

Protection against ionizing radiation *vis-à-vis* Protection against non-ionizing radiation: Different approaches

Rodolfo Touzet¹ and Abel Julio González^{2*}

¹ *Comisión Nacional de Energía Atómica, Av. del Libertador 8250, Buenos Aires (1429), Argentina*

² *Autoridad Regulatoria Nuclear, Av. del Libertador 8250, Buenos Aires (C1429 BNP), Argentina*

*Corresponding authors' e-mail: rodolfotouzet@gmail.com, abel_j_gonzalez@yahoo.com

Abstract: The purpose of this paper is to explore an apparent dichotomy between the protection against ionizing radiation (IR) and the protection against non-ionizing radiation (NIR). The international and intergovernmental radiation safety system for IR is: universal and consensual; founded on internationally accepted science accorded at the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR); based on a universally accepted paradigm developed over the years by the International Commission on Radiological Protection (ICRP); resulted in an intergovernmental regime of standards co-sponsored by all relevant international agencies under the aegis of the International Atomic Energy Agency (IAEA); enforced by obligations undertaken by States; and, including provisions for practical applications supported by all relevant international agencies. For the protection against NIR., the *proxy* is the International Commission on Non-Ionizing Radiation Protection (ICNIRP), created by IRPA on 1992. After 30 years its work is not replacing the combined effort of UNSCEAR, ICRP and the intergovernmental agencies. Such differences in protection approaches between IR and NIR are against the fundamental bases of IRPA. The interest of IRPA, its constituting societies and their thousand professional members, is to resolve the gap. They need clear answers to such basic questions as: What is the internationally endorsed consensual science on NIR? What is the ethical basis of the protection paradigm and the factual protection principles being used for NIR? What is the intergovernmental regime of safety standards and obligations for NIR? What are the provisions for the global application of such standards? The paper concludes that the time seems to be ripe for closing the gape between protection against IR and protection against NIR.

KEYWORDS: *Ionizing radiation; Non-ionizing radiation; Radiation protection; ICNIRP.*

1. INTRODUCTION

Most radiation protection professionals grouped in national radio-protection societies and these societies, which – duly associated – have constituted the International Radiation Protection Association (IRPA), seems to be convinced on the benefit of an international and intergovernmental radiation safety system. Such a system should: be universal and consensual; be founded on international science; be based on a universally respected paradigm; result in an intergovernmental regime of standards and binding obligations; and, include provisions for practical applications supported by international professional societies. The protection against ionizing radiation (IR) can proudly show such a system. Unfortunately, this is not the case for the protection against non-ionizing radiation (NIR).

The purpose of this paper is to explore such dichotomy. For reasons discussed in the paper, the differences in protection approaches between IR and NIR are against the fundamental roots of IRPA. It is in the interest of IRPA, its constituting societies and the thousand professionals forming IRPA, to resolve the gap.

2. THE IR PROTECTION SYSTEM

The IR protection system has a long tradition. After more than a century of professional activities a global safety system for IR has been consolidated, becoming one of the more significant international and intergovernmental successes

The international and intergovernmental radiation safety system for IR is universal and consensual and founded on an extended international and intergovernmental accord, as follows:

- it is founded on internationally accepted science accorded at the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and endorsed by the highest international intergovernmental body, the United Nations General assembly (UNGA);
- it is based on the universally accepted paradigm developed over the years by the International Commission on Radiological Protection (ICRP);
- it has resulted in an intergovernmental regime of standards, which under the aegis of the International Atomic Energy Agency (IAEA), is co-sponsored by all relevant international agencies, the European Atomic Energy Community (Euratom), the Food and Agriculture Organization of the United Nations (FAO), the International Labour Organization (ILO), the International Maritime Organization (IMO), the OECD Nuclear Energy Agency (OECD/NEA), the Pan American Health Organization (PAHO), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO);
- it is generally enforced by obligations undertaken by States, such as the 1960 ILO Radiation Protection Convention No. 115, and the many Conventions and Codes of Conduct agreed under the aegis of the IAEA; and,
- it includes provisions for practical applications supported by all relevant international organizations, including IRPA.

3. THE NIR PROTECTION SYSTEM

For NIR, a comparable system to the IR system does not exist.

The *proxy* is the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and some activities carried out by the WHO.

The ICNIRP was created by IRPA on May, 1992, in Montreal, to continue the work previously conducted by the IRPA's International Non-Ionizing Radiation Committee. Its *leitmotiv* was 'advancing NIR protection for the benefit of people and the environment'.

In theory, at least, IRPA and ICNIRP should have had a strong relationship, e.g., much powerful that the liaison between IRPA and the relevant IR organizations such as UNSCEAR, ICRP or the IAEA. By statutory mandate ICNIRP shall submit its formal recommendations on protection against NIR for comment by the IRPA Executive Council and the IRPA Associate Societies, prior to publication. Moreover, IRPA shall contribute an annual grant for ICNIRP. Thus, while ICNIRP was created as an independent body, from a scientific point of view, its statutory mandate call it for an strong association to IRPA.

4. DIFFERENT APPROACHES

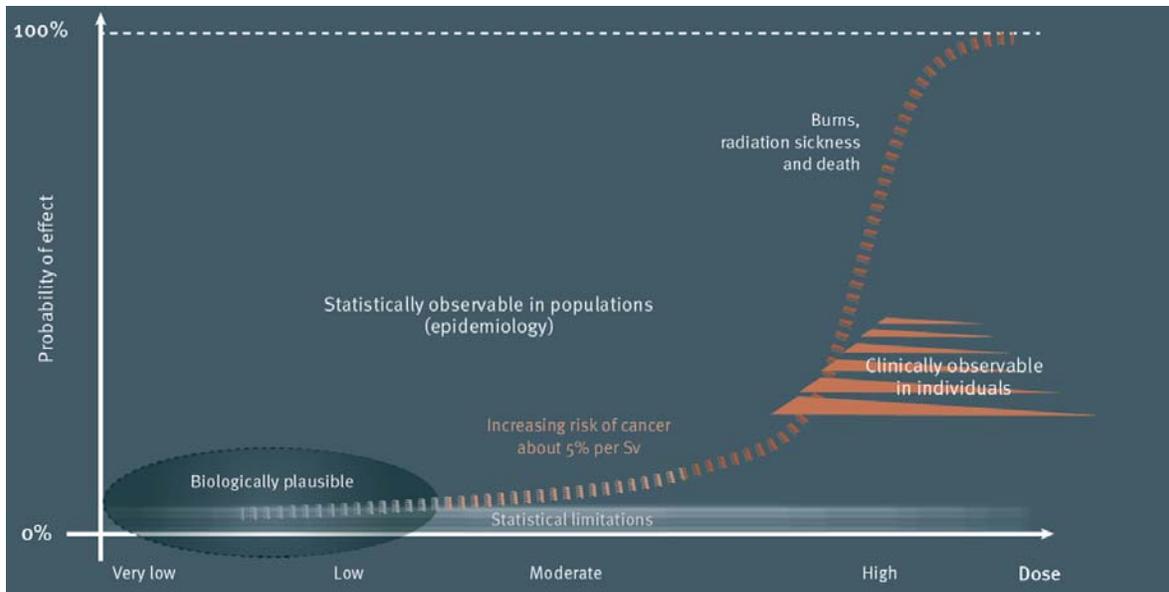
4.1. Consensual Science

4.1.1. IR

The consensual scientific bases for protection against IR are provided by UNSCEAR. This unique organization was established by UNGA in 1955. While its name refer to 'atomic radiation' (i.e., given the impression that it could deal with both IR and NIR, its mandate however was limited to assess and report levels and effects of exposure to IR [1]. Governments and organizations

throughout the world rely on the UNSCEAR's estimates as the scientific basis for establishing protective measures against IR.

UNSCEAR has, relatively recently, provided estimates on the attribution to IR of effects on health *vis-à-vis* the inference of IR risks. [2] UNGA has unanimously welcomed with appreciation the scientific report of UNSCEAR on this issue [3]. The UNSCEAR estimates have been summarized by UNEP [4], and condensed in a simplified IR's exposure-response relationship, which is presented in Figure 1.



↑
**PROTECTION
PRINCIPLES
BEING APPLIED
HERE**

Figure 1: Simplified IR's exposure-response relationship

The Simplified IR's exposure-response relationship in Figure 1 present three zones clearly differentiated, as follows:

- levels of exposure at which effects are *clinically observable in individuals*;
- levels of exposure at which effects are *epidemiologically observable in populations*; and,
- levels of exposure where the effects are just *biologically plausible* (marked an ovals in the figure).

It is important to underline this differentiation. As indicated in Figure 1, the protection policy against IR would be based on protecting people being exposed to incur effects that are considered biologically plausible but not observable.

4.1.2. NIR

There is not a similar process for achieving international scientific consensus on the effects of NIR. There is no a similar international intergovernmental organization like UNSCEAR achieving such a needed consensus at the highest governmental level. The ICNIRP appears to be acting as a *proxy* for this process

The achievement of internationally recognized consensual science seems to be difficult to achieve. Just as an example, there have been divergences between ICNRP and other relevant institutions on the crucial issue of the biological plausibility of carcinogenic effects following NIR exposure.

For instance, the US National Toxicology Program (NTP) concluded that long-term exposure to radiofrequency (RF) electromagnetic fields (EMFs) associated with mobile (or cell) phones or base stations appears to be carcinogenic. The NPT provides the scientific basis for U.S.A. programs, activities, and policies that promote health or lead to the prevention of disease. Founded in 1978, NTP plays a critical role in generating, interpreting, and sharing information about potentially hazardous elements and strives to remain at the cutting edge of scientific research and the development and application of new technologies. NPT has being involved in a large number of studies of NIR carcinogenesis

Similar conclusions on NIR carcinogenic were reported by the prestigious Ramazzini Institute in Italy. The Ramazzini institute is a prestigious non-profit social cooperative that has dedicated more than two decades to fighting cancer. Its activities focus on three areas of action: scientific research, early diagnosis, and spreading information. The Institute collaborates with the Collegium Ramazzini, an international academy with about 180 fellows in 32 countries.

However, the ICNIRP concluded that substantial limitations in their studies preclude conclusions being drawn concerning RF and EMFs and carcinogenesis [5].

Many other prominent institutions have been investigating the carcinogenic plausibility of IR. They include the prestigious International Agency for Research on Cancer (IARC), an intergovernmental agency forming part of WHO, whose role is to conduct and coordinate research into the causes of cancer [6].

The bibliography on plausibility of carcinogenic effects of NIR is vast. For instance, a substantive compilation can be found at the WHO's Environmental Health Criteria documents that provide international, critical reviews on the effects of *inter alia* NIR on human health and the environment.

Notwithstanding the vast availability of information discussing the biological plausibility for NIR exposure to be carcinogenic, it seems that there is not yet full consensus for attributing unequivocally detrimental health effects to NIR exposure. This will require larger and well designed epidemiological studies of human populations, in addition to those available. But the evidence seems to be overwhelming towards a consensus on the *biologically plausibility* that NIR exposure might be carcinogenic. Such a consensus however is not available. There is not an international institution similar to UNSCEAR building up such a consensus.

In sum, it seems that there is not an international mechanism available to reach a universal scientific consensus on the detrimental health effects of NIR exposure. A basic question remains without answer: **How to build a universally accepted protection paradigm for NIR if there is not an international consensual science to support it?**

4.2. Universal paradigm

4.2.1. IR

The universal paradigm governing the protection against IR has been recommended by the ICRP and used worldwide. The ICRP is a charity (not-for-profit organisation) registered with the Charity Commission of England and Wales, which was established in 1928 at the second International Congress of Radiology to respond to growing concerns about the effects of IR being observed in the medical community. The ICRP presents itself as ‘an independent, international organisation that advances for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation’. The ICRP paradigm has been built over the years on the basis a solid ethic doctrines and consequential core values, resulting in the latest ICRP recommendations [7].

The basic ethical doctrines giving basis to the ICRP paradigm have been discussed elsewhere [8]. They comprehend individual oriented ethical doctrines and societal oriented ethical doctrines. The individual oriented ethics include the deontological ethics, based on duty, responsibility and obligation (*not do unto others what they should not do unto you*), and the aretē (ἀρετή) ethics, based on virtue and asset (*do good to others even if it will not be returned*). The societal oriented ethics include the teleological ethics, based on consequence, result, and outcome (*mind the ends, which justify the means*) and the utilitarian ethics, based on utility, helpfulness and effectiveness (*do the greatest good for the greatest number of people*). A proper balance of these somehow disparate ethical doctrines has been used to formulate the principles of the IR protection paradigm.

The ethical foundations of the IR paradigm has resulted in the core values of the IR protection system. These have been reported by ICRP [9] and include the following:

- beneficence and non-maleficence, which prevents harmful effects for humans and the environment;
- prudence, which allows uncertainties to be taken into account;
- justice, which ensure social equity and fairness in decisions; and,
- dignity, which consider the respect that one must have for people.

On these bases the basic principles of the paradigm for the protection against IR has been built [7]. They comprehend, as it is well know by the radiation protection community, the *justification* of decisions involving changes in the exposure to IR, the *optimization* of options of the protection against IR; and the *limitations* (or restrictions) of individual exposures. An embedded principle in the ICRP principles is the protection of future generations and the environment; notwithstanding, the safety fundamentals of the international intergovernmental organizations recognize it as a separate principle. A further classification of the ICRP paradigm includes the situations given rise to IR exposure, extant, planned and emergency, and the type of exposures, occupational, public, and medical

4.2.2. NIR

The main function intended by IRPA for ICNIRP seems to have been to recommend a protection paradigm for the protection against NIR, following, *mutatis mutandi*, that paradigm build over the years by ICRP for the protection against IR. It has not been clear, however, on what ethical basis the NIR protection paradigm would be built. As a result, it is not clear what the radiation protection principles of this paradigm should be.

After a lot of questioning in this regard, just recently, nearly six lustrum after its constitution, the ICNIRP issued an 'ICNIRP statement on principles for non-ionizing radiation protection'[10]. In these principles is stated declared that the general principles for NIR protection are based....upon the well-established principles in ICRP 2007 and the under-pinning ethical values published by ICRP. This declaration is very much welcomed, because for the first time in many years a clear framework of principles was declared for the protection against NIR.

Notwithstanding this welcomed declaration, it is not clear how it will be properly implemented in practice. For instance,

- For the justification principle both ICRP & ICNIRP states that any decision that alters the radiation exposure situation should do more good than harm'. However, there is an ICNIRP proviso: ICNIRP indicates that it does not explicitly address social and economic issues, as these are deemed to be the remit of governments and relevant authorities (?!). It is not clear how the justification principle could be addressed without addressing social and economical issues.
- For the optimization principle, while the ICRP: aims at the best protection under prevailing circumstances, the ICNIRP declares that: when the exposure restrictions set by ICNIRP are well below threshold levels for adverse health effects [?], further reduction in the limit values does not result in additional health benefits, and therefore ...optimization is not necessary [!].
- For the limitation principle, while the ICRP recommends limits of individual exposure for restricting inferred risks for stochastic effects, namely effects that are biologically plausible but not necessarily attributable, and which are well below the thresholds for deterministic effects and the epidemiological limits for detecting increases in the incidence of stochastic effects, the ICNIRP: declares that exposure is limited to either below the level with an accepted risk for adverse effects, or below the threshold level for adverse health effects, where it is feasible to reduce the exposure to below these thresholds
- For the principle of future and the environment, which is implicitly recognized by ICRP and established in international safety fundamentals (see hereinafter), while ICRP recommends to limit the exposure committed rather than the exposure incurred, and that the environment be protected for maintaining biological diversity, ensuring the conservation of species, and protecting the health and status of natural habitats, communities, and ecosystems, it is absolutely unclear what the position of ICNIRP is on this crucial issues.

It seems that there is a mismatch between the ICRP paradigm intentions and the ICNIRP understanding. .

Intergovernmental regime

4.3.1. IR

A very comprehensive intergovernmental safety regime on the safety of activities involving the exposure to IR has been built by the system of intergovernmental international organizations over a period of more than half a century. It was triggered by resolutions of the policy making organs of the IAEA [11]

It is sustained on Fundamentals Safety Principles [12] including: responsibility for safety; role of government; leadership and management for safety; justification of actions; optimization of protection; limitation of risks to individuals; protection of present and future generations prevention of accidents; emergency preparedness and response; and, protective actions to reduce existing or unregulated radiation risks.

In addition to the Safety Fundamentals, which present the fundamental safety objective and principles of protection and safety in relation to IR, the system includes a plethora of Safety Requirements and Safety Guides.

The Safety Requirements are an integrated and consistent set of regulatory documents that establish what must be met to ensure the protection of people and the environment against IR, both now and in the future. The *primus inter pares* requirement for protection against IR is the so-called Basic Safety Standards [13]. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of these international requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered ‘overarching’ requirements, are expressed as ‘shall’ statements.

The Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The guidance provided in Safety Guides are expressed as ‘should’ statements.

The corpus of safety fundamentals, requirements and guides comprehend hundreds of documents establishing precise safety standards for the protection against IR.

4.3.2. NIR

Nothing equivalent or even similar to the international intergovernmental safety regime for IR exist for NIR. The establishment of an international and intergovernmental safety regime of standards and obligations for the protection against NIR is beyond the statutory competence of ICNIRP.

4.3. Provisions for practical applications

4.4.1. IR

A system exists for providing for the application of the standards and guides established by the international intergovernmental safety regime. it include *inter alia*:

- providing technical assistance to requesting States;
- fostering information exchange among specialists;
- promoting education & training for the new professionals;
- coordinating research & development among specialised centres and laboratories; and, last but not least,
- rendering appraisal services for checking compliance with standards

4.4.2. NIR

For NIR there is nothing equivalent or even similar than the system of provisions for the application of the standards for IR. However, ICNIRP has had some initiatives in this regard. Workshops organized by the ICNIRP, such as the International NIR Workshop that was planned in the framework of IRPA15 and had to be cancelled, are examples of attempts to foster information exchange.

5. CONCLUSIONS

IR and NIR are within the remit of IRPA. The system of protection against IR precedes IRPA. Being conscious of the challenges of NIR, IRPA duly created an International Non-Ionizing Radiation Committee and then, in 1992, ICNIRP. IRPA itself and its constituencies were supposed to be duly informed by ICNIRP on the evolution of the protection system for NIR.

Notwithstanding these good intentions, 30 years after, a number of fundamental questions remain and merit unambiguous answers. What is the international consensual science on the detrimental health effects of exposure to NIR? What is the rational ethics of the paradigm of protection against NIR and what are its real protection principles being used for NIR? What is the intergovernmental system of standards and obligations that are planned in order to formalize internationally the protection against NIR? What provisions are settled for the practical applications of protection standards against NIR?

The years are passing and many colleagues might be questioning whether we are treating the protection against NIR with the same ethical considerations that we have treated the protection of IR. It seems to be essential for the national radiation protection societies constituting IRPA and their plethora of radiation protection professionals, as well for IRPA itself, to search for unequivocal and unambiguous answers to the questions raised heretofore. The time seems to be ripe for closing the gape between protection against IR and protection against NIR!

6. REFERENCES

- [1] UNGA. Resolution 913 (X) [the UNSCEAR founding resolution], 3 December 1955.
- [2] UNSCEAR. Report of the UNSCEAR fifty-ninth session. UNGA. Annex A: Attributing health effects to ionizing radiation exposure and inferring risks. New York; UN; 2015.
- [3] UNGA. Resolution 67/112, Effects of atomic radiation, adopted on 18 December 2012.
- [4] UNEP. Radiation: effects and sources. UNEP, Nairobi, 2016;
- [5] ICNIRP. ICNIRP Note: Critical Evaluation of Two Radiofrequency Electromagnetic Field Animal ... Magnetic Fields (1 Hz – 100 kHz)” - Health Phys 118(5):533-542; 2020
- [6] IARC. Non-ionizing radiation. Radiofrequency electromagnetic fields. IARC Lyon, France. 2011 ISBN 978 92 832 1325 3 (NLM Classification: W1).ISSN 1017-1606.
- [7] ICRP. The 2007 Recommendations of the ICRP, Publication 103, Elsevier, 2007.
- [8] González, A:J. Las bases éticas de los principios internacionales de la protección radiológica. Radioprotección, No.69, Volumen XIX, 2011.
- [9] ICRP. Ethical Foundations of the System of Radiological Protection. ICRP Pub. 138, 2018.
- [10] ICNIRP. ICNIRP Statement: Principles for Non-Ionizing Radiation Protection. Health Phys 118(5):477–482; 2020.
- [11] IAEA. The Agency's Health and Safety Measures, INFCIRC/18, IAEA, Vienna [1960] and INFCIRC/18/Rev. 1, IAEA, Vienna [1976].
- [12] Euratom, FAO, IAEA, ILO, IMO, OECD/NEA, PAHO, UNEP, WHO. Fundamental Safety Principles: Safety fundamentals. IAEA, Vienna, 2006.
- [13] IAEA. Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards: General Safety Requirements. IAEA safety standards series, ISSN 1020-525X ; no. GRS Part 3.. IAEA, Vienna, 2011, STI/PUB/1531. ISBN 978-92-0-120910-8