The Radiological Protection of Electromagnetic Fields (EMF)

Information guide for the application of the 3 Fundamental Principles of Radiation Protection by Regulatory Agencies and Authorities (Revision No. 9 of November 2021)

Ibero-American Commission for Radiological Protection of Electromagnetic Fields (CIPRACEM)

Latin American and Caribbean Federation of Radiation Protection Societies (FRALC)

International Radiation Protection Association (IRPA)

Abstract

This Informative Guide produced by CIPRACEM is a “NON-PRESCRIPTIVE” consultation document prepared only to help competent authorities in the understanding and practical application of the “ICNIRP-2020 Principles” and the ICRP-103 of 2007, which are the 2 International Standards produced and accepted by the responsible body created by IRPA and by the international community.

These ICNIRP-2020 Principles were reviewed and approved by representatives appointed by:

- **The International Radiation Protection Association (IRPA),**
- **The International Commission on Radiological Protection (ICRP),**
- **The United Nations Scientific Committee on Atomic Radiation Effects (UNSCEAR),**
- **The International Labor Organization (ILO) and**
- **The World Health Organization (WHO),**

Therefore, it is a document of broad consensus, endorsed by the international community, which must be complied with by all countries in order to ensure the protection of the population and the environment.

The ICNIRP 2020 Principles propose to establish "a coherent Radiological Protection framework for the entire spectrum of Ionizing and Non-Ionizing Radiations"

The 3 Basic Principles of Radioprotection set forth in ICRP-103 of 2007 are established and applied

1- Principle of Justification: Exposures that are not duly justified should not be made.

2- Principle of Optimization of protection: The probability of an exposure, the number of people exposed and the magnitude of individual doses will be kept as low as possible to achieve (ALARA principle)

3- Principle of application of Dose Limits: The total dose to every individual should not exceed the appropriate limits specified by the competent Authority in order to prevent harmful effects on health. .

An important issue highlighted by the “ICNIRP 2020 Principles” is the **concept of Dose**; and, as such, it is the product of the intensity of the exposure and the duration of the exposure. Doses must be measured and controlled.

Since the ICRP Principles have not been initially applied to non-ionizing radiation, there is still no experience or qualified specialists, which is why this Guide was designed by CIPRACEM to provide information and support to all authorities in the application of the ICRP principles based on the experience acquired over many years in the regulation of Ionizing Radiations.

Some Objectives and Recommendations to be considered by the competent regulatory authorities

1. The necessary measures will be taken so that no worker or any person in the public receives doses that can produce Deterministic Effects and that Stochastic Effects have a probability of occurrence of less than 1 ‰ / year in order to reduce the frequency of cancers, in particular the brain, to the values existing at the beginning of the use of cell phones, without the measures affecting communications or free access to the Internet.

2. Communications will be regulated to comply with the International Agreements on Climate Change ...

3. The practices and / or the use of electronic devices that generate electromagnetic fields without obtaining a net benefit and / or mean an unnecessary energy expenditure, or that can be replaced by wired devices that do not emit radiation, will be prohibited:

4. Wireless transmission equipment will be prevented from being connected and active when not in use, so they should all be turned off automatically.

5. It will be avoided that more than three Wi-Fi signals coexist in public places unless it is reliably demonstrated that they are essential for connectivity.

6. The base antennas for cellular networks of wireless communication will not operate if the connectivity can be carried out and maintained satisfactorily by the existing Wi-Fi signals in a certain place.

7. Cell phones that have a geo-location system must be replaced as soon as possible by a manual location system operated by the user when they need to change their geographic location.

8. The dose limit for workers and the public should be established to avoid the occurrence of deterministic effects and reduce the probability of stochastic effects, in particular brain tumors, to 1 ‰ / year.

9. A record must be kept of the doses received by the population and a statistic of the frequency of diseases related to exposure to EMF, such as brain tumors and thyroid cancers of the colon and rectum, according to age, to verify the effectiveness of the established control system.

The current practice of setting Power Density limits is very useful but it is not enough if all the unjustified exposures, which are many, are not also avoided. CIPRACEM considers that it is feasible to maintain wireless communications with dose values to the population that are 100 or 1000 times lower than the current ones…!! (And this also implies reducing deaths and diseases in those same proportions…!! and maintaining the benefits)

CIPRACEM

Comisión Iberoamericana de Protección Radiológica de los Campos Electromagnéticos y las Radiaciones no Ionizantes

Protection of the population from Non-Ionising Radiation (NIR)

TABLE OF CONTENTS

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Protection of the population from Non-Ionising Radiation (NIR)

Historical Background on Non-Ionising Radiation Protection

NIR control from 1964 to 1992: In 1964, the International Radiation Protection Association (IRPA) was formed to ensure the protection of people and the environment against the dangers caused by ionising and non-ionising radiation. In 1974, the IRPA created the Commission on Non-Ionising Radiation Protection (CNIRP), with the aim of establishing specific criteria to adequately protect the public and the environment from non-ionising radiation.

Creation of ICNIRP by the IRPA: Subsequently in 1992, the CNIRP becomes the International Commission on Non-Ionising Radiation Protection (ICNIRP) with a Statute stating that it would "maintain a close liaison and working relation with the Executive Council of IRPA" and would submit its recommendations in advance for review by the IRPA Executive and all Associated Societies before proceeding to publication,and the prior deadline for comments would be 90 days, but "these prior review requirements were in practice not met by ICNIRP" so that recommendations made "without the established review process" have their scientific quality compromised and by not complying with ICNIRP's founding statute make their formal validity doubtful. Moreover, ICNIRP did not maintain a close relationship with the International Commission on Radiological Protection (ICRP) as foreseen in its formation and *did not apply the basic principles of Radiation Protection recommended by the ICRP*. This behaviour led to important differences between the ICRP and ICNIRP.

Correction of the ICNIRP's deviations: In order to correct the ICNIRP's deviations from the Statute of its creation, several steps were taken and in 2008 for the IRPA-12 Congress in Buenos Aires an ICNIRP-ICRP meeting was scheduled to reach a consensus on the Principles of Radiation Protection used, but the ICNIRP decided not to attend Argentina. Later, at the IRPA-13 Congress in Glasgow in 2012, it was declared that it was urgent for the ICNIRP to apply the ICRP's fundamental Radiation Protection criteria, but this objective was not achieved. In 2018, a "working group" is created within IRPA that requires ICNIRP to comply with the ICRP-2007 principles. CIPRACEM issues a critical report on the ICNIRP's deviations from the statute of its creation. On the occasion of the IRPA-15 Congress in Seoul, Korea, several calls by the IRPA for faithful compliance with the ICRP-2007 principles are reiterated and the IRPA and ICRP participate in the review of the ICNIRP Principles during their development.

Acceptance by ICNIRP of ICRP-2007: ICNIRP finally accepts the IRPA's claim and issues the ICNIRP Principles (ICNIRP STATEMENT, Principles for Non-ionizing Radiation Protection, published in the journal Health Physics 118 (5); 477-482; 2020) in which *it finally proposes to comply with the same Radiation Protection Principles applied by the International Commission on Radiological Protection (ICRP) and adopts ICRP-103 of 2007 as a reference document*. **The ICNIRP-2020 Principles mark a turning point in radiation protection against non-ionising radiation.**

These ICNIRP-2020 Principles were reviewed and approved by representatives appointed by the International Radiation Protection Association (IRPA): Sigurður Magnús Magnússon, for the International Commission on Radiological Protection (ICRP), Jacques Lochard, for the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR), Ferid Shannoun, for the International Labour Organisation (ILO), Shengli Niu and for the World Health Organisation (WHO), Emilie van Deventer, which is why it can be considered as a reasonably consensual document that has the endorsement and support of the international community and should be considered by all countries.

Application of the ICNIRP-2020 Principles in the Latin American region: International communications cover countries and regions, in our case Latin America, and it is very important to have a consensus document in order to establish common criteria and standards of application in all our countries and this is the function that the Ibero-American Commission for Radiological Protection of Electromagnetic Fields and Non-Ionising Radiation (CIPRACEM) designated by the Latin American and Caribbean Federation of Radiation Protection Societies (FRALC) wishes to facilitate.

The ICNIRP 2020 Principles

A "single framework" is created for the whole radiation spectrum

It establishes "***a coherent Radiation Protection framework for the whole spectrum of Ionising and Non-Ionising Radiation***" and applies the 3 basic Principles of the International Commission on Radiological Protection (ICRP-2007) and the underlying ethical values, which includes the following:

1- Principle of Justification: any decision that alters the radiation exposure situation should do more good than harm. Exposures that are not adequately justified should not be undertaken. (The benefit should always outweigh the harm).

2- Principle of Optimisation of Protection: The probability of an exposure, the number of people exposed and the magnitude of their individual doses should be kept as low as reasonably achievable, taking into account economic and social factors.

3- The principle of Dose Limitation: The total dose to any individual should not exceed appropriate limits specified by the Competent Authority.

The ICRP-2007 is taken as a reference document that the ICNIRP formally declares to accept and includes three fundamental concepts that are highlighted: The Dose Concept, the Conservative Approach and the concept of "Scientifically Proven Effects".

The Dose concept: A very important issue highlighted by ICNIRP in its 2020 Principles is the Dose concept; a certain risk of harm is normally assumed and, as such, is the product of **the intensity of exposure and the duration of exposure**, whereby a similar effect or a similar risk for an effect can be obtained by a short exposure at high intensity or a long exposure at low intensity (reciprocity). Thus, the Dose Limits (Gy) that are set to protect individuals must be controlled by considering the product between the exposure levels and the times involved.

4- The Conservative Approach: For the estimation of Dose Limits, ICNIRP generally "assumes worst-case scenarios" and "takes into account uncertainties in the scientific evidence" always for the benefit of the people to be protected (this is equivalent to the Conservative Approach used by the ICRP in all its recommendations).

5- Scientifically proven effects (Bradford Hill criteria):

ICNIRP sets its exposure guidelines solely on the basis of "scientifically proven effects". With this objective for epidemiological studies, there must be an adequate description of the population group under investigation, the exposure must be well defined and there must be adequate identification and control of confounding factors for the minimisation of bias. To achieve "scientifically proven effects" it is essential **to apply the 9 Criteria formulated by Sir Bradford Hill** (1965) which are essential to determine "Causality".

In summary, the proposal to establish a coherent radiation protection framework for the ENTIRE SPECTRUM of ionizing and non-ionizing radiation is fully justified and well-founded, because the risks are the same throughout the entire spectrum. The International Agency for Research on Cancer (IARC) has categorized all radiation, ionizing and non-ionizing, as carcinogenic agents and therefore there is always a cancer risk, higher or lower, according to the magnitude of the radiation doses received.
Non-ionizing radiation even has a carcinogenic power a thousand times higher than ionizing radiation, considering the established dose limits, and can also affect the reproductive system, the immune system and the environment. For this reason, the application of radioprotection criteria should be carried out in the same way as for ionizing radiation protection (ICRP-2007) but could be even more restrictive and severe.

Information Guide to apply the Principles of Radioprotection

required in the ICNIRP-2020 Principles and ICRP-2007

The purpose of this Informative Guide:

1) Due to the fact that the ICRP Radiation Protection principles have not been applied to non-ionizing radiation and there are not yet enough experienced specialists to apply these principles to all practices, the need arises to develop a methodology and this Informative Guide was designed by CIPRACEM to provide support in the implementation of regulatory activities.

2) It should also be considered that the general public is not aware of the risks to which it is exposed and it is convenient to carry out training tasks so that the population can cooperate in the application of protection measures. For this reason, this Guide contains technical information on the fundamentals of radioprotection principles and their practical application in order to properly train public officials and the population in general.

Objectives of Radiation Protection

The fundamental objective of radiation protection is to contribute to an adequate level of protection of people and the environment from the harmful effects of radiation exposure without unduly limiting all the benefits that may be associated with the use of radiation.

The system of radiation protection of individuals should be designed so that Deterministic effects do not occur and the increase in the probability of Stochastic effects is of a sufficiently low percentage value to be accepted by society.

In the case of environmental protection, the aim is to prevent the early death, morbidity or reproductive capacity of animals and plants, in particular for those species that are most useful to man, and the objective is to prevent or reduce the frequency of deleterious effects of radiation to a level sufficiently low that the effects have a negligible impact and do not affect the maintenance of biological diversity.

Radiation effects:

Deterministic effects:

Damage to populations of cells, characterised by a threshold dose and an increase in the severity of the reaction as the dose increases. Also called tissue reactions. Typical cases are skin reddening from sun exposure or the production of chromosomal aberrations or a change in the permeability of a membrane. There is always a threshold of exposure at which these effects appear, and the higher the exposure, the greater the magnitude of these effects.

Stochastic effects:

These are heritable diseases and effects for which the probability of an effect occurring, but not its severity, is considered to be a function of dose, with no threshold.

The typical case is cancer whose probability of occurrence increases with increasing radiation exposure. It is not possible, in general, to determine whether a cancer is caused by radiation exposure or is of natural origin, but it is observed that the higher the dose, the greater the increase in the observed frequency.

It is useful to give a practical example to understand these effects:

In the case of electromagnetic fields, it was observed that from the intensification of the use of mobile phones, the frequency of brain tumours, which was approximately two new cases per 100,000 inhabitants per year, increased for example in Brazil, by a factor of 5 to a new frequency of 10 new cases per 100,000 inhabitants per year. This means that currently, on average, out of every 5 cases of brain tumours, 4 of them are due to the use of mobile phones, and it is observed that this frequency continues to increase at a rate of 10 percent per year due to the doses received by the population from EMFs. This epidemiological information is consistent with the increase in frequency observed in case studies (Interphone, CERENAT and others) as well as in animal studies (NTP, The Ramazzini Institute).

1.- Application of the Principle of Justification:

This principle states that before authorising a practice it must be determined that the doses received by exposed persons are justified and that no greater dose is received than is strictly necessary to meet the objectives of that practice.

As there is very little experience of applying the Justification Principle to electromagnetic fields, some examples of application in the medical use of ionising radiation will be presented:

Example of application of medical radiodiagnosis:

In radiodiagnosis, radioactive sources and X-ray equipment are used to obtain anatomical images of the human body. This results in patients undergoing these studies receiving radiation doses that could give rise to deterministic or stochastic effects.

For radiodiagnosis of a lung condition, a physician prescribes a chest X-ray to assess the condition of the lungs, which involves exposure of the patient to a low dose of radiation.

A CT scan would allow obtaining a diagnostic image of higher quality than an X-ray and with more anatomical information for medical diagnosis, but the dose would be 100 or 200 times higher and the increased risk is greater than the additional benefit obtained, so it is considered that a CT scan is NOT JUSTIFIED and therefore should not be performed.

Neither is it justified to perform several X-rays instead of just one, nor is it justified to perform several CT scans, since these practices would be highly unjustified because they would unnecessarily increase the probability of that patient contracting cancer.

In other words, only those studies that are justified are performed and those that represent a lower radiation dose are chosen in order to avoid the occurrence of deterministic effects and to avoid unnecessarily increasing the frequency of cancer.

Example of application for protection against electromagnetic fields:

For wireless communication a transmitter and a receiver are required. The transmitter is usually a base antenna or a wifi antenna and the receiver is a cell phone or a laptop. For the receiver to receive the signal and communicate it is not necessary the presence of several signals, since a single signal is enough for the communication to take place!!!

Redundant antennas: Currently, at any point of a city, signals from dozens of wifi antennas arrive simultaneously and also signals from 4 or 5 base antennas of different telephone companies, and only one of these signals is required to make a communication. In this case, in order to achieve the objective of communication, the signals are very redundant and the doses received by the users can be 10 or 100 times higher than what is required to communicate...!!!! This is because there are several companies working independently!!!!

This situation would be equivalent, in the above radiodiagnostic example, to a patient who, although needing a single chest X-ray, has several chest X-rays and also several CT scans performed to involve all the companies, which work independently. And also, the patient is given several X-rays with different X-ray equipment, since this would be the equivalent of the presence of different wifi signals at a given point.

This example is given to point out that the user receives a much higher radiation dose than he/she would receive with a single wifi signal, which would be sufficient to establish communication.

The application of the principle of justification consists of using a single emitting source and that this emitting source is the one that produces the lowest dose to the users and that allows the necessary connectivity to be maintained. Redundancy is not justified as it increases the doses received.

Continuous geolocation: On the other hand, the mobile phone has a geolocation system designed to provide the communication system with continuous a information about the user's location, even if the user does not change location. If the object is location, it is not justified to irradiate the user if the

user does not change location or if the location can be done without irradiating the user and/or only when the user changes location.

Due to this function the cell phone emits radiation continuously which contributes to increase the doses received by the user and compared to ionizing radiation can be equivalent to the person being forced to carry a radioactive source in his pocket continuously to be located.

These examples help to understand the objective of the Principle of Justification and how it is applied to avoid unjustified risks, whether ionizing or non-ionizing radiation.

<u>Collective doses</u>: To achieve the objective of the communication, it is not necessary to expose the entire population to multiple sources emitting electromagnetic fields, giving the supply companies an independence that allows them to establish the systems and devices to be used without taking into account compliance with the Principles of Radioprotection established in the ICNIRP-2020 Principles and in the ICRP-2007. When many people are exposed, care must be even greater as the Collective Dose increases and the risk of cancer is greater.

On the other hand, it should be borne in mind that in the example given of the patient undergoing a radiodiagnostic test, radiation doses are received only by the patient performing the X-ray study, whereas in the case of wireless communications antennas can irradiate hundreds or thousands of people simultaneously, many of whom do not receive the benefits and/or do so involuntarily and may also have particular health problems or increased sensitivity to radiation.

2.- <u>Application of the Principle of Optimization:</u>

This Principle determines that once a risk is justified, all necessary measures should be taken to make that risk as low as reasonably achievable (ALARA Principle).

<u>In Ionizing Radiation</u>: Going back to the previous case of medical Radiodiagnosis: When the physician prescribes an X-ray, the aim is to obtain that X-ray with the lowest possible dose...!!! Because the lower the dose the lower the risk and the lower the harm to the patient. Therefore, before taking an X-ray, a previous study is made to know what is the best distance from the emitting source to the patient and the existing relationship with the position of the radiation detector or the radiographic plate to be used so that the dose is the lowest possible.

<u>In Non-Ionizing Radiation</u>: With Electromagnetic Fields (EMF), the same type of studies must be done but in addition to the doses (SA) received by people expressed in Gy (J/kg), there are other variables that play an important role in the production of biological damage to a tissue; this is the case for example of the frequency, the pulsed character of the radiation, its polarization, the form of modulation and many other variables that we must consider in the optimization because the effects on health depend on all these variables.

Therefore, to ensure that "as low as resonably achievable", in addition to controlling the doses, the rest of the exposure variables must also be duly controlled, since they contribute in some way to the magnitude of the damage or disease produced.

<u>Example of variables influencing the effects of EMF:</u>

<u>Frequencies</u>: there are some relevant works such as the one carried out by Hans Geesink and Dirk Meijer, a meta-analysis of more than 700 works carried out over 50 years, where it is concluded that there are "healthy frequencies" and "unhealthy frequencies" for humans and animals. Therefore, one should try to use frequencies that are considered healthy for wireless communications.

<u>The pulse</u>: It has been shown in many studies (e.g., REFLEX Project) that the pulse is a very important variable that determines whether or not effects occur and therefore the use of pulsed emissions should be avoided as far as possible.

<u>Polarisation</u>: It has also been observed that living tissues have a greater sensitivity to polarised fields than to non-polarised fields and this variable must also be considered.

<u>Power windows</u>: there is work suggesting the existence of "power windows" as some biological effects are observed at certain SAR or power density values that are not observed at higher or lower exposure values!!!

<u>Intermittency</u>: Intermittency: It is also very important whether the exposure is permanent or intermittent. This is also observed in the case of ionising radiation, where the biological effects are of much lesser magnitude when the doses are fractioned over time, and this characteristic is used precisely to protect certain tissues or organs in radiotherapy.

In the case of electromagnetic fields, it has also been observed in humans and animals that if exposure is interrupted, tissue recovery generally occurs and the observed effects disappear over time, in particular a recovery of cellular oxidative stress can be achieved, allowing the body to eliminate oxidative species and free radicals that have been generated by natural mechanisms of the body.

This observation on the benefits of intermittency suggests that a temporary interruption of exposure to electromagnetic fields could be beneficial to the body. This can be achieved by scheduled interruptions of the emitting equipment.

<u>Coherence and decoherence</u>: It must also be considered that endogenous electromagnetic fields (EMF) are generated inside cells due to the vibration of dipolar macromolecules and/or components of the microskeleton such as microtubules. These electromagnetic fields generated inside the cells can be positively or negatively affected by external electromagnetic fields according to whether there is coherence or decoherence between them. From this very particular situation arises the concept of "electromagnetic homeostasis", i.e., the ability of the human body to maintain a balance of highly complex electromagnetic interactions within cells, despite a noisy external electromagnetic environment (De Ninno and Pregnolato, 2016).

<u>Set of variables</u>: Set of variables: This scenario of complex characteristics of exposure to electromagnetic fields would seem to require that the Optimisation Process should consider, in addition to doses, all factors that may affect the biological effects and health of humans and animals, some of which may include the following:

<u>Those relating to the emitting source</u>

- **dose received and/or power density**
- **total duration of exposure**
- **dose rate or SAR**
- **wavelength and wavelength frequency**
- **Polarisation mode (linear, circular) / non-polarisation.**
- **continuous or pulsed fields (pulse type, pulse width, etc.)**
- **wave modulations/modulation shape**
- **intermittent or continuous exposure and post-exposure elapsed time**
- **near-field / far-field characteristicsduración total de la exposición**
- **presence of stray electromagnetic fields**

<u>Those relating to the recipient of the doses</u>

- **coherence and/or decoherence between external EMFs and endogenous EMFs**
- **type of cells/tissue used and their genotype**
- **gender and age in the case of laboratory animals.**
- **density of cells in a medium (cell-cell spacing)**

In summary, to apply the Optimisation Principle in the case of EMFs it is very important that the doses are kept "**as low as reasonably achievable**"", but it is also convenient to consider the rest of the variables at stake, as it has been demonstrated in humans and animals that it is possible to reduce the magnitude of damage and disease by varying some of these parameters. **The overall objective should be: "to keep doses as low and as little harmful to health as possible"**.

3º <u>Application of the Principle of Dose Limitation</u>:

The dose limit for workers and the public should be set to <u>avoid deterministic effects</u> and <u>reduce the risks of stochastic effects</u> to a percentage value low enough to be accepted by society.

1) To avoid deterministic effects

<u>Application of dose limits to Ionising Radiation:</u>

In the case of ionising radiation, the annual dose limits for workers (20 mSv) are at least 10 times lower than the doses that could cause, for example, the appearance of chromosomal aberrations or any other deterministic effect, so that a worker cannot in any case have deterministic effects, unless a radiological accident occurs. In other words, there are no known measurable effects in animals, in humans or in vitro studies that occur at values of 20 mSv even if received in a short period of time. In the case of annual dose limits for the public (1mSv/year) the values at which deterministic effects are observed are 100 to 200 times higher than these limits.

<u>Application of dose limits to Non-Ionising Radiation:</u>

It should be noted that in exposure to electromagnetic fields there are deterministic effects that occur at dose rate values that are up to 100 times below the currently used and recommended limits. For example: **1) Co-carinogenesis** in laboratory animals occurs at SAR ≤ 0.04 W/kg, well below the limit values, **2) Calcium channel opening** and inhibition of Calcineurin which seriously affects the body's immune system, occurs at values 100 times below the limits, **3) Loss of blood-brain barrier (BBB) permeability** occurs in animals at values 100 times below the limits. **4) Chromosomal aberrations are detected in peripheral blood lymphocytes** from people residing in the vicinity of a base antenna with exposure values 10 times below the limits, 5) **90% of tadpole eggs** have been observed to die within the immediate area of a base antenna, **6) Chromosomal aberrations (dicentrics)** have been observed in human foetal cells exposed 3 hours daily to EMF produced by cellular phones. **7)** A **tripling in the frequency of miscarriages** has been observed **in healthy pregnant women** who were exposed to EMF levels 100 times lower than the established limits (2 mG). **8)** A **doubling of childhood leukaemias** at values 100 times below the established limits has been observed with low-frequency EMF. **9)** Deterministic effects **(increased mortality)** have been observed **in bee larvae exposed** to the field generated by a mobile phone. **10)** Infertility and loss of sperm motility have been studied in animals and humans at exposure values below the established limits. **11)** Significant genotoxic effects have been observed with RF-EMF in worms exposed to values 10 times below the established limits and the effect is doubled when the field is modulated. **12) DNA damage** has been observed in **workers exposed to ELF-EMF** with average workplace values 100 times below the established limits.**13) Chromosomal aberrations (micronuclei) in biological dosimeters** (Allium cepa test) of much higher intensity than those produced by exposure to 30 KBq of Plutonium-239

In summary, **the carcinogenic power of non-ionising radiation is at least 1000 times greater than that of ionising radiation, as deterministic effects are observed at values below the limits recommended by the ICNIRP, whereas with ionising radiation it is necessary to increase the doses 100 times above the limits in order to observe such effects**. All this observed information indicates that in order to avoid deterministic effects it is necessary that the doses are low enough so that none of these effects can occur and therefore the doses must be decreased to **values that are estimated to be at least 100 times below the current power density limits** and a safety factor must also be added to cover the statistical errors.

This applies to both ELF EMFs and RF EMFs.

Failure to set appropriate dose limits contravenes the objective of the ICNIRP-2020 Principles "to establish a consistent framework of radiation protection over the ENTIRE SPECTRUM of ionizing and non-ionizing radiation". It also fails to comply with the criteria of ICRP-2007 which is the reference document. Failure to comply with the dose limits would result in large differences between the protection limits for ionising and non-ionising radiation.

2) To reduce the risks of stochastic effects

In addition to avoiding Deterministic effects, the ICNIRP-2020 Principles as well as ICRP-2007 recommend **reducing the risks of Stochastic effects to a percentage value low enough to be accepted by society**.

Requirements for Ionising Radiation:

In the case of ionising radiation, the dose limit value established for workers (20 mSv) corresponds to an increase in the probability of contracting cancer of 0.1%/year, and for the public (1mSv) the probability is 0.005 %/year.

Requirements for No-Ionising Radiation:

Currently, if we take the results of case studies, such as the CERENAT project, we can see that there was a 200% increase in the frequency of brain tumours (OR=3) for doses received from 900 hours of mobile phone use over a lifetime, which, assuming a period of 20 years, corresponds to doses received from 45 hours/year of use, which corresponds to an increase in the frequency of brain tumours of 10%/year.

Very recent statistical studies in Europe (Van Wel et al) give an average value of mobile phone use, close to the body, of 30 hours/year, so the value of 45 hours/year is a reasonable figure to use in the estimates.

This value is consistent with epidemiological data from several countries where, according to statistics, the frequency of brain tumours has increased by a factor of 5 (OR=5) since the 1990s, when mobile phone use began to become popular, and the current slope observed in several countries is approximately 10%/year, with a doubling of cases every 8 years.

The information available from Argentina for Acoustic Neurinomas shows that the frequency has quadrupled in 10 years, which corresponds to an increase of 15%/year.

Therefore, on the assumption that there is currently an increase in frequency of 10%/year, to make the increase in the probability of getting cancer equivalent to the ICRP recommended values of 0.1%/year **the doses would have to decrease by at least 100 times** and as we have seen above, this action is exactly the same as that required to avoid deterministic effects.

In order to meet the objectives of the ICNIRP-2020 Principles to "establish a coherent framework of Radiation Protection for the whole spectrum of Ionising and Non-Ionising Radiation" it is therefore necessary to reduce the doses currently received by the population exposed to electromagnetic fields by a factor of 100 so that no deterministic effects occur and the probability of brain and other tumours is 0.1% /year.

Further information on the deterministic and stochastic effects of EMF on humans and animals can be found in Appendix 1 and the accompanying bibliography.

3) Also to reduce Non-radiological risks:

According to reports from specialised organisations in the field, wireless communications have a strong impact on climate change due to their **high energy consumption compared to wired communications, which requires burning fossil fuels and producing an increasing volume of greenhouse gases (GHG)**. In addition, rocket fuel for 5G satellite deployment causes irreparable damage to the Ozone Layer, which also leads to an increase in global temperature.

More detailed information on this subject is given in Appendix 2.

It is very important to note that lowering the doses 100 times to avoid the deterministic effects and lowering the frequency of brain tumours to the values before the use of mobile phones, also contributes to saving energy and avoiding the increase of greenhouse gas emissions that cause damage to the planet...!

But saving energy is also saving resources and money...!!! that is why "improvements in the protection of people and improvements in the care of the planet do not represent an expense for society but rather a saving of its resources"

This objective of lowering doses by a factor of 100 can be achieved in the short term and in a sustainable manner over time if the principles of radiation protection, and in particular the principle of justification, are applied immediately. As a complement, doses can be lowered by means of adequate training of the population in the intelligent use of mobile phones and a set of measures to gradually replace wireless communication with wired communication.

4 - Measures to protect the environment

There is no single universal definition for "protection of the environment" but the general objective may be to prevent or reduce the frequency of deleterious effects of radiation on animals and plants to a level at which they would have a negligible impact on the maintenance of biological diversity, the conservation of species or the health and status of natural habitats, communities and ecosystems.

The use of Reference Animals and Reference Plants is proposed for the purpose of relating exposure and doses to effects on living animal and plant organisms.

The use of plant biological dosimeters that detect genotoxicity due to EMF exposure by chromosomal aberrations (dicentrics) such as the Allium cepa test (garlic) and the Vicia faba root (beans) is also possible. These plant biological dosimeters are low-cost, easy to use and sensitive to both ionising and non-ionising radiation, allowing comparative genotoxicity studies. Biological dosimetry laboratories for ionising radiation have the necessary measuring instruments for dose assessment.

5 - Application of the Conservative Approach:

In cases where, due to lack of complete information, it is not possible to establish exactly what the risks of a practice are, the worst-case scenario for humans and/or animals is always assumed. **In the case of two equally likely alternatives, it is always assumed that the alternative involving the greater harm to health is correct**, and it is appropriate here to give some specific examples of the ICRP's application of this criterion in the case of ionising radiation, given that ICRP-2007 is the reference document adopted by the ICNIRP in establishing its ICNIRP-2020 Principles:

The application of the Conservative Approach by ICRP

Example a)

The cause/effect relationship of ionising radiation has been established at very high dose values, 100 or 1000 times higher than the limit values established for the public. Therefore, it is not really known what the "Low Dose Effects" are. There is no scientific work, neither in humans nor in animals nor in in vitro studies where any effect at low doses can be observed. Moreover, there are some studies (K. Rothkamm and M. Löbrich) that show that cancer induction at low doses is impossible because enzymatic repair of the damage does not occur after many days. However, "as there is a possibility a possibility of posing damage" **the ICRP assumes that it is scientifically plausible** to assume that the incidence of cancer will increase in direct proportion to the increase of the equivalent dose in the relevant organs and tissues and assumes that the cause/effect relationship holds even at extremely low doses, below 1 mGy and the so-called "linear no threshold" (LNT) model is applied.

Example b) Hereditary effects of radiation have not been detected, even at high doses, in any of the study groups evaluated, but hereditary effects have been detected in mice and flies at high doses. Given this scenario, both the International Commission on Radiological Protection (ICRP) and the Committee on the Biological Effects of Ionizing Radiations (BEIR) of the National Research Council (NRC) of the USA, have assumed that if there are hereditary effects in some living beings, there may also be hereditary effects in humans, even at low doses, and therefore these effects are included as part of the detriment to humans.

Example c) When a diet or behaviour of people living near a nuclear or radioactive facility is to be assumed, the diet or behaviour that results in the highest dose to the resident is always taken, even if this is extremely unlikely.

The application of the Conservative Approach to EMFs:

The application of the conservative approach is very important in the case of non-ionising radiation in cases where there are doubts because the scientific evidence is not conclusive. As recommended by the ICRP in these cases, one should always be on the safe side when it comes to the protection of people, assuming those hypotheses that benefit people.

Therefore, if there is evidence from animal studies, it should be considered that the same effects may occur in humans.

6 - Scientifically proven effects (Bradford Hill criteria):

The ICNIRP 2020 Principles state that in order to make determinations and establish regulatory requirements it is imperative that the "effects are scientifically proven". In order to achieve "scientifically proven effects" it is essential to apply the 9 Criteria formulated by Sir Bradford Hill (1965) which are essential to determine "Causality".

In short, decisions cannot be taken on the basis of a few papers but "**on the basis of all existing information**" using the 9 Criteria formulated by Sir Bradford Hill.

This task has been carried out by two prestigious IARC experts: Dr. Lennart Hardell and Dr. Christopher J. Portier, who have considered the totality of scientific information including in vitro work, case studies, animal studies, statistical studies, etc. and both have concluded that the evidence for causality of electromagnetic fields in cases of brain tumours such as gliomas and acoustic neurinomas is very strong, which is why **causality is duly demonstrated**.

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PROPOSED RECOMMENDATIONS TO BE CONSIDERED

In order to comply with the principles established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in the Standard "ICNIRP Statement Principles for Non-Ionizing Radiation Protection", published in the journal Health Physics in 2020, the competent authorities of each country will establish the necessary measures for its effective compliance, maintaining the necessary connectivity for communications and free access to the internet for all people.

Basic requirements:

1 - It is recommended that all necessary measures be taken to ensure that no worker or general public receives doses that can produce deterministic effects and that stochastic effects have a probability of occurrence of less than 1‰ /year in order to lower the frequency of cancers, in particular brain cancers, to the values existing at the start of the use of mobile phones, without the measures affecting communications and free access to the internet for all persons who require it.

2 - The use of wireless communication will be duly regulated in a way that allows the country to meet the objectives of the Paris Agreement on Climate Change, which establishes restrictions on the emission of greenhouse gases (GHG) to limit the increase in global temperature to 1.5ºC, for which effective measures must be taken to avoid any use that is not duly justified.

3 - Application of the Principle of Justification: All practices or activities and/or the use of electronic devices that generate electromagnetic fields for no net benefit and/or waste unnecessary energy, or that can be replaced by wired devices that do not emit radiation, e.g., shall be prohibited:

- **Wireless transmission equipment should be prevented from being switched on and active when not needed and should be automatically switched off when not required, particularly at night.**
- **Avoid more than three Wi-Fi signals coexisting in public places unless it can be clearly demonstrated that they are essential for connectivity.**
- **Base antennas for cellular wireless communication networks shall not operate if connectivity can be achieved and maintained satisfactorily by existing Wi-Fi signals in a given location.**
- **Low orbiting satellites will also not be allowed if their purpose is communications that can be replaced with terrestrial transmitting antennas. In summary, the redundancy of electromagnetic field emitters is not permitted because it violates the principle of justification established in current international standards, and in all cases, preference will be given to those emitting antennas that produce the lowest collective doses to the exposed population.**
- **As a general rule, in all cases where several alternatives are available for wireless communication, the one that produces the lowest collective dose and the lowest energy expenditure should always be used in order to avoid increased health risks and increased energy consumption.**
- **The use of any wifi broadcast shall be free for all persons, without requiring an authorisation code or password, which does not mean that it must be free of charge.**
- **Mobile phones with a geo-location system that operates continuously must be replaced as soon as possible by a GPS-based location system and/or a manual location system operated by the user himself when he has to change his geographical location (change of telecommunication network cell) and decides to communicate it. In summary, no automatic and continuous electromagnetic emission from any electronic device shall be allowed, except for the purpose of communication by the user of the device.**
- **All wireless devices that remain fixed in a given location must be wired to avoid radiation emission, increase communication speed and reduce energy expenditure and battery usage.**
- **Advertising and commercial promotions should not be done wirelessly but only wired. It has been proven that more than 90% of wireless traffic, according to the schedule, corresponds to advertising**

and commercial promotions, unsolicited by users, which produces a large congestion that hinders the communication of emergency systems, causes delays, a greater waste of energy and resources and significant damage to the environment and people's health, all of which must be avoided. The more messages that are broadcast, the greater the collective dose to the exposed population and to animals and plants in the vicinity.

- **The communication of electronic devices with the data centres, usually called "clouds", for the back-up of the devices, should only be done in wired form, which is faster, has a higher capacity for sending information and consumes much less energy. In order to meet this requirement for electronic devices, connection facilities should be available in private homes, companies and public places in order to be able to back-up electronic devices on a regular basis.**

4 - Waivers:

When there are special circumstances or conditions in which the operator or person responsible for the practice judges that the communication cannot be carried out in compliance with the established requirements, he/she may make a "Request for exception to the competent authority", justifying the reasons that make connectivity difficult, formulating an alternative proposal and an estimate of the collective doses that the approval of such an exception entails. The application of the established Recommendations must not impede or hinder connectivity, which must be maintained while avoiding consequences for human health and the environment. Care will be taken to ensure adequate connectivity for emergency, police, medical and fire services, among others.

5 - Complementary structural measures: In order to facilitate and stimulate all those forms of communication that are less risky for the health of the population and the biota:

- **National broadband networks covering the country and branching out to all towns and cities should be developed and optimised to facilitate wired communications.**

- **In addition, home, industrial, commercial and commercial Ethernet cabling will be implemented, especially in schools and universities, in order to avoid the use of wifi in education.**

- **In public places, squares and main avenues, RJ-45 connectors will be installed so that people who wish to communicate by wired means can do so. Internet connectors may also include DC power supply to avoid the use of batteries, for which appropriate connectors (IEEE 802.3cg standard) may be provided.**

- **All fixed telephones should have touch screens, multiple memories, automatic dialling from existing contacts, hands-free operation, internet connection, zoom or meet management or other applications and all the necessary advances for normal use, given that wired communication is cheaper, does not use batteries, is much faster, has a higher data transmission capacity, shorter latency time and does not cause damage to health and the environment.**

- **Tax and incentive measures will be developed to promote and encourage the use of wired communication and discourage the use of wireless communication in order to promote good practices and create a culture of Radioprotection, energy saving and care for the environment in the population, particularly among young people.**

Note: It should be noted that the policy of the telephone companies has been to encourage wireless communication and discourage the use of wired telephony, which is why fixed telephones have not been properly upgraded. This incorrect policy was pointed out by the Council of Europe in Resolution 1815/2011 and should be strongly penalised as it is one of the main reasons for preferring a form of communication that causes greater damage to health and the environment, as well as higher energy consumption and battery consumption.

According to the opinion of the National Institute for Science, Law & Public Policy Wash, DC, in the United States "*The history of U.S. communication infrastructure increasingly supports the proposition that it is unrealistic to expect private monopolies, duopolies, or triopolies—regulated or unregulated—to make the long-term investments necessary to build the enduring and*

***sustainable public broadband fiber information highway that the country needs. Corporations will invariably seek the cheapest, quickest, and most profitable path, which has led to the current emphasis on wireless*".**

These reflections based on the experience of this prestigious institution in the United States lead us to assume that it is totally unacceptable that it is the companies that decide on communication policies based on their commercial interests and not the institutions that represent the society in which we live. A system is being promoted which is more expensive, slower, with less data transmission capacity and which causes serious illnesses such as brain tumours which currently cause 1000 deaths a day worldwide, not to mention the sum of other serious health and environmental disorders which burden humanity.It should be up to the people and their representatives to make decisions on policy with the advice of technical bodies specialised in communications, medicine, biology, epidemiology, environment, animal and plant care, climate change, etc.

6 - Application of the Principle of optimization:

- **Wireless communication shall be used only in cases where it cannot be replaced by wired communication.**

- **When wireless communication is the only possible alternative, "doses should be as low as reasonably achievable", for which the signal emitted by an antenna should be of sufficient strength to connect to the devices to which the signal is directed.**

- **But in addition to the doses, the set of variables involved in the exposure must also be controlled, as they can contribute to the magnitude of the damage or the magnitude of the risk of disease in humans or other living beings. To meet this requirement, it will be determined in each case which parameters of the electromagnetic emission produce the least damage to health without affecting the connectivity necessary to meet the objectives of the electromagnetic emission under consideration.**

7 - Application of the Principle of Dose Limitation:

- **The dose limit for occupationally exposed workers and the general public should be set so as to avoid the occurrence of any deterministic effects in humans or living organisms and to reduce the risks of stochastic effects, in particular brain tumours, to a limit frequency of 1‰ /year.**
- **Considering the results of several case studies conducted and the current increase in the frequency of brain tumours observed in several countries that have published their statistics, it is estimated that the dose limits to be established should be approximately 100 times lower than the current values of doses received by the population.**
- **Personal dosimeters should be developed to assess the doses received by individuals, in particular those with the highest exposure such as workers professionally exposed to electromagnetic fields. Average body doses and doses to tissues or organs of highest exposure such as doses to the temporal lobe of the brain, thyroid, colon and rectum, and reproductive organs should be determined.**
- **To protect animal life, doses should be assessed at the highest exposure sites using physical and biological dosimeters, as well as population studies of species considered most sensitive, such as pollinating insects like bees and some amphibians like frogs, and environmental monitoring of areas set aside to protect wildlife.**
- **It is recommended that mobile phones have applications to measure the strength of the electromagnetic fields present and their temporal integration in order to estimate the doses that the carrier may receive. These dosimetric applications may include alarm signals to alert the user to dose values approaching the limit values set by the competent authority.**

8 – Protection of the most sensitive persons:

A No Observed Adverse Effect Level (NOAEL) should be established to protect the most sensitive or at-risk individuals such as children, pregnant women, cancer patients and hypersensitive individuals.

In crowded public places, adequately protected places should be made available for the most sensitive people to stay.

Authorities should take measures to ensure the availability on the market of electromagnetic field protection materials for people who require them for their homes and for their personal protection.

9 - Use of Indicators to monitor the effectiveness of control measures:

- **It is recommended that a record be kept of the average doses received by the general population in order to assess the effectiveness of measures taken for their effective control.**
- **Statistics should be kept on the frequency of diseases related to exposure to electromagnetic fields, such as brain tumours (gliomas, glioblastomas, acoustic neurinoma), thyroid, colon and rectum and testicular cancers. Statistics should be sectorised for each age group in order to be able to assess possible changes in the age at which the different conditions occur.**
- **The production of greenhouse gases (GHG) that are produced annually by wireless communication should be determined and it should be assessed whether these values allow compliance with the targets set out in the International Agreement on Climate Change.**
- **Statistics should be kept on the population of the most sensitive animal species, such as pollinating insects, in particular bees and migratory birds.**

10 – The most urgent measures:

There is a relatively urgent need to reduce the doses received by the population, mainly to reduce the frequency of brain tumours that cause thousands of deaths per day, to avoid all stochastic effects, of which there are many, and to reduce the production of GHGs, and for this the most effective, and therefore the most urgent, measures are the elimination of automatic geolocation of mobile phones and cancelling emissions from base antennas when connectivity can be covered by the wifi emissions present. It is estimated that these two measures could increase current doses by a factor of 100.

APPENDIX 1

Biological and Epidemiological information produced by the exposure of living beings to Electromagnetic Fields. Only a few cases considered most relevant and/or representative have been selected.

1 – The increase in frequency of brain tumors:

This has been observed in several countries with epidemiological statistics from before the use of mobile phones, such as France, Sweden, Australia, England and Brazil, where the frequency of tumours has tripled, quadrupled and quintupled and continues to grow by an average of 10% per year.

Also in Argentina, an increase in the frequency of acoustic neuroma tumours has been observed, particularly the most aggressive ones (grade 4) called giants, which have increased fivefold in only 10 years. All this confirms the results of several case studies, the evidence of ipsolaterality, the animal studies carried out in recent years and the in vitro studies where the mechanisms of cancer production have been redundantly proven.

In addition, to confirm causality, two IARC experts (Drs. C. Portier and L. Hardell) applied Sir Bradford Hill's 9 criteria and obtained very strong evidence of causality attributed to exposure to electromagnetic fields (EMF).

Currently the increase in frequency is on average 10% per year and this is related to a calculated mobile phone use in proximity of approximately 45 hours/year.

These data of increased frequency of brain tumours with high morbidity (glioma and glioblastoma multiforme) are very consistent with the results of several case studies, e.g. CERENAT, which reports a tripling of frequency (OR = 3) with a lifetime mobile phone use of 900 hours.

Assuming that this phenomenon also occurs in countries without statistics and extrapolating the data obtained in countries with statistics to all countries, the total number of deaths from brain tumours since the beginning of mobile phone use is estimated at 4 million deaths. No equilibrium value has been reached and the frequency continues to increase exponentially, doubling every 8 years, so that if measures are not taken now, the situation will worsen over time.

The current increase in the frequency of brain tumours should therefore be reduced from 10% per year to 1 per thousand, which is the value recommended by the International Commission on Radiological Protection (ICRP) for ionising radiation workers who have an annual dose limit of 20 mSv, which is equivalent to an increase in the frequency of cancer of 1 per thousand. (For members of the public the increase in frequency is 20 times lower).

Achieving this decrease in the likelihood of brain tumours and hence the mortality rate requires measures to lower the average doses to people to 100 times lower than at present. This can be achieved by proportionally decreasing the time of mobile phone use or by decreasing the power density produced by the base antennas and the power density produced by the mobile phone itself.

2 – The decrease in the body's natural defences due to the effects of EMFs on the immune system:

There is a first phenomenon on the defences that is produced by the opening of the calcium channels located in the cell membrane which determines the uncontrolled entry of calcium ions into the interior of the cells initially producing the synthesis of nitric oxide and then a set of reactions that include the production of peroxynitrite and free radicals that finally determine "the inhibition of Calcineurin" which is an essential enzyme for the production and differentiation of T cells whose function is to protect from the entry of external agents into the organism such as viruses, bacteria, fungi and parasites, which determines an increase in the risks inherent in infections and therefore a greater number of deaths due to the impossibility of using the natural defences, bacteria, fungi and

parasites, which leads to an increase in the risks inherent to infections and therefore to a higher number of deaths due to the impossibility of using natural defences. This situation is doubly serious in the case of a pandemic.

Likewise, EMF causes an increase in the permeability of the haemato-encephalic membrane, reducing its protective function against the entry of toxins, macromolecules, viruses and bacteria, which exposes neurons to damage that has been quantified in various experiments with laboratory animals.

It should be noted that these two processes of opening calcium channels and increasing the permeability of the haemato-encephalic membrane occur at doses 100 times lower than the established limits, which is why it is desirable to lower the current limits to 100 times lower values.

In relation to the immune system and infections it can be added that very recently Taheri et al (2017) have shown that exposure to radiation from mobile phones and Wi-Fi determines that 2 bacteria, Listeria monocytogenes and Escherichia coli become resistant to different antibiotics. Considering that listeriosis is a fatal disease with symptoms of miscarriage, septicaemia and meningitis, this is a fact that should be taken into account.

3 – <u>The cocarcinogenic potency of EMFs increases cancer mortality by increasing the number and size of existing tumours, as well as their metastasis</u>:

Unlike Ionising Radiation (IR), which acts only in the initial "Induction" stage of the cancerogenesis process, electromagnetic fields and in particular pulsed electromagnetic fields, in addition to inducing the start of the cancerogenesis process by damaging the DNA molecule, act in the final "Progression" stage, producing an increase in the number, size and aggressiveness of pre-existing tumours, whether these have been induced naturally or by chemical or physical agents. This particular effect means that measures must be taken to protect cancer patients who are in the process of recovery or treatment, which is why radiotherapists and oncologists must be duly informed and prepared to take the corresponding radioprotection measures.

This process has been proven, both in humans (INTEROCC) and in animals (Tillmann, Lerchl) and whatever the origin of the tumour, whether it is of chemical origin (Tillmann, Lerchl, Ramazzini) or physical origin (Inst. Ramazzini), with low-frequency EMF (INTEROCC), or with radiofrequency EMF (Tillmann, Lerchl) and the mechanisms that cause it are also known through epigenetic effects that determine the change in gene and oncogene expression (REFLEX Project).

It should also be noted here, as indicated in the two previous points, that co-cancerogenic effects occur at exposure values that are 100 times lower than the protection limit values established by ICNIRP (SAR ≤ 0.04 W/kg), which is why here too it is appropriate to lower exposures by at least a factor of 100 to prevent them.

4 – <u>Damage to animal life and in particular to some endangered species due to electromagnetic fields.</u>

The health and death risks, some of which have already been reported for humans, are much higher for some animal and plant species which are more sensitive and lead to increased mortality and reduced populations affecting biodiversity.

In a review of about 1000 studies on different animals, plants and wildlife, in 70% of the cases it was found that there was an impact on animal life at values below the established limits, both at low frequencies and at radio frequencies.

The case of greatest concern is that of bees; when researchers bring mobile phone radiation close to bee hives, the bees occupying the hive choose to move away and never return. In such cases the queen is left alone with her helpers and eventually the life of the hive ends. Exposure of the developing eggs and pupae in a hive to a mobile phone result in the death of a large proportion of the hive's eggs and pupae. Worldwide, drastic reductions in pollinating insect populations are observed,

particularly in Germany, where more than 75% of them have disappeared. In India, declines in fruit production due to reduced pollination have been observed.

An experiment with frogs near a base antenna has been carried out for two months. Frog eggs were placed near the cellular network antenna from the initial stage to an advanced tadpole stage before metamorphosis. The electric field strength measurements were between 1.8 and 3.5 V/m, which is well below the ICNIRP limits of 61 V/m for that frequency.

In the group of exposed tadpoles (n = 70), poor coordination of movements, asynchronous growth, resulting in very large and very small tadpoles, and high mortality (90%) were observed. Compared to the control group (n = 70) which was kept under exactly the same conditions, but inside a Faraday cage, the coordination of movements was normal, the development was synchronous and a mortality of only 4.2% was obtained.

On a farm in Switzerland with cows that were exposed to a cellular network base antenna, spontaneous abortions occurred and some calves were born with nuclear cataracts. When the antenna stopped working all problems disappeared. The antenna was reconnected and the same problems reappeared until it was decided to disconnect the antenna for good.

In Europe, a decrease in the sparrow population has been noticed in large cities, and something similar is happening with migratory birds that do not return to their usual mating and nesting places.

Plants and trees are also sensitive to the proximity of the base station antennas, with clear differences being observed in plants on the side closest to the transmitting antenna.

All these results and many others not mentioned indicate that the radiation emitted by cellular network base station antennas in a real-life situation can affect the development and may cause increased mortality of different plant and animal species, which significantly affects biodiversity conservation.

Note: There are many other health effects that have been observed on the male and female reproductive system in humans and animals including miscarriages, on the endocrine system and hormones, on the blood circulation system, on the nervous system with neurological and psychiatric diseases, and on specimens of various species such as worms, ants, reptiles, bats, birds, mammals, fish and micro-organisms.

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APPENDIX 2

Non-radiological Aspects of Electromagnetic Fields: Climate Change, the Ozone Layer and Military Uses.

1 - The strong impact of wireless communications on climate change:

According to reports from specialised agencies in the field such as: The US National Institute for Science and Public Policy (NISLAPP), The German Federal Environment Agency (UBA) and The Australian Centre for Energy Efficiency Research in Telecommunications (CEET), wireless communication represents a tremendous waste of energy relative to wired given that it consumes 10 times more, necessarily forcing the burning of fossil fuels and producing an increasing volume of greenhouse gases (GHG) and the consequent increase in global temperature and risk of environmental disasters.

4G transmission produces 6 times more CO2 emissions compared to fibre optic or cable. From 2012 to 2015 we went from emitting 6 million to 30 million tons of CO2, a five-fold increase in 3 years, and this was due to the excessive use of wireless communication.

Wifi increases energy use very little, but when access occurs via a cellular network tower, energy use skyrockets!! 4G consumes 23 times more than Wifi!!

On the other hand, fibre optic and copper networks are far superior to wireless in speed, security and cost, which is why they are harming the planet and people without any benefits in return.

The advantages and disadvantages of technological change must be analysed. The use of wireless communication according to the opinion of specialised organisations basically implies:

- **Higher costs than wired systems.**
- **Lower transmission speed and longer latency period.**
- **Sensitivity to cyber-attacks and information theft.**
- **Lower efficiency and energy expenditure 10 times higher than wired systems.**
- **Greater vulnerability and less resistance to natural events.**
- **Increased delay and data loss due to congestion and blockages.**
- **Need for periodic upgrades due to obsolescence.**
- **Dependence on a battery system which, in addition to being more expensive, affects the environment.**
- **Health risks and in particular brain tumours, thyroid, colon and rectum tumours, testicular tumours, damage to the immune system, the reproductive system, the nervous system, the blood system and the endocrine system, with a higher risk for children and pregnant women.**
- **It is estimated that 4 million deaths have already occurred due to brain tumours alone and the frequency continues to increase at a rate of 10% per year.**
- **Damage to various species of animals, insects, birds and plants.**
- **Risk of global warming due to CO2 emissions and damage to the ozone layer.**

In addition, the rocket fuel used to deliver tens of thousands of satellites for 5G deployment is causing irreparable damage to the Ozone Layer, which will also lead to a rise in temperature at various latitudes around the globe. One model predicts ozone loss of up to 4% in the tropics and subtropics, and an increase of 3 degrees Celsius in summer temperatures over the South Pole, an increase of more than 1 degree Celsius in Antarctic temperatures and a 5% decrease in Antarctic ice.

The signatory countries of the Paris Agreement have committed themselves to take measures to avoid a global temperature increase of more than 1.5°C, which is why measures must also be taken to reduce energy consumption, which will also result in better protection of people's health and save money for increased research for peaceful purposes.

Here too, as in other points above, lowering doses by 100 times by applying the 3 Radiation Protection Criteria used also contributes to saving energy, avoiding damage to the planet and improving the protection of people.

2 – <u>The uses of 5G for military purposes</u>:

In the context of the launch of 5G, there is a risk of the use of cyber and artificial intelligence technologies in the skies and in cyberspace to increase the lethality of warfare by enabling near real-time communication and the use of weapons, drones and hypersonic missiles to dominate land and space.

The use of 5G by the military may sooner or later determine that this technology will also reach terrorist groups that will be able to conduct devastating and large-scale cyber-attacks around the world. This possibility is very worrying for the population and it would be desirable that 5G is not used for military purposes, for which the best guarantee would be to avoid its global deployment.

Satellites can be used to carry nuclear warheads and deliver them to military targets in such a way that Nagasaki and Hiroshima can be repeated at the space level.

SpaceX, among other private companies, is partnering with the military to provide a dual-use satellite connection for the military through its Starlink broadband Internet programme. The result is that customers who subscribe to Starlink's internet service are, at least in part, funding space weaponry, which may be one of the goals of 5G.

It is worth remembering that military uses of nuclear power led to major environmental disasters, pollution of the seas and the environment. Even the Chernobyl disaster originated in a plutonogenic reactor for military use that did not have the safeguards and safety measures of commercial nuclear power plants.

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THEMATIC BIBLIOGRAPHY (pages 28-105)

INDEX OF SECTIONS

Thematic Bibliography (pages 28-105)

Section 1
Human health effects of EMF, carcinogenesis, brain tumours, animal studies, reproductive effects, spermatogenesis and semen, epigenetic effects and apoptosis. (86)

Review work: Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other WirelessDevices. by Anthony B. Miller [1], Margaret E. Sears [2], L. Lloyd Morgan[3], Devra L. Davis [3], Lennart Hardell [4], Mark Oremus [5] and Colin L. Soskolne[6,7] (Edited by: Dariusz Leszczynski, University of Helsinki, Finland) Frontiers in Public Health

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Section 2

EMF and the production of brain tumours and other cancers. EMF in cancer induction and cancer promotion. Glioma, Meningioma, Acoustic Neurinoma. Case studies, Interphone, CERENAT and epidemiological data. The impact of different emitting devices and cellular network antennas. (30)

Review work: Mobile phone radiation causes brain tumors and should be classified as a probable human carcinogen (2A) (Review) byL. Lloyd Morgan [1], Anthony B. Miller [2], Annie Sasco[3] and Devra Lee Davis [1]

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Section 3

Dependence of the production of biological effects on physical parameters and biological variables, and the great importance of their consideration in order to be able to compare different scientific works. Exposure intensity, total duration of exposure, intermittent or permanent exposure, wave frequency, polarisation modes, pulsed modes, intermittent or continuous exposure, near field / far field. Frequency windows and power density windows Cell type, sex, cell density, differentiated and undifferentiated cells, young, adult or old. Dose and dose rate, SA and SAR. (159)

Review work: Dependence of non-thermal biological effects of microwaves on physical and biological variables: implications for reproducibility and safety standards. by Igor Y Belyaev

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Section 4

Parameters to be considered in the optimisation of practices. Frequencies, frequency windows, endogenous electromagnetic fields, electromagnetic homeostasis in living tissues. Effects of external electromagnetic fields on endogenous electromagnetic fields. Coherent and decoherent frequencies, Quantum coherence, healthy and unhealthy frequency patterns, Fröhlich and Davydov models, 5G frequencies. (158)

Review work: An integral predictive model that reveals a causal relation between exposures to non-thermal electromagnetic waves and healthy or unhealthy effects, by Hans J Geesink[1] and Dirk K F Meijer[2]

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Section 5

Determination of Causality by L. Hardell. Application of the 9 principles developed by Sir Bradford Hill, Strength of association, Consistency of association, Specificity, Temporality, Biological gradient, Biological plausibility, Coherence. Evidence from human cases, Analogy. (72)

Review work: Evaluation of Mobile Phone and Cordless Phone Use andGlioma Risk Using the Bradford Hill Viewpoints from 1965 onAssociation or Causation, by Michael Carlberg and Lennart Hardell

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<u>Section 6</u>

Determination of Causality by C. J. Portier. Application of the 9 principles developed by Sir Bradford Hill, Strength of association, Consistency of association, Specificity, Temporality, Biological gradient, Biological plausibility, Coherence. Evidence from human cases, Analogy. (434)

<u>Review work</u>: Expert Report Christopher J. Portier, Ph. D. in support of general causation on behalf of plaintiffs, United States District Court Northern District of California (A, MDL No. 274 1 Case 3:16-md-0274 1-VC)

https://usrtk.org/wp-content/uploads/2017/10/Expert-Report-of-Chris-Portier.pdf

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Section 7

Baseline information on the action of EMF and 5G. Genotoxic effects by producing single and double DNA strand breaks. Initiation of the carcinogenesis process

Review work: 5G: Great risk for EU, U.S. and International Health, Compelling evidencefor eight Distinct Types of great harm caused by Electromagnetic Field(EMF) exposures and the mechanism that causes them. Written and Compiled by Martin L. Pall, PhD

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Section 8

Damage to male and female fertility, lower sex hormones, lower libido and increased levels of spontaneous miscarriage.

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Section 9

Ataque de los CEM al sistema nervioso, incluido el cerebro, lo que lleva a efectos neurológicos y/ neuropsiquiátricos y posiblemente muchos otros efectos. Autismo.

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Section 10

Production of elevated levels of apoptosis (programmed cell death), a cause of neurodegenerative diseases and infertility.

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Section 11

Production of cellular oxidative stress and free radical damage.

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Section 12
EMF attack on endocrine system and hormones.

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Section 13
Production of excess intracellular calcium by opening of calcium channels.

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Section 18:
Effect of Electromagnetic Fields and Wireless Communication on Climate Change and the Ozone Layer.

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Section 20

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Section 21:

Biological and clearly deterministic effects of electromagnetic fields in the vicinity of base antennas, biological dosimetry and recent publications.

Review work: Consequences of Chronic Microwave RF Exposure/ ECFS Public API Documentation. US-Federal Communications Commission. https://ecfsapi.fcc.gov/file/7520940908.pdf

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2. **Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study.** By De-Kun Li, Hong Chen, Jeannette R. Ferber, Roxana Odouli & Charles Quesenberry. Nature, Scientific Reports/Published:13 december,2017, www.nature.com/scientificreports
3. **Dosimetría biológica de Rayos X mediante el estudio de micronucleos en sangre perisférica** por: Gómez Sánchez, E.; Navlet Armenia, J. Departamento de Ciencias Morfológicas y Cirugía de la Universidad de Alcalá de Henares Silva Mato, A. Departamento de Ciencias Sanitarias y Medicosociales (Bioestadística) de la Universidad de Alcalá de Henares. https://inis.iaea.org/collection/NCLCollectionStore/_Public/38/064/38064932.pdf

4. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. By Zothansiama,Mary Zosangzuali, Miriam Lalramdinpuii and Ganesh Chandra Jagetia.Received 27 Apr 2017, Published 04 Aug 2017/NIH/National Library of Medicine/National Center for Biotechnology Information. https://doi.org/10.1080/15368378.2017.1350584

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7. **Comparison of cytotoxic and genotoxic effects of plutonium-239 alpha particles and mobile phone GSM 900 radiation in the Allium cepa test,** by Dmitry S. Pesnya, Anton V. Romanovsky, Russian Academy of Sciences, 152742 Borok, Nekouz, Yaroslavl region, Russia / Mutation Research/Genetic Toxicology and Environmental Mutagenesis Journal / www.elsevier.com/locate/gentox / Community address: www.elsevier.com/locate/mutres, https://www.sciencedirect.com/science/article/abs/pii/S1383571812002914

8. **DNA effects of low level occupational exposure to extremely low frequency electromagnetic fields (50/60 Hz) May 2019**, Rezvan Zendehdel, Il Je Yu, Behnam Hajipour-Verdom, Zahra Panjali, (Shahid Beheshti University of Medical Sciences, Tehran, Iran, Project: DNA Damage-occupational hazards). Toxicology and Indust. Health 35(2):074823371985169/ http://dx.doi.org/10.1177/0748233719851697

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