

REQUEST FOR PROPOSAL

EMF Exposure Limits and Compliance Assessment for Wireless Devices Operating at Frequencies above 6 GHz

1. Background

Spectrum is a scarce resource, and the interest for utilizing frequency bands above 6 GHz for future radio communication systems is increasing. The possible use of higher frequency bands implies new challenges in terms of electromagnetic field (EMF) exposure assessments since the fundamental exposure metrics (basic restrictions) are changing from SAR to power density (PD).

The basic restrictions in power density, as provided by ICNIRP, FCC and IEEE for general public exposure, are presented in Table 1. ICNIRP [1] specifies basic restrictions in terms of power density starting from 10 GHz and the limit value is intended to be spatially averaged over an area of 20 cm²; in addition, the spatial maximum PD averaged over 1 cm² should not exceed 20 times the given limit. For frequencies above 6 GHz, FCC [2] specifies a spatial peak PD of 10 W/m² for the general public. In IEEE C95.1 ([3] and [4]) PD basic restrictions are specified starting already from 3 GHz. These are intended to be spatially averaged values over an area of 100λ² for frequencies below 30 GHz and over 100 cm² for frequencies above 30 GHz. The peak PD limit in IEEE C95.1 is $18.56f^{0.699}$ for frequencies between 3 GHz and 30 GHz (where f is the frequency in GHz). Above 30 GHz, the peak power density in IEEE C95.1 is 200 W/m².

Table 1 EMF power density basic restrictions as provided in [1], [2], and [3-4] for general public exposure.

ICNIRP	FCC	IEEE C 95.1 – 2005 + IEEE C 95.1 – 2010a	
$f \geq 10$ GHz	$f \geq 6$ GHz	$3 \text{ GHz} \leq f \leq 30 \text{ GHz}$	$f \geq 30 \text{ GHz}$
10 W/m ² (averaged over 20 cm ²)	10 W/m ² (spatial peak)	10 W/m ² (averaged over 100λ ²)	10 W/m ² (averaged over 100 cm ²)
200 W/m ² (averaged over 1 cm ²)	–	$18.56f^{0.699}$ (spatial peak)	200 W/m ² (spatial peak)

The lack of consensus among the different standards indicates that further research is needed to define accurate limits at these frequency bands. In addition, recently published papers [5]-[7] question the suitability of the current limits at the 'high frequencies'. The limits appear to be designed with extremely large safety margins: much larger than those adopted for the basic restrictions at lower frequencies. According to [6]: "[...] the temperature increase for the ICNIRP public 10 g SAR limit is approximately 12 x higher than for the ICNIRP power density limit in the 6-10 GHz range". In [7], a power density of 2000-3000 W/m² is estimated to increase the skin

temperature of 10° C corresponding to the temperature threshold for thermal pain. The predicted skin temperature increase for a power density of 10 W/m² is only 0.05° C.

A likely explanation for this discrepancy in the safety margin is that basic restrictions above 6 GHz (10 GHz for ICNIRP) have been designed to protect against whole-body heating effects rather than localized [6]. The relevant averaging area for the 10 W/m² limit is thus the overall projected area of the body exposed rather than the peak value or the average over a small area. Furthermore, ICNIRP and IEEE already provide limits relevant for localized exposure (200 W/m²) which validity might need to be investigated.

The Mobile Manufacturer Forum (MMF) intends to support more research in this area with the objective to enhance the understanding of dosimetric aspects and develop efficient and accurate procedures for EMF compliance testing at frequencies above 6 GHz. The purpose of this request for proposal is to indicate the areas that MMF is interested in supporting and to invite interested parties to submit proposals for funding consideration.

2. Project Work Packages

2.1 Dosimetric understanding at frequencies above 6 GHz (WP1)

The main objective for the WP is to suggest possible improvements of the basic restrictions at frequencies above 6 GHz for whole-body and localized exposure in terms of power density limits and related averaging areas.

Objectives:

1. Provide an overview of biological effects including the basis for current limits at frequencies above 6 GHz (up to 300 GHz). Include both localized and whole-body effects (if relevant).
2. Determine the safety margin for the current limits as function of frequency considering spatial averaging as applicable for different standards. Compare those with the margins applied below 6 GHz. Include both localized and whole-body exposure (if relevant).
3. Identify which are the current most accurate basic restrictions at frequencies above 6 GHz (ICNIRP, FCC, IEEE, etc.) taking effects of spatial averaging into account as applicable.
4. Suggest possible improvements in the power density limits above 6 GHz differentiating between whole-body and localized exposure.

2.2 Compliance testing at frequencies above 6 GHz (WP2)

Objective: Define compliance assessment methods and procedures to demonstrate compliance of wireless equipment with the basic restrictions at frequencies above 6 GHz. The focus should be on measurements for portable devices used in close proximity of the body. Things to consider include but are not restricted to

- Test equipment.
- Spatial averaging.
- Sampling resolution.

3. Work Products

The principal work product will be one or more papers per work package published in suitable peer-reviewed journals. In addition, brief quarterly progress reports and a final report are required. In general it is expected that each work package should be completed within a maximum of 12 months from the date of commencement.

4. Budget

The MMF will make available a total budget of €100,000 to cover both work packages.

5. Proposal Response Format

The proposal must be submitted electronically and in the format outlined in Appendix A.

6. Method of Evaluation

The MMF will undertake an evaluation of proposals in accordance with the Evaluation Criteria outlined in Appendix B. The MMF reserves the right to determine, in its sole and absolute discretion, whether a response to this RFP satisfactorily meets the provided evaluation criteria.

The MMF may elect to fund more than one proposal in each WP.

The MMF and its members will treat all the proposals as confidential.

7. Contractual and IP Issues

Nothing in this RFP document shall be construed as an offer to enter into contract with any party, and the MMF will not pay for the information solicited or obtained during this process. The MMF may elect not to award a contract based on the responses received to this RFP.

The MMF Standard Terms and Conditions will apply to any contracts that result from this process, including coverage by the laws and courts of Belgium. A copy of the Standard Terms and Conditions can be obtained by email from: michael.milligan@mmfai.info

In consideration of the funding received as part of any contract awarded the MMF will have a joint right to any intellectual property rights generated in the course of the project.

The MMF reserves the right for one or more other associations to fund parts of this research on the same or similar terms as the MMF. In the event that this is the case, successful proponents will be informed prior to the conclusion of a contract.

8. Additional Information Requests

The MMF reserves the right to request additional information from a proponent during any phase of the proposal evaluation process. During the evaluation and selection process, the MMF may require the presence of proponents to make presentations and answer specific questions. Notification of any such requirements will be given as necessary.

9. Instructions for Submission

All proposals must be received by 5pm Central European Time on the 16 January 2015 at the following email address: rfpresponse@mmfai.info

Proponents will be sent a confirmation of receipt by email.

Please Note: The subject line of the email must state: *Response to RFP: Dosimetry at Frequencies Above 6Ghz*

References

- [1] ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)", International Commission on Non-Ionizing Radiation Protection (ICNIRP), Health Physics, vol. 74, pp 494-522, April 1998.
- [2] FCC, Code of Federal Regulations CFR title 47, part 1.1310 "Radiofrequency radiation exposure limits", Federal Communications Commission (FCC), August 1997.
- [3] IEEE C95.1- 2005, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, April 2006.
- [4] IEEE C95.1a- 2010, Amendment 1: Specifies Ceiling Limits for Induced and Contact Current, Clarifies Distinctions between Localized Exposure and Spatial Peak Power Density", March 2010.

- [5] Anderson et al, "SAR versus Sinc: What is the appropriate RF Exposure Metric in the Range 1- 10 GHz? Part 1: using planar body models", Bioelectromagnetics, April 2010.
- [6] McIntosh and Anderson, "SAR versus Sinc: What is the appropriate RF Exposure Metric in the Range 1- 10 GHz? Part 2: using complex human body models", Bioelectromagnetics, March 2010.
- [7] Foster et al, "Thermal response of tissues to millimeter waves: implications for setting exposure guidelines", Health Physics, December 2010.

APPENDIX A: Format for Research Project Proposals

1. Executive Summary. An 'Executive Summary' comprising of:

- A. Proposed Project Title
- B. Name of the project leader
- C. Which work package/s are addressed
- D. Site(s) of research
- E. MMF funding period requested
- F. Amount of funding and the number of person-years
- G. Brief objective and description of the project and main deliverables
- H. Relevance for on-going international standardization work

2. Background. The background should be brief and provide necessary information to support proposed procedures only.

3. Specific objectives. Provide concise objectives in chronological order. Under each objective give a statement of the approach or methods to be used. If a specialized procedure has been previously published, attach publications containing the relevant materials and methods sections.

Example:

Specific objective 1

Approach or methods

Anticipated accomplishments

Specific objective 2

Approach or methods

Anticipated accomplishments

Et cetera

4. Work Products. The principal work product will be one or more papers published in a suitable peer-reviewed journal and contributions made to standardization working groups. In addition, brief quarterly progress reports and a final report are required.

Time sequence. Include a flow chart for the proposed work. This chart should include milestones as well as submission dates for quarterly reports, publications, and a final report.

Group qualifications. Discuss experience with numerical or experimental dosimetry, and/or any relevant fields of study. Describe the responsibilities of each individual staff member. Attach resumes of principal investigators. List up to ten most important publications supporting the proposal.

Facilities. Briefly demonstrate that you have the required facilities to accomplish the proposed work.

5. Funding. Include a separate document with a proposed budget denominated in Euros or U.S. dollars. Please supply a description of status and amount of current or planned applications for complementary funding from national or other sources. Participation by National bodies is desirable and demonstrates a broad interest as well as supports the independent nature of the research.

APPENDIX B: Criteria for Evaluation

The MMF will evaluate the scientific merit of each proposal according to the following specific criteria:

- responsiveness to the call for proposals
- appropriateness and adequacy of the proposed approach and methodology
- qualifications and research experience of the principal investigator and associates, particularly (but not exclusively) in the area of the proposed research
- availability of resources to conduct the research
- proposed budgeted cost and duration in relation to the proposed research

Please note: The MMF does not require proposals to include a general literature review and/or a general scientific background on topics relevant to RF standards due to the high level of technical and scientific competencies within the MMF. The proposals should be focused only on technical and administrative issues concerning the proposal.

If the need arises, proposals may be reviewed by an ad-hoc Scientific Review Committee (SRC) appointed by the MMF. In the event that this is deemed necessary, those asked to participate will be required to sign a confidentiality agreement with respect to the non-disclosure of information contained in the proposals reviewed.