Dear Contributor,

Thank you for participating in the public consultation of the ICNIRP draft guidelines.
Please note that it is important that ICNIRP understands exactly the points that you are making. To facilitate our task and avoid misunderstandings, please:

- be concise
- be precise
- provide supporting evidence (reference to publication, etc.) if available and helpful.

How to complete the comments table:

Please use 1 row per comment. If required, please add extra rows to the table.
This response document asks you to provide your 'comment', your 'proposed change', and the 'context' to this comment and proposed change. What is meant by these is the following:

Comment : A brief statement describing the issue that you have identified (and that you would like ICNIRP to take into account in the final version of the guidelines).
Proposed Change: A brief statement describing how you would like the document changed to account for this issue.
Context: A brief statement identifying relevant documents in support of your comment and proposed change.

Please, provide your details below as per the online form and the provision of the privacy policy

Last name, first name: Douglas, Mark	Email address:	Affiliation (if relevant): IT'IS Foundation, Zurich, Switzerland
If you are providing these comments officially **on behalf** of an organization/company, please name this here: n/a		
☒ I hereby agree that, for the purpose of transparency, **my identity (last and first names, affiliation and organization where relevant) will be displayed** on the ICNIRP website after the consultation phase along with my comments. ☐ I want my comments to be displayed anonymously.		

	Document (Guidelines, App A, App B)	Line Number #	Type of comment (General/ Technical/ Editorial)	Comment. Proposed change. Context.
1	Guidelines	523	Technical	"either 4 cm2 (>6 to 30 GHz) or 1 cm2 (>30 to 300 GHz)" Decrease the averaging area. Recent publications (Neufeld and Kuster, 2018; Neufeld et al, 2018) show that this averaging area is too large for narrow beams, as those expected in 5G technology, allowing the temperature at the surface of the body to increase considerably. We do agree with the notion that the power density averaging area should decrease with increasing frequency. However, a step function at 30 GHz makes compliance testing very difficult. Therefore, we recommend a reduction of the averaging area as a function. Please note that the function is also a function of the limit. It can be calculated that a beam with a Gaussian profile of 1 mm width, normally incident on the skin, can induce a surface temperature rise of 3.9°C instead of the 1°C produced by a plane wave with the same incident power density averaged over 4 cm^2. The temperature rise can become even higher, if a lower perfusion rate is assumed, since the 102 ml/min/kg perfusion rate assumed in the document is rather high: the energy is absorbed superficially on the skin in non-perfused layers, therefore a three-fold lower effective perfusion rate would be more reasonable. Then, in the above example the localized temperature rise would be about 4.1°C (i.e., 5 % higher). References: Neufeld et al. 2018. Discussion on consistent spatial and time averaging restrictions within the electromagnetic exposure safety framework. Bioelectromagnetics. Submitted. Neufeld and Kuster, „Systematic derivation of safety limits for time varying 5G radiofrequency exposure based on analytical models and thermal dose," Health Physics, Sept. 2018. Neufeld et al., "Theoretical and Numerical Assessment of Maximally Allowable Power-Density Averaging Area for Conservative Electromagnetic Exposure Assessment Above GHz," Bioelectromagnetics. Submitted.
2	Guidelines	553	Technical	„less than 1 second" Introduce a limit to the maximum energy density per pulse. Introducing a constant energy density below 1 s allows for ultrashort pulses to deliver high amounts of energy and increase the temperature considerably. It is recommended to introduce a limit to the maximum energy density per pulse, taking into account the work of Neufeld et al. Reference: Neufeld et al., "Discussion on consistent spatial and time averaging restrictions within the electromagnetic exposure safety framework," Bioelectromagnetics. 2018. Submitted.

3	Guidelines	156	Editorial	In the third column of Table 1, line 10, the entry is „radiant exposure“, instead of the units. Change to „joule per square meter“ Consistency
4	Guidelines	596	Technical	„square“ Change the shape of the surface for the averaging of the incident power density for frequencies above 6 GHz from a square to a circle of the same area. On non-planar evaluation surfaces, the shape of the averaging area would then be determined by intersecting it with a sphere with its center at the evaluation point and a radius that maintains the averaging area. Defining the averaging area as a square leads to problems with reproducibility, because the square is not rotationally symmetric. A square requires the definition of the orientation of its edges around its surface normal. This definition is arbitrary and will lead to ambiguities when assessing compliance in practical situations. Furthermore, a square does not conform to a non-planar surface. The definition that we propose is free of these problems. Despite the problem of definition, a sphere intersection will also substantially reduce the effort required for compliance testing.
5	Appendix A	79	Technical	“power and energy densities” „power density“ Equation 2.9 is the averaged power density, not the energy density.
6	Appendix A	94	Technical	„absolute strength of the Poynting vector“ „modulus of the complex Poynting vector“ Change to technically correct wording
7	Appendix A	733-736	Technical	“Recent research has shown that the normal angle results in the maximum transmitted power density (greatest absorption) and is used for calculating the reference levels (Li et al., 2018).” This statement is incorrect and should be replaced by the conclusions from the publication by Samaras et al. (see below). The angle that corresponds to maximum transmittance at TM mode cannot correspond to normal incidence. This reference cannot be used to support the incorrect assumption that normal incidence is the worst case. The Li 2018 presentation is not published in a peer-reviewed journal, and the paper by Samaras et al comes to a different conclusion. Reference: Samaras and Kuster. 2018. Power transmitted to the body as a function of angle of incidence and polarization at frequencies >6GHz and its relevance for standardization. Bioelectromagnetics. Submitted.

8	Guidelines	122	Editorial	„polarized molecules“ „polar molecules“ “polarized” means that something caused the substance to acquire polarity. Water is a polar molecule meaning that its polarity is inherent, not acquired.
9	Guidelines	71	Editorial	„These quantities cannot be easily measured“ „These quantities may be difficult to evaluate“ Induced quantities, such as SAR, have become relatively easy to evaluate. This the reason for changing to “may be difficult”. Also, changed “measure” to “evaluate” as a more general term, as numerical methods are well used and standardized.
10	Guidelines	89	Editorial	„which may include particularly vulnerable groups or individuals“ „which includes particularly vulnerable groups or individuals “ “general public” includes everyone, so “may include” is incorrect.
11	Guidelines	156	Technical	„$\mathbf{H}_{tr}$“ “U_{tr}” It is confusing to use **H** for energy density and magnetic field. Use a different symbol (e.g., U). It should be a scalar, not a vector (i.e., not bold).
12	Guidelines	429	General	„To be compliant with the present guidelines, exposure cannot exceed any of the restrictions described below, nor those for the 100 kHz – 10 MHz range of the ICNIRP (2010) low frequency guidelines“ Please specify which limits to apply where there are differences between ICNIRP 2018 and ICNIRP 2010. The limits should be consistent and in one single standard. Also replace “cannot” with “must not”. Reference levels in ICNIRP 2018 and 2010 are different in some cases.
13	Guidelines	590	Technical	Headings of Tables 2 and 3, and Tables 5 and 6, are misleading. Delete ">= 6 minutes" and "< 6 minutes" from the headings. The two sets of limits should always apply together. The SA and energy density restrictions are limiting when transmitting short pulses, and the SAR and power density restrictions are limiting when transmitting continuous signals, but both sets of limits apply regardless of the type of signal. This should be made clear in the text also.
14	Guidelines	813	Technical	„Simultaneous exposure to multiple frequency fields” Add guidance if a person is exposed simultaneously to signals that fall under both > 6 minutes and < 6 minutes. There is no guidance if a person is exposed simultaneously to signals that fall under both > 6 minutes and < 6 minutes.

15	Guidelines	140	Technical	„10-g cubical mass“ Add guidance on what to do if the body surface is not flat. A cube does not conform to a non-flat surface, resulting in air in the volume or tissue that is not considered. IEC 62704-1 includes considerations on what to do about this problem. Adapting the surface of the cube to the curved SAM shell is common practice in compliance testing standards. However, problems still remain dealing with the lack of rotational symmetry of a cube. A better approach is to use a sphere whose center is at the point of interest and radius is set such that 10 g is included. This would be a hemisphere for a point on a flat surface.
16	Guidelines	374	Technical	„From 6 to 10 GHz there may still be significant absorption in the subcutaneous tissue. “ Extend the frequency range for SAR as a basic restriction to 10 GHz. The above statement supports the need to extend the frequency range of SAR as a basic restriction to 10 GHz. Furthermore, the paper of Carrasco et al. (see below) outlines the problems with using power density in the reactive near field and supports extending SAR to 10 GHz. IEC draft 62209-1528 has already included procedures, sources and validation for frequencies from 6 – 10 GHz. The work of Pfeifer et al and Pokovic et al (see below) demonstrate that SAR measurements are achievable within reasonable uncertainty bounds at these frequencies. References: Pfeifer et al., “Total field reconstruction in the near field using pseudo-vector E-field measurements,” IEEE Transactions on Electromagnetic Compatibility, June 2018. K. Pokovic et al., "Methods and Instrumentation for Reliable Experimental SAR Assessment at 6 – 10 GHz," BioEM Meeting, Hangzhou China, 2017. Carrasco et al., "Exposure assessment of portable wireless devices above 6 GHz," Radiation Protection Dosimetry, October 2018.
17	Guidelines	481	Editorial	„(5 C in Type-1 tissue and 2 C in Type-2 tissue)“ “(2 C in Type-2 tissue)” This section talks about the Head and Torso only.
18	Guidelines	522	Editorial	„200 W m^{-2} “ Keep on same line This is broken across 2 lines.
19	Guidelines	715	Technical	„no reference levels are provided for reactive near-field exposure conditions within this frequency range “ Add reference levels for near-field exposure, or extend SAR as a basic restriction above 6 GHz. An alternative is to recommend compliance testing based on transmitted power. Exposure to reactive near fields is likely to be common for 5G devices and the basic restrictions may be difficult to measure. This is supported by the paper of Carrasco et al (see below). Currently there are no measurement systems available that measure the transmitted power density. This makes it very difficult to demonstrate compliance with EM exposure. It is also important to point

				out that the incident power density flux crossing the surface is not always conservative as a proxy for transmitted power (see Samaras et al. 2018). References: Samaras and Kuster, "Power transmitted to the body as a function of angle of incidence and polarization at frequencies > 6 GHz and its relevance for standardization." Bioelectromagnetics. 2018. Submitted. Carrasco et al., "Exposure assessment of portable wireless devices above 6 GHz," Radiation Protection Dosimetry, October 2018.
20	Guidelines	156	Editorial	„**Seq, Sinc, Htr, Str**" Use scalar rather than vector quantities. The limits are defined as scalar values, so the symbols should also be scalars (without bold)
21	Appendix A	171-172	Technical	„As described above, power absorption is confined within the surface tissues at frequencies above 6 GHz. This may lead to thermoregulatory response initiation time being reduced." Remove the sentence. No reference is provided to support this statement. In addition, it is in contradiction with the work of Christ et al (see below). At the surface of the body (skin) there are numerous heat receptors sending signals to the hypothalamus. Reference: Christ et al., "RF-Induced Temperature Increase in a Stratified Model of the Skin for Plane-Wave Exposure at 6 to 100 GHz." Bioelectromagnetics. 2018. Submitted.
22	Appendix A	672	Technical	„Conversely, the only study using the internationally standardized child models shows only a modest increase of 15 % at most (Nagaoka et al., 2008). " Remove the sentence. These are scaled voxel models of Japanese children, i.e., (a) they are not models of real children but scaled down from adult Japanese models; (b) they are not globally valid; and (c) they should not be considered „standardized" unless there is an international standard document describing who standardized them, how, and when.
23	Appendix A	412	Technical	The Sasaki study is an important paper. Latest studies taking into considerations detailed skin properties, showed that simplifications result in insufficient conclusions. The most important one is that the layered model considered did not take into account the epidermis structure, i.e., did not differentiate between stratum corneum and viable epidermis. This is important, as it increases power transmission at higher frequencies (stratum corneum acts as a matching layer). The thermal parameters used in the Sasaki study generally yield a lower temperature increase than the ones in published databases. These different parameters (and using fat instead of muscle as terminating layer) explain the remaining differences to Sasaki even without the stratum corneum and with mixed thermal boundaries instead of the adiabatic ones. Consider newer results about the heating factor, taking into account more detailed models. It can be shown that at frequencies above 15 GHz, the stratum corneum (SC) acts as an impedance matching layer for the incident electromagnetic fields. Considerably increased transmission of the energy can be observed for thick layers of the SC

				(0.36 – 0.70 mm), which occur in the palms. The worst-case heat conversion factor for normal incidence occurs at 60 GHz for a thick SC and is 0.04 K/(W/m^2). References: Christ et al. 2018. RF-Induced Temperature Increase in a Stratified Model of the Skin for Plane-Wave Exposure at 6 to 100 GHz. Bioelectromagnetics. Submitted. Samaras and Kuster. 2018. Power transmitted to the body as a function of angle of incidence and polarization at frequencies > 6GHz and its relevance for standardization. Bioelectromagnetics. Submitted.
24	Appendix A	415	Technical	This may not be so conservative after all, considering the limitations of the study by Sasaki et al (2017) and the ambiguity about the transmitted power density at oblique incidence, especially for TM polarization. Consider newer results about the heating factor, taking into account more detailed models. Conservativeness of reference levels.
25	Guidelines	156	Technical	Missing references The following references should be added to the guidelines (manuscripts available on request): Neufeld and Kuster, ”Systematic derivation of safety limits for time varying 5G radiofrequency exposure based on analytical models and thermal dose,“ Health Physics, Sept. 2018. Christ et al., “RF-Induced Temperature Increase in a Stratified Model of the Skin for Plane-Wave Exposure at 6 to 100 GHz.” Bioelectromagnetics. 2018. Submitted. Samaras and Kuster, “Power transmitted to the body as a function of angle of incidence and polarization at frequencies > 6 GHz and its relevance for standardization.” Bioelectromagnetics. 2018. Submitted. Neufeld et al., “Discussion on consistent spatial and time averaging restrictions within the electromagnetic exposure safety framework,” Bioelectromagnetics. 2018. Submitted. Pfeifer et al., “Total field reconstruction in the near field using pseudo-vector E-field measurements,” IEEE Transactions on Electromagnetic Compatibility, June 2018. Pokovic et al., "Methods and Instrumentation for Reliable Experimental SAR Assessment at 6 – 10 GHz," BioEM Meeting, Hangzhou China, 2017. Carrasco et al., "Exposure assessment of portable wireless devices above 6 GHz," Radiation Protection Dosimetry, October 2018. Neufeld et al., "Theoretical and Numerical Assessment of Maximally Allowable Power-Density Averaging Area for Conservative Electromagnetic Exposure Assessment Above GHz," Bioelectromagnetics. Submitted.