of the European Union and the recommendations of the leading international institutions.

This is especially important now when we are trying to harmonize the standards for limiting of human exposure to EMF. The national and international organizations generally based on common basic restriction (induced current and SAR) but not on derived levels (field strengths) and time limitations. However, a controversy sometimes occurs with regard to the "grey area" in between two dose ranges (exposure to high EMF - clear adverse physiological effects; exposure to low EMF - no known adverse effects). Once threshold exposures are established, safety factors may be incorporated into the limits depending on the degree of certainty about the threshold dose. **Safety factors in health protection standards do not guarantee safety, but should represent an attempt to compensate for the unknown and the uncertainties.**

Global harmonization of EMF standards calls for the co-ordinated programme of work, based on an international consensus.

SPAIN

Spanish Exposure Standards Situation:

There are no specific Spanish official standards for exposure limits to EMF. The standards for general public and occupational exposure are in the process of elaboration.

The public interest is particularly important on power lines and on the significant increase of the presence of aerials for mobile communications on the top of residential buildings. The interest, especially on EMF power lines is due to the recent history of the Spanish development during the past 20 years. The cities increased quickly in activities, as well as the social economic levels. In comparison to other European States, Spain has probably a higher fraction of the urban population living close to power lines. At the same time the rapid increase of technological development produced a special interest for domestic and occupational exposure levels recommendations. These are the reasons why any new report and re-evaluation of scientific studies are considered with attention in this country.

The Spanish Ministry of Health took responsibilities and is elaborating protocols of EMF exposure limits. The policy can be summarized as follows.

- The reference established in the 1998 ICNIRP guidelines are considered valid. The proposed recommendations of the European Union Council being virtually identical, have therefore the same consideration.

- However, the substantial public requirement in this country for a precautionary approach is reflected in a principle of prudent avoidance: the standards would be revised on the basis of well established health effects obtained by a necessary international enhancement of scientific research. The Spanish policy is also associated to an increased interest on national scientific researches in EMF bioeffects.

- In any case, beside of this knowledge, methods to reduce human exposure at the lowest level possible are recommended.

As a reference unit on NIR Protection in the Spanish National Institute of Health, this laboratory carries the responsibility of the assessment on guidelines and information on health related scientific results and data. The need for harmonization of standards for EMF exposure have become urgent.

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SWITZERLAND

EMF Standards - Situation in Switzerland

Mirjana Moser

There is no general legislation or ordinance covering all aspects of the protection from non ionizing radiation, or specifically EMF, in Switzerland. A number of ordinances, based on different laws, regulates distinct fields of the EMF applications.

The most extensive EMF radiation protection regulation is the new ordinance for the protection of the population from non ionizing radiation in the frequency range between DC and 300 GHz from stationary sources. At the moment this ordinance is undergoing public consultation and is expected to be enforced in 1999.

The reference levels of the 1998 ICNIRP guidelines are used as exposure limits. By this limits harmful or annoying effects must be excluded. In addition a principle of prudent avoidance has been built in the ordinance. Requirements, according to the state of the art, have been defined for the new installations, or when old ones are going to be rebuilt: mainly conductor or phase arrangements for high voltage power lines and distance to living areas.

Protection of the occupationally exposed persons is regulated in the "Law for Prevention of occupational Accidence and Disease."

A number of ordinances and regulations sets technical requirements on the different apparatus producing EMF. The aim is to guarantee electrotechnical security and properly functioning of the apparatus. Among these ordinances there is also one particular for the medical devices and another one for electromagnetic compatibility.

Although many aspects of health protection against EMF are covered by these regulations, the situation is not satisfying. There are some uncovered fields like cell phones. The regulations are not flexible enough to react on the new applications. In many cases for installations only electrotechnical security is regulated, but not the radiation and the application itself.

An ideal solution would be a general law on protection against non ionizing radiation, similar to the one for ionizing radiation. In such a law the limits based on the known health effects could be defined, but in addition a philosophy or a principle could be built in, covering aspects like: unknown health aspects, risk perception and risk acceptance of the population, economical standard and economical constrains. The preferential philosophy would be the same one as for ionizing radiation: ALARA principle with justification, optimization and limitation options.

UK

Restriction of Exposures to Electromagnetic Fields in the United Kingdom

Arwel Barrett

1. Advice was first issued on exposure restriction by the Home Office[1], in 1960, addressed to Post Office (telecommunications and broadcasting) workers. The single value power density restriction (100 W/m^2) was applied to radio frequencies (30 MHz - 30 GHz) and was confirmed by a committee of the Medical Research Council in 1970.

2. In 1970 the National Radiological Protection Board was established by Act of Parliament[2] and mandated to provide scientific advice (as well as other functions, such as undertaking research) to Government and others on matters of radiation protection. The scope was originally for ionizing radiation, but extended to include non-ionizing radiations by Order[3] in 1974.

3. In 1977 the NRPB received Directions under the Radiological Protection Act, 1970 which required it to provide advice on the acceptability to, and the application in the UK of standards recommended by international or intergovernmental bodies.

4. The NRPB published their first comprehensive guidance[4] on limiting exposures to time varying electric and magnetic fields and the 1988 IRPA/INIRC recommendations in 1989 following a review of the international scientific literature and extensive consultation. The Guidance established a set (from static fields to 300 GHz) of basic restrictions, expressed in dosimetric quantities, designed to prevent the adverse effects of acute exposure to EMFs. As some of the restrictions are extremely difficult to assess directly, they also derived a set of reference levels in terms of field quantities. The derivation of these reference levels used conservative assumptions to ensure that exposures to field strengths below the reference levels would not lead to the basic restrictions being exceeded. Exposures to fields above the reference levels would not necessarily show a failure to comply with the basic restrictions, but indicate a need for further, more detailed, assessment based on the actual conditions observed.

5. Increasing public concerns and reports in the scientific literature associating exposure to EMFs with increased incidence of various cancers led to the NRPB establishing an Advisory Group on Non-Ionizing Radiations (AGNIR) chaired by the eminent epidemiologist, Sir Richard Doll. AGNIR's first report[5], and two supplementary reports[6,7] concluded that epidemiological studies do not establish that exposure to EMFs is a cause of cancer, although taken together, they suggest that the possibility exists in the case of childhood leukaemia. The risks if any, however, would be very small.

Current Guidance

6. The NRPB revised its advice in 1993 and published the new advice[8] along with a detailed explanation of its scientific basis[9].

7. The NRPB recommendations apply equally to workers and to members of the public. The recommendations do not apply to those people who are exposed to electromagnetic fields and radiation for medical diagnosis or therapy or those with implanted

medical devices. Separate guidance has been published[10] for the protection of patients and volunteers during clinical magnetic resonance imaging procedures.

8. The 1993 guidance replaced the term "reference" levels with "investigation" levels, more appropriately to reflect the action that should be taken if they are exceeded. The investigation levels are not exposure limit values.

9. In some complex exposure situations (e.g. with multiple frequencies; to fields with high harmonic contents; to pulsed and transient magnetic fields) straightforward application of the investigation levels may not always be appropriate. In light of the considerable experience of advising on implementing the recommendations which the NRPB has gained over the last five years, they have published a report[11] describing some strategies for the practical application of their Guidance.

Legislative Position

10. There is no specific UK legislation regulating exposures to EMFs. The advice provided by NRPB in accordance with their statutory obligations is carefully considered by Government Departments (such as Department of Health, Department of Trade and Industry [DTI]) and the Health & Safety Commission and is used when assessing whether exposures have been adequately restricted to comply with the duties described below.

11. Section 2 of the Health & Safety at Work Act 1974[12] places a duty on employers to ensure that they provide, so far as is reasonably practicable, safe and healthy places of work. Section 3 extends this duty to include other people (e.g. non-employees such as the public). Regulation 3 of the Management of Health and Safety at Work Regulations 1992[13] (which implements the Framework Directive[14]) requires employers to assess the risks arising from their work activities and the measures they need to put in place to comply with their statutory duties. The Health & Safety Executive advises its Inspectors that if exposures of people have been restricted to below the NPRB's basic restrictions then the employers have complied with their legal duties.

12. Regulation 17 of the Electricity Supply Regulations, 1988[15] requires all public electricity suppliers to construct, operate and maintain their installations so as to prevent danger, which includes danger to health. These regulations are enforced by the DTI who use the NRPB restrictions in assessing compliance.

ICNIRP 1998 Guidelines[16]

13. Both ICNIRP and NRPB have expressed the view that the published epidemiological data do not provide a basis for restricting human exposure to EMFs and radiation. Both sets of guidelines are based on the available scientific data describing thresholds for well-established effects of exposure. For occupational exposures the two sets of guidelines are similar.

14. ICNIRP has adopted a further reduction factor of up to five when setting the basic restrictions for members of the public. No supporting scientific data are referenced either in the Guidelines, or in the additional clarifications[17].

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14. The Framework Directive, 89/391/EEC

15. The Electricity Supply Regulations, 1988. Statutory Instrument 1988 Nr 1057; HMSO

16. Guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields (up to 300 GHz). ICNIRP; Health Physics, 74, Nr 4, pp 494-522, 1998

17. Correspondence and Responses to questions and comments on ICNIRP Guidelines; Health Physics, 75, Nr 4, pp 436-439, 1998

USA FCC

Adoption and Implementation of Radiofrequency Exposure Guidelines in the United States by the Federal Communications Commission {PRIVATE **}**

Robert Cleveland

The United States Federal Communications Commission (US FCC) is responsible for licensing and authorizing radiofrequency (RF) transmitting devices and facilities in the US, except for those operated by the US Government itself. The FCC must also determine whether there may be harmful environmental impact from the RF devices and facilities that it approves as directed by the National Environmental Policy Act of 1969. One of the environmental factors that must be evaluated by the FCC is human exposure to RF electromagnetic fields.

In 1996, the FCC adopted new guidelines for evaluating RF exposure. No general RF exposure guidelines have been developed independently by the US Government. The FCC guidelines are based on exposure criteria recommended by the National Council on Radiation Protection and Measurements (NCRP) as well as on the ANSI/IEEE C95.1-1992 RF exposure standard.

The FCC's decision in adopting new guidelines was largely based on recommendations made by several US Government civilian agencies responsible for public health and safety. These agencies include the US Environmental Protection Agency (EPA), the US Food and Drug Administration (FDA), the National Institute for Occupational Safety and Health (NIOSH) and the US Occupational Safety and Health Administration (OSHA). All these agencies have written letters to the FCC expressing support for the FCC's use of the new guidelines.

FCC exposure criteria are defined in terms of electric and magnetic field strength, power density and time averaging for two exposure tiers. Limits for whole-body and partial-body specific absorption rate (SAR) were also adopted. The FCC has issued a technical bulletin and three supplements in order to provide technical guidance in evaluating compliance with the new guidelines. Sections I and II below summarize the MPE and partial-body SAR limits adopted by the FCC. Further information is available at the following Web Site: www.fcc.gov/oet/rfsafety

(I) FCC Limits for Maximum Permissible Exposure (MPE){PRIVATE **}**

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	–	–	f/300	6
1500-100,000	–	–	5	6

f = frequency in MHz
* = Plane-wave equivalent power density

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	–	–	f/1500	30
1500-100,000	–	–	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

(II) FCC Limits for Evaluating Portable (Hand-held) Devices

Limits for Occupational/Controlled exposure:

Spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and

ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment. **{**PRIVATE **}**

Limits for General Population/Uncontrolled exposure:

Spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure.

USA FDA

FDA - Engineering Point of View

Howard I Bassen

The Food and Drug Administration, Center for Devices and Radiological Health is involved with several voluntary, engineering standards-setting activities associated with human exposures to radiofrequency radiation. These include active participation in the following:

Howard Bassen is Chairperson of the Institute of Electrical and Electronics Engineers (IEEE) Standards Coordinating Committee SCC34 subcommittee 2 - IEEE Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices. This group is developing a recommended practice for the measurement and computation of the spatial-peak Specific Absorption Rate (SAR) in the human body of users of certain hand-held radio transceivers, including hand-held telephones used for cellular and personal wireless communications.

Howard Bassen is Chairperson of the IEEE Standards Coordinating Committee SCC28 subcommittee 1. This group is developing a revised document "Recommended Practice for the Measurement and Computation of Potentially Hazardous Electromagnetic Fields – RF and Microwave: 3 kHz to 300 GHz" to "Recommended Practice for Measurements and Computations with Respect to Human Exposure to Electromagnetic Fields - 3 kHz to 300 GHz").

The FDA has voting members on the IEEE SCC28 subcommittee 4. This subcommittee is developing a revision to their "Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields (3 kHz to 300 GHz). Howard Bassen is involved with the engineering aspects of the Radiofrequency radiation Literature Review.

Finally, Mr Bassen is the FDA/CDRH representative to the International Commission on Nonionizing Radiation Protection (ICNIRP) Standing Committee III: Physics and Technology. He is developing a chapter for a new ICNIRP criteria document on the characterization of static and low frequency electric and magnetic fields (0 – 1000 kHz).

USA IEEE

THE STATUS OF RADIO FREQUENCY RADIATION PROTECTION STANDARDS IN THE UNITED STATES AND THEIR RELATIONSHIP TO THE IEEE C95.1 STANDARD*

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1. Introduction

The radio frequency (RF) region of the electromagnetic (EM) spectrum extends over a huge range of frequencies, and in the United States it is assumed that it covers those frequencies between 3 kHz to 300 GHz. Over the last several years, the use of devices that emit RF radiation has increased markedly. RF devices include radio and television transmitters, military and civilian radar systems, a variety of communications systems, microwave ovens, industrial RF heat sealers, and various medical devices.

The proliferation of RF devices has been accompanied by increased attention to ensuring the safety of their use. Throughout the world many organizations, both government and non-government, have established RF safety standards or guidelines for exposure. In the United States, the development of RF safety standards has followed a pattern based upon the unique Federal system of government. Unlike ionizing radiation, where the Federal government has developed a comprehensive set of protection standards with the force of law, RF standards in the United States, with few exceptions, have matured through the adoption of consensus standards by certain Federal agencies. Because of this, there is no single, comprehensive, Federal RF safety standard that is applicable throughout the United States. This paper will review US Federal policy on standards, the status of RF safety standards in the United States and how they relate to one another, as well as their commonality with each other.

2. US Federal Policy on Standardization

The National Technology and Transfer Advancement (NTTA) Act of 1995 [1] codified Federal policy on the required use and development of voluntary non-governmental consensus standards (V-NGCS). Subsequently, the Executive Office of Management and

Budget (OMB) revised its circular OMB-A-119 [2], which directs Federal agencies to use V-NGCS in lieu of government-unique standards, in procurement and regulatory activities including both national and international activities. Although the policy does not establish a preference between domestic and international V-NGCS, Federal agencies are encouraged to consider international standards in procurement and regulatory applications. However, the requirements of consensus –openness, balance of interests, and due process --likewise apply to international organizations.

The policy does not pre-empt or restrict Federal agencies authorities or responsibilities for determining level of acceptable risk; setting the level of protection; and balancing risk, cost, and availability of technology in establishing regulatory standards. The policy does, however, direct Federal agencies to use V-NGCS for evaluating compliance with regulations and for establishing performance or technical standards, including those that contribute to health and safety (i.e. safety standards).

A V-NGCS body is defined as having the attributes of (i) openness, (ii) balance of interest, (iii) due process, (iv) an appeals process, (v) consensus that is general agreement, but not necessarily unanimity.

3. The Institute of Electrical and Electronics Engineers (IEEE) C95.1 Standard (1991) [3].

The most important and widely accepted RF safety standard in the United States is the IEEE C95.1 standard. It is a V-NGCS published by the international IEEE Standards Coordinating Committee (SCC) 28 in 1991, and adopted by the American National Standards Institute (ANSI) in 1992. The IEEE-SCC-28 standards process leads to a broad consensus through due process and input from all interested stakeholders. The process is open and subject to oversight of the IEEE Standards Association (including the Standards Board) and the ANSI. The C95.1 has existed since it was chartered as an ANSI committee sponsored by IEEE and the US Navy in 1959. The ANSI C95 committee became IEEE SCC-28 in 1988. The recommendations of C95.1 have continued to be refined and have become increasingly sophisticated since the first frequency independent limit of 10 mW/cm^2 was issued as a standard in 1966. It forms the basis for mandatory standards adopted by several Federal agencies, including the Department of Defence (DoD), the Federal Communications Commission (FCC), and to a certain extent, the Occupational Safety and Health Administration (OSHA). It is also used extensively by industry and governments throughout the world. It should again be emphasized that the jurisdiction of each of these Federal agencies is limited, by law, to only certain users of RF radiation. It also forms the basis for the North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2345 [4].

The C95.1 standard is a living document that is always under active revision. There are 93 members and over 300 individuals participating in the work of SCC28 and its five subcommittees. It is significant that in 1998, extensive revisions were made to the induced and contact current limits first adopted by C95.1 in 1991. The C95.1 standard was reaffirmed in 1996 and it is in the late stages of a complete revision based on the most comprehensive literature review on RFR biological effects and measurements ever conducted. It is expected that the complete revision of the document will be issued at the turn of the century. In the interim, a supplement to C95.1, including the revised induced and contact limits, as well as other refinements and clarifications, is in press.

In addition to issuing guidance of RF safety, SCC28 has also issued a comprehensive document on techniques for measuring potentially hazardous RF fields [5]. This document is also under active revision. Subcommittee 2 of SCC28 has also completed an extensive revision to ANSI Standard C95.2 [6] providing detailed guidance on design and use of RF warning symbols, which should be published shortly. A guide for safer distances from transmitters for use of Electro-Explosive Devices (EEDs) is in early balloting stages.

4. US Federal Guidelines for Exposure to Radio Frequency Radiation

At present, there is no universal Federally mandated RF safety regulation in the United States. Several Federal agencies, which have limited jurisdictions, have nonetheless promulgated RF safety regulations.

The 1966 ANSI standard was adopted by OSHA in 1971 and was incorporated into the Code of Federal Regulations (29 CFR 1910.97). This standard technically still exists on the books of OSHA regulations, although it has been litigated against in the 1970's because of its non-mandatory language. OSHA, at present, does not see RF radiation as a physical agent for which it intends to release an updated regulation. Rather, OSHA's policy is to encourage industry to adopt a consensus standard, which in the US will be, more than likely, either IEEE C95.1 or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) [7]. OSHA can still cite industry under its "general duty clause" should there be a situation where there is an injury due to RF radiation.

The US DoD has long been a 40+ year supporter of the V-NGCS RF safety standards developed by ANSI and then IEEE. The DoD adopted the present C95.1 standard in 1995, when the Secretary of Defence issued DoD Instruction 6055.11 [8]. The DoDI 6055.11 provides additional militarily relevant guidance for induced and contact currents and high peak power pulsed systems. This document forms the basis of the individual services (Army, Navy and Air Force) RF standards. In addition, the DoD has been at the forefront of developing standards for new RF modalities, such as high power microwave and ultra wide band sources. The use of these modalities in the commercial arena is increasing, so the limits developed by the DoD will form the basis for further work by civilian consensus groups such as IEEE and ACGIH.

The FCC has also promulgated regulations [9] on RF safety applying only to their licensees (primarily television, radio, telecommunications, and amateur radio operators) as part of the Telecommunications Act of 1996. The FCC limits are an amalgam of the IEEE C95.1 standard and the 1986 recommendations of the National Council on Radiation Protection and Measurement (NCRP) [10]. Previously, the FCC used the 1982 C95.1 limits exclusively. FCC has yet to issue limits for induced and contact currents, but will probably do so in the near future, due to the revision of the C95.1 limits in 1998.

The Interagency Radio Advisory Committee (IRAC) of the National Telecommunications Information Administration (NTIA) has been reviewing the FCC RF environmental guidance and the C95.1 standard to develop new Federal guidelines to be included in the NTIA Manual, which provides regulatory guidelines, rules, and procedures for Federal agencies. The IRAC Ad Hoc 189 is close to achieving consensus on the new guidance.

The Environmental Protection Agency (EPA) is not currently active in setting RF safety standards, although they issued a Notice of Proposed Rulemaking (NOPR) in 1986 which finally did not result in an environmental standard. There was a brief flurry of activity in 1993 on producing an EPA RF standard, which did not result in any rulemaking on the part of the agency.

5. Other United States Organizations Developing RF Safety Recommendations and Standards: ACGIH and NCRP

Neither the ACGIH nor the NCRP are true consensus organizations in the sense that IEEE SCC28 is. Unlike the IEEE process, not all interested stakeholders are allowed to participate in deliberations. The ACGIH is a professional organization of personnel from governmental agencies and educational institutions. It is devoted to the development of administrative and technical controls for worker health protection, and establishes recommended TLVs concerning chemical substances and physical agents to which employees may be exposed during the course of their employment. The RF safety recommendations of the ACGIH [11] are identical to the controlled area limits of C95.1, with the one exception that it covers the frequency range of 30 kHz to 300 GHz. The ACGIH relies on its Physical Agents TLV committee (PA-TLV) to revise its recommendations. Members of the ACGIH may comment on this process when changes are published as a Notice of Intended Change (NIC). Normally the deliberations of the PA-TLV committee are open to members and invited guest advisors only. The ACGIH is an important RF safety guideline since the ACGIH TLVs are widely used by industrial hygienists throughout the world. ACGIH has also developed limits for sub-radiofrequency radiation and fields (below 30 kHz). IEEE currently does not have limits for electromagnetic radiation and fields below 3 kHz, although this has been a project of subcommittee 3 of SCC28 for several years now. The ACGIH limits, at least in the US, are the *de facto* occupational limits for low frequency fields below 3 kHz. Several members of the ACGIH PA-TLV committee are also members of IEEE SCC28, which strengthens the development of consensus standards in the US The ACGIH PA-TLV committee is studying limits for the new modalities of ultra wide band and high peak power, short duration, microwave pulses.

The NCRP is a congressionally chartered organization, which traditionally produced reports on how to safely use ionizing radiation. In the early 1980's, it expanded its purview into the area of non-ionizing radiation. Similar to the ACGIH, the NCRP process is closed except to members of its chartered committees and invited guest advisors. Again, several members of the NCRP are also active participants in IEEE SCC28. NCRP is currently updating its 1986 report on RF exposure limits.

6. Conclusion

The harmonization of world-wide RF safety standards is a laudable project that should be pursued vigorously. A careful review of other western RF safety standards, such as the recently published International Commission of Non-ionizing Radiation (ICNIRP) standard [11], reveals that they are essentially based on similar scientific rationale and data, as are the US standards. However, in many cases the different standards bodies have developed standards based on somewhat differing emphasis and interpretation. The same cannot be said of some Eastern European standards, which because of their emphasis on low-level thermal effects, cannot easily be reconciled with current US or European standards. Reconciling

these differences represents a significant challenge to harmonization for the international RF safety community.

7. References

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11. *American Conference of Governmental Industrial Hygienists, ACGIH Threshold Limit Values and Biological Exposure Indices for 1997-1998*, (1998)[Available from ACGIH at (513) 742-2020).

12. *"Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 GHz)"*, Health Physics, 74: 494 - 522, (1998).

[Secretary's NOTE: Dr J Lin noted the following points in his comments on the provisional minutes in order to "make corrections for factual errors" in the preceding paper.

1. Regarding Section 5, first paragraph, first sentence.

The statement is FACTUALLY INCORRECT. NCRP, by mandate and charter is a consensus Organization. "NCRP" should be deleted from the first sentence.

2. Regarding Section 5, last paragraph, second sentence.

The reference to the 1980s is incorrect. It should say 1970s, 1973 to be precise.

3. Regarding Section 5, last paragraph, third sentence.

The sentence should be deleted and replaced with: "Unlike the ACGIH process, upon completion of a draft NCRP report, the document enters the NCRP review process, the first stage being Critical Review which is similar to the review given scientific papers undergoing peer review for journal publication. The committee then re-drafts the document based on the comments received and submits the draft document to the NCRP for final review by its 80 Council members, 44 Honorary members, 61 Collaborating Organizations and 14 Special Liaison Organizations who are all asked to provide comments (numbers are current counts). The Council members are also requested to vote on whether or not the document merits publication. Approval of the Council members is requested prior to publication of the report reflecting the true consensus nature of the document."]

USA NCRP

NCRP

James Lin

The National Council on Radiation Protection and Measurements (NCRP) s a non-profit corporation chartered by the US Congress in 1964, among others, to collect, analyse, develop, and disseminate, in the public interest, information and recommendations about (a) protection against radiation and (b) radiation measurements, quantities, and units, particularly those concerned with radiation protection. The Council is made up of the members and participants who serve on the scientific committees of the Council. The Scientific Committees, composed of experts having detailed knowledge and competence in the particular area of the Committee's interest, draft proposed recommendations. These are then submitted to the full membership of the Council for careful review and approval before being published. In the area of non-ionizing radiation, NCRP has published a series of reports concerning radiofrequency electromagnetic (RFEM) fields. They include Report 67 on Radiofrequency Electromagnetic Fields-Properties, Quantities and Units, Biophysical Interaction, and Measurements, Report 119, A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields, and Report 86 on Biological Effects and Exposure Criteria for Radiofrequency Fields, When Report No. 86 was published, it was recognized at that time that our understanding of biological effects of exposure to radiofrequency electromagnetic fields was still evolving. It was expected that the exposure criteria set forth in Report 86 would be evaluated periodically, and possibly revised as new information becomes available from continuing research in the subject.

At present, NCRP Scientific Committee 89-5, under the chairmanship of Dr James C Lin, has the responsibility to update the database and the critical analysis upon which Report 86 was based. The rationales for the exposure criteria are being re-evaluated in view of new laboratory findings and human health studies conducted during the past decade. The rationale for new exposure criteria will be thoroughly documented. The new report and recommendations will include the additional consideration of DNA and gene expression, cancer induction and promotion, drug interaction, epidemiology, as well as pulsed power and modulation effects on biological responses.

Upon completion of the SC 89-5 draft report, the document will enter the NCRP review process, the first stage being Critical Review which is similar to the review given scientific papers undergoing peer review for journal publication. The committee will then re-draft the document based on the comments received and submit the draft document to the NCRP for final review by its 80 Council members, 44 Honorary members, 61 Collaborating Organizations and 14 Special Liaison Organizations who are all asked to provide comments. The Council members are also requested to vote on whether or not the document merits publication. Approval of the Council members is required prior to publication of the report, reflecting the true consensus nature of the document.

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NCRP Report 67, "Radiofrequency Electromagnetic Fields - Properties, Quantities and Units, Biophysical Interaction, and Measurements," National Council of Radiation Protection and Measurements, Bethesda, MD, (1981).

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NCRP Report 119, "A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields," National Council on Radiation Protection and Measurements, Bethesda, MD, (1993).

APPENDIX "C"

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