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ECRR Non-Ionizing Radiation Risk Committee (ECNRR)
Exposure Limits for 4G and 5G range radiofrequency radiation.

Preamble

Whereas the human rights framework provides an unassailable moral and legal justification for immediate action to protect the environment for the benefit of all persons.

Whereas States have clear human rights obligations to prevent the adverse impacts of environmental degradation on the enjoyment of human rights and to protect environmental human rights defenders.

Whereas, additionally, businesses have a responsibility to respect human rights, do no harm, and exercise due diligence in carrying out their activities.

Whereas a significant number of court cases, national constitutions and legislation, and international instruments have acknowledged the close linkages between environmental and human rights law.

Despite States having yet to universally recognise a right to a healthy environment or define its content and correlative obligations.

Whereas International human rights mechanisms have addressed environmental aspects of a number of human rights including the rights to life, religion, and property, health, water, food, and culture.

On occasion, they have addressed the right to a healthy environment directly but mainly they have focused on the environmental dimensions of more established rights.

Whereas, the human rights implications of exposure to **ionizing radiation** have been addressed through legislation in a number of instruments in different countries following scientific research since 1952.

Whereas such research is continuing and leading to changes in defined exposure limits as a result of epidemiological and other data becoming available.

Whereas the massive increase in exposure to radiofrequency devices, including cell phone communication systems and allied devices has now led to a situation where human health is being clearly affected.

Whereas the International Agency for Research on Cancer has now classified cell phone RF radiation as a possible carcinogen.

Whereas as early as 2011 the European Parliament published in Resolution 1815 its affirmation of concerns about exposure to low frequency non-ionising radiations.

Whereas no scientific body has yet defined any basic safety limits for integrated exposure to non-ionising radiation in the radiofrequency range.

Whereas no scientific environmental risk assessment on any such exposures has been published by Business or State.

Whereas no JUSTIFICATION has been published by States for the exposure of citizens to non-ionising radiation which has been shown to be associated with serious harmful downstream health effects and also deterministic effects on mental equilibrium.

Whereas current controls of the generation of radiofrequency radiation are based merely on the heating effects of such radiation in water.

Whereas recent research has now clearly identified worrying health effects of exposure to current radiofrequency radiation in rodent experiments.

Whereas several published studies associate cell phone radiation frequency exposures with infertility and foetal development in animal and insect studies.

Whereas research on the biological and health effects of such devices has therefore been sufficiently carried out to demonstrate clear and objectively measurable harmful outcomes of exposures (see Appendix C).

Whereas new advances of historically unprecedented and epidemiologically untested technology are proposed (termed 5G) which would increase the photon energy of radiofrequency communication devices by more than an order of magnitude.

Whereas the European Committee on Non-Ionising Radiation Risk developed a framework for quantifying exposure to radiofrequency devices and published its initial guidelines for discussion on December 12th 2018 with a three month period for discussion and input from interested parties.

Whereas all such input has been assessed over the previous 5 months and included in the development of the following guidelines.

The European Committee on Non-Ionising Radiation Risk proposes the following guidelines for Exposure to radiofrequency devices including cell-phones and cell-phone signal towers, wifi devices and all and any other device producing radiofrequency up to 2GHz.

ECNRR Committee hereby establishes Basic Safety Standard for Exposure to Radiofrequency electromagnetic radiation up to 2Gz frequency.

1. No adult shall be exposed to more than 50 Nrads per annum of non-ionising radiation of frequency below and including 2GHz.

2. No adult shall be exposed to more than 0.14 Nrad per 24 h day.

3. No teenager the age of 12-19y shall be exposed to more than 10 Nrad per annum of non-ionising radiation of frequency below and including 2GHz. This dose is even suggested for adult parents before consumption.

4. No teenager the age of 12-19y shall be exposed to more than 0.03 Nrad per 24 h day. This dose is even suggested for adult potential parents.

5. No child the age of 6-12y shall be exposed to more than 5 Nrad per annum of non-ionising radiation of frequency below and including 2GHz.

6. No child the age of 6-12y or pregnant woman shall be exposed to more than 0.014 Nrad per 24 h day.

7. No child below 6y should be exposed in any way and all inevitable exposures must be kept as low as reasonably achievable.

8. For the purposes of calculation these limits refer to all sources combined.

9. The Recommended Dose Limits are tabulated for convenience in Table 1

Table 1 ECNRR Dose limits for Radiofrequency exposures up to and including 2GHz. Nrads

	Adult	Age 12-19 Adult to conceive	Child 6-12 Pregnant	Child <6
Nrad/ per year	50	10	5	0 ALARA
Nrad / per 24h day	0.14	0.03	0.014	0 ALARA

Basic Safety Standard for Exposure to Radiofrequency electromagnetic radiation above 2Gz frequency.

The photon energy of radiofrequency radiation above 2Gz shall be defined a weighting factor Q based upon the relative frequency of the radiation to the standard at 2Ghz. The corresponding unit will be known as the Nrep or Non-Ionising Radiation Equivalent Person. For further definition see Appendix.

Thus, Equivalent Non ionising Radiation Dose S is:

$$\mathbf{S = QE/E_0}$$

where E_0 is the Dose D at 2GHz as defined by the absorption in kJ/kg.

Accordingly, and as an example, the Equivalent Dose (Nrep) for a 5G radiation of 100GHz will involve a Q of 100/2 = 50 The annual exposure limit for an adult then becomes 1.0 Nrep.

Weighting factors and Adult annual dose limits for different frequencies are shown in Table 2.

Table 2 Weighting factors to give Nrep for different frequencies

Frequency ν GHz	Weighting Q	Annual Limit Nrep	Daily exposure limit at 0.2 watts/kg SAR full power (minutes)	Daily exposure limit at 0.08 watts/kg SAR full power (minutes)
2	1	50	12	30
6	3	17	4	10
20	10	5	1.2	3
100	50	1	15 seconds	37,5 seconds

These limits must be applied on all RF emitting devices, including Wifi masts with mobile data generators, mobile phones, laptops, Wifi Modems, I-pads, smart meters and all other devices which cause RF exposure to humans. As for ionizing radiation equivalent dose, all sources of different frequency will be assessed in terms of combined total equivalent dose in Nrep.

The Dose Limits for the purposes of the ECNRR advice will be thus calculated as:

$$\text{Dose} = \sum \mathbf{S_n}$$

Where S is the Equivalent Dose for each of n exposures from different sources.

Acknowledgement of limitations and necessary reform

The ECRR Non-ionising radiation dose (Nrad/ Nrep) model assesses a dose limit mainly in regard to cancer in rodents, infertility and foetal development effects in animal and insect studies. It presently does not assess potential effects of RF on other conditions or effects on other living creatures which may emerge following research. These include neurological disturbances in humans, effects like memory loss, sleeplessness etc.

Health authorities of some governments have recently taken steps to reduce public exposure to radiofrequency electromagnetic radiation by regulating use of wireless devices by children and recommending preferential use of wired communication devices in general, but this shall be a coordinated international effort within a conceptual safety reform.

Due to the most rapidly increasing anthropogenic RF environmental exposure effects since the mid-20th century, and because the industry is preparing experimental technologies like the *Internet of Things* and *5G* that would add significantly more radiofrequency exposures, which would be invisible and unavoidable by those wishing not to be exposed, a legal and geographical conceptual reform of RF safe exposure is urgently necessary through environmental risk assessment based on epidemiology and animal experimentation.

For the ECRR

Christopher Busby

Scientific Secretary

Appendix A
The ECNRR

The new ECNRR Committee was appointed from the main Committee in September 2018 to assess and propose regulations on risk from non-ionizing radiation sources, particularly Mobile Phone exposures. Sufficient evidence has accumulated in the last 20 years to show unequivocally that exposures to RF sources cause a wide range of serious health detriments including cancer. The Committee are aware of a number of proposed mechanisms for objective measurements demonstrating effects at the cell and organism level but does not feel that there is a necessity at this stage to have to connect the biological links with the epidemiological findings. A complete knowledge of “mechanism” must not prevent action on an exposure which is clearly harmful to health.

It was a source of concern to the committee that no official organisation has properly addressed the epidemiological and animal study evidence nor has there been any attempt to quantify cumulative exposure, as is the case with ionizing radiation. Current practice is to limit power of cell-phones on the basis of Specific Absorption

(SAR) rate of approximately 1.6W/kg. This permits very large exposures since the individual behaviour is not included. Such exposures, which are often not elective (that is to say, those exposed cannot avoid them, nor are they aware of them) have never been Justified.

Accordingly, the committee has developed a tool for quantifying cumulative exposure. A new quantity is hereby defined, the Nrad (Non-ionising Radiation Absorbed Dose). One Nrad, is defined as an absorption of Radiofrequency (RF) energy by tissue equal to 1kJ per kg of tissue. The quantity is thus defined as energy per unit mass, just as the ionizing radiation units Gray and Rad are.

Non Ionizing Dose (Nrad) = Energy (kJ) / Tissue mass (kg) …..

The Dose is cumulative as is the case with ionizing radiation. The Committee has assessed the evidence, particularly evidence from recent lifetime rodent irradiation experiments in the USA [1] and Italy [2] and is hereby proposing a provisional safe Dose limit of 50Nrads per year for adults and 5Nrads per year for children between the age of 6-12 and pregnant women. For teenagers 12-19 the Dose limit is 10 Nrad per year and 0.03 Nrad per 24 hour period. This value is established on the basis of the argument below, and the Committee has taken inputs from interested parties recommendations during a 5 month period.

The rodent experiments show that a 1year exposure to 1.5W/kg with a 50% duty cycle causes a wide range of cancer and benign tumour development. This translates into 64.8 kJ/Kg cumulative annual non-ionizing dose (Nrad) per day for 1 Year; an annual Dose of 23,650 Nrad.

The Committee employs the approach of the early health physicists to objective tissue responses to internal ionizing radiation and proposes an annual limit of $1/500^{th}$ the annual dose that causes cancer in rodents (23,650Nrad) in the NIH study [1]. The proposed annual limit value of $1/500^{th}$ of this is rounded up to 50Nrads. For children 6-12y and pregnant women the Committee proposes an annual limit of $1/10^{th}$ of these adult limits giving 5 Nrads annual limit and a daily limit of 0.015Nrad.

Using a smartphone with a Specific Absorption Rate of 1w/kg (most have SAR greater than this up to the current limit of 1.6w/kg) will deliver a Dose of up to 0.6Nrad in one 10-minute call if held close to the head and if the device is employing full power. Survey data suggest that the average daily use of a smartphone is between 2.3 and 3.5 h. Such use would potentially deliver a dose of about 10 Nrad.

The Committee position on children under the age of 6 years is that they should not be permitted to use mobile phones and that their exposure to other RF devices should be reduced as far as possible.

These limits must be applied also to other RF emitting devices, including Wifi masts, laptops, Wifi modems and smart meters and overall exposures from different sources must be added.

Since the initial assessment the ECNRR has considered the likely increased dangers from radiofrequency devices operating at higher frequencies than 2GHz. The

Committee has taken the step of assuming that the biological effects of higher frequencies will be at least proportional to the photon energies **E=Hν**. Accordingly, and in the same way as ionising radiation power density was qualified for alpha emitters and neutrons, the Committee define the unit Nrep or Non-ionising Radiation Equivalent Person where the quality factor Q is used as a multiplier to the Dose at 2Ghz, Q being derived from the ratio of the frequency of interest to the Frequency 2GHz. The Committee is aware that this assumption may be unsafe and recommends that research is urgently commissioned to examine the biological effects of frequencies in the 5G range and further that no 5G devices be permitted until such research is carried out and an Environmental Impact assessment published.

Appendix B

Measuring exposure doses in Nrad

1. The unit of Dose, the Nrad refers to integrated absorption by living tissue of kJoules per kilogram at the point of highest absorption (termed the "hotspot").

2. It may be approximately assessed by employing the specific absorption rate (SAR) in watts per kilogram. The regulation of mobile phones currently limits the output of phones on the basis of this unit to a maximum of 1.6W/kg. Manufacturers have to make measurements with the phone held to the side of a water phantom representing the head and limit the phone's maximum power output.

3. These limits do not take into account accumulated or integrated exposure. 1 watt is 1 Joule per second. Therefore a 60 minute call would involve 1x60x60 = 3600Joules of energy absorbed by 1 kg of the head or other tissue. That is written 3.6kJ (kilojoules). If a grown up person made five 60 minute calls in a day, the tissue would have absorbed 18kJ per kilogram of the head if the device were operating at maximum permitted power.

4. For ionizing radiation it is accepted that accumulated or integrated exposures are what causes health effects and regulations are based on such accumulated exposure and not on emission absorption limits as is the present case with mobile phone restrictions. This is like stating that a person may be continuously exposed to a radioactive Caesium-137 source so long as the dose rate were below some specified value. The units of ionizing radiation are Grays. 1 Gray (Gy) is a cumulated absorption of 1J per kg of tissue. It is biologically plausible that if non-ionising radiation causes biological effects, these would also be due to accumulated damage. It is merely arguing that 5 phone calls cause 5 times the biological damage that one does.

5. The Committee find it curious that non-ionising radiation is regulated without reference to accumulated absorption, especially since exposures are increasingly continuously 24 hours a day from an increasing number of fixed devices which continuously emit microwave radiation, phone masts, antennae, smart meters etc.

6. Accordingly, the Committee has developed the Nrad and Nrep as tools for establishing limits to cumulative exposures.

7. Whilst the measurement of RF fields should be carried out using expert equipment, such equipment is not in the arsenal of traditional protection items, it is not available in the local shops, it is expensive online, and generally - not at all easily available to the public. For this reason, the Committee suggests that approximate exposures in Nrad can be obtained using more simple electrosmog meters and measuring the exposure field in milliwatts per square metre. Approximating for complete absorption of the incident energy over the depth of the human body, the absorption rate in mJ/kg/sec can be obtained approximately by dividing by a factor of 10.

8. The following example shows how this is done. In a measurement 100m from a communication mast the incident field was measured at 6mW/square metre. Dividing by 10, this gives the incident field over a 1kg cube which is 0.6mW/10cm square plane ($100cm^2$). This is 0.6mW or 0.6×10^{-3} W. For a 24 hour exposure, that is $0.6 \times 10^{-3} * 24*60*60 = 51.8$ Joules per kilogram or about 0.05Nrad. Over one week this is 0.35Nrad and over one year 127Nrad. This would be above the ECNRR limit both for adults and children.

9. **Practical considerations.** Use of a mobile phone at a distance from the head of about 10cm can be assumed to be associated with a specific absorption rate of about 0.2w/kg, about $1/5^{th}$ of the maximum output power of most current phones if they operate at maximum power. This would also depend upon the signal strength at the point of use. At this exposure level a 1-hour call would involve $0.2 \times 3600 =$ 0.72Nrad which exceeds the 24h limit given in Table 1 of 0.2 Nrad. At the full output power from a new smartphone the time of use close to the head must be below about 12 minutes in a day. Individuals should be aware of the dangers of exceeding the limits in Table 1 and should proceed on the basis of holding the phone at sufficient distance from the body to reduce the dose in Nrads to the lowest possible. In experiments the power emitted by a smartphone at 10cm from the head was about 25% of that close to the head and at 20cm the power was 2.5% which shows how important it may be to keep the phones at a distance from the body. Thus they should not be kept in pockets close to the body, especially in trouser poskets near the testicles and ovaries.

Appendix C

Selected References

Selected research on which the Committee's dose limits are based; these documents and reports themselves refer to many studies which the Committee has considered in reaching its conclusions.

[1] NTP Technical Report on the Toxicology and Carcinogenesis Studies in Hsd: Sprague -Dawley SD Rats exposed to whole body radiofrequency radiations at frequency (900MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR595. Washington USA: National Institute of Health.

[2] Falcioni L, Bua L, TibaldiM et al. Ramazzini Institute (2018) Report of final results regarding brain and heart tumours in Sprague Dawley rats exposed from pre-natal life until natural death to mobile phone radiofrequency filed representative of a 1.8GHz GSM-based station environmental emission. Environmental Research 165: 496-503

[3] International Commission on Non-Ionizing Radiation Protection (ICNIRP), 1998. ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300GHz)
Published in: Health Physics 74 (4):494-522; 1998

[4] Gandhi et al, 2012, Electromagn Biol Med. 2012 Mar;31(1):34-51.
Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. (full paper)

[5] European Parliament, 2008-2009
2008/2211(INI) – 02/04/2009 Text adopted by Parliament, single reading
Mid-term review of the European Environment and Health Action Plan 2004-2010, Thurs 4 Sept 2008, items 21-23.

[6] ICEMS Position Paper on the Cerebral Tumor Court Case Final Paper, Rome-Bologna-Chicago, October 23, 2012.

[7] Johansson, Pathophysiology 16 (2009) 157–177
Disturbance of the immune system by electromagnetic fields — A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment

[8] Oberfeld et al, 2004, Presented at Conference in Kos.
The Microwave Syndrome – Further Aspects of a Spanish Study

[9] Parliamentary Assembly of the Council of Europe, Resolution 1815 (2011) (Final resolution; precautionary principle)

[10] Canadian Human Rights Commission, May 2007. The Medical Perspective on Environmental Sensitivities

[11] Seletun Panel, 2009.

[12] Irish Doctors Environmental Association (IDEA)

[13] Venice Resolution, 2008, ICEMS (International Commission for Electromagnetic Safety).

[14] Salzburg Resolution on Mobile Telecommunication Base Stations, Austria 2000

[15] London resolution, 2007. Johansson, Pathophysiology 16 (2009) 247–248

[16] Helsinki Appeal 2005

[17] Canadian Teachers' Federation, 2013 (over 200,000 teachers across Canada)
Brief to the expert panel of the Royal Society of Canada reviewing Safety Code 6A Canadian Teachers' Federation Brief on Wi-Fi exposure in Canadian classrooms, October 2013

[18] Russian National Committee on Non-Ionising Radiation Protection RCNIRP, 2012
Recommendations of the Russian National Committee on Non-Ionizing Radiation Protection of the necessity to regulate strictly the use of Wi-Fi in kindergartens and schools

[19] Blackman, 2009, Pathophysiology. 2009 Aug;16(2-3):205-16.
Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. (full article)

[20] American Academy of Environmental Medicine (AAEM)
AAEM Letter to the FCC regarding Radiofrequency Exposure Limits. (Aug 2013)

[21] BioInitiative Report 2012

[22] Ozgur et al, 2014, Cell Biochem Biophys. 2014 May 11.
Mobile Phone Radiation Alters Proliferation of Hepatocarcinoma Cells.

[23] Huber et al, 2002, J Sleep Res. 2002 Dec;11(4):289-95.
Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG.

[24]. Neubauer C et al, 1990, Bioelectromagnetics. 1990;11(4):261-8.
Microwave irradiation of rats at 2.45 GHz activates pinocytotic-like uptake of tracer by capillary endothelial cells of cerebral cortex.

[25] Hinrikus et al, 2008, Bioelectromagnetics. 2008 Oct;29(7):527-38.
Effect of low frequency modulated microwave exposure on human EEG: individual sensitivity.

[26] Panagopoulos et al, 2013, PLoS One. 2013 Jun 4;8(6):e62663.
Evaluation of specific absorption rate as a dosimetric quantity for electromagnetic fields bioeffects.

[27] Blackman, 2009, Pathophysiology. 2009 Aug;16(2-3):205-16.
Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. (full article)

[28] Panagopoulos et al, 2010, Int J Radiat Biol. 2010 May;86(5):345-57.
Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna.

[29] Jiang et al, 2012, PLoS One. 2012;7(2):e32040.
Adaptive response in mice exposed to 900 MHz radiofrequency fields: primary DNA damage.

[30] Abu Khadra et al, 2014, Electromagn Biol Med. 2014 Feb 5.
Evaluation of selected biochemical parameters in the saliva of young males using mobile phones.

[31] Marinelli et al, 2004, J Cell Physiol. 2004 Feb;198(2):324-32. (Erratum in J Cell Physiol. 2004 Mar;198(3):479-80.)
Exposure to 900 MHz electromagnetic field induces an unbalance between pro-apoptotic and pro-survival signals in T-lymphoblastoid leukemia CCRF-CEM cells.

[32] Chavdoula et al, 2010, Mutat Res. 2010 Jul 19;700(1-2):51-61.
Comparison of biological effects between continuous and intermittent exposure to GSM-900-MHz mobile phone radiation: Detection of apoptotic cell-death features.

[33] Elhag et al, 2007, Pak J Biol Sci. 2007 Dec 1;10(23):4271-4.
Effects of electromagnetic field produced by mobile phones on the oxidant and antioxidant status of rats.

[34] Ozgur et al, 2010, Int J Radiat Biol. 2010 Nov;86(11):935-45.
Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants N-acetyl cysteine and epigallocatechin-gallate.

[35] Pyrpasopoulou et al, 2004, Bioelectromagnetics. 2004 Apr;25(3):216-27.
Bone morphogenetic protein expression in newborn rat kidneys after prenatal exposure to radiofrequency radiation.

[36] Rezk et al, 2008, Saudi Med J. 2008 Feb;29(2):218-23.
Fetal and neonatal responses following maternal exposure to mobile phones.

[37] Panagopoulos et al, 2007, Mutat Res. 2007 Jan 10;626(1-2):69-78. Epub 2006 Oct 11.
Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation.

[38] Burch et al, 2002, International Journal of Radiation Biology, 2002, Vol. 78, No. 11 : Pages 1029-1036. Melatonin metabolite excretion among cellular telephone users

[39] Liu et al, 2014, Toxicol Lett. 2014 May 8. pii: S0378-4274(14)00195-7.
The protective effect of autophagy on mouse spermatocyte derived cells exposure to 1800MHz radiofrequency electromagnetic radiation.

[40] Dr Isaac Jamieson, 2015
Electromagnetic Hypersensitivity & Human RightsCommentary to the European Economic and Social Committee

[41] Benevento Resolution, 2006, ICEMS (International Commission for Electromagnetic Safety).

[42] Canadian Human Rights Commission, May 2007
The Medical Perspective on Environmental Sensitivities

[43] Catania Resolution Catania Resolution, Italy 2002

[44] Swiss Physicians for the Environment (MfE), 2012 (Basel, March 16, 2012) Non-ionizing radiation (NIR): As much as necessary and as little as possible

[45] Swiss Government Information Document, Swiss Agency for the Environment, Forests and Landscapes SAEFL Electrosmog in the environment, 2012

[46] Vienna Resolution, Austria 1998, ICEMS (International Commission for Electromagnetic Safety)

[47] Kheifets et al, 2005, Pediatrics. 2005 Aug;116(2):e303-13. The sensitivity of children to electromagnetic fields.

[48] French National Assembly, January 29 2015 Draft law on sobriety, transparency, information and consultation for exposure to electromagnetic waves. (Final text)

[49] Devra Lee Davis et al, 2013, Pathophysiology Volume 20, Issue 2, April 2013 P 123-129 Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen

[50] ANSES (French Government Agency for Food, Environmental and Occupational Health) Radiofrequencies, mobile telecommunications and wireless technology Health effects of wireless communication technologies and other radiofrequency applications