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Linear No-Threshold Model and Standards for Protection Against Radiation; Notice of Docketing and Request for Comment

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General Comment

I have airmailed the attached file to you today but recognise that it may not reach you before September 6

See attached file(s)

Attachments

USNRC submission

From: Donald J Higson, PhD, FARPS, FIEAust
260 Glenmore Rd
Paddington
NSW 2021
AUSTRALIA

To: Annette L. Vietti-Cook
Secretary, USNRC
Attention: Rulemaking and Adjudications Staff
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852, USA

September 1, 2015

Dear Ms. Vietti-Cook:

***http://www.regulations.gov* Docket ID NRC-2015-0057**

I wish to support petitions that the U.S. Nuclear Regulatory Commission (NRC) has received, requesting that the NRC cease to use the Linear No-Threshold (LNT) model of radiation risk as the basis of its "Standards for Protection Against Radiation" regulations and permissible radiation dose limits, and cease to apply the "as low as reasonably achievable" (ALARA) principle using the LNT assumption.

My reasons for this support are outlined in the appended document entitled "INEA and the problem of LNT" that I prepared for the International Nuclear Energy Academy (INEA) in 2014. The Academy adopted this document as its position statement on radiation and health, which is posted on the Academy's website at http://www.ineacademy.com

Regarding radiation hormesis: Although radiation hormesis certainly occurs, I do not see the hormesis model as an appropriate basis for regulation of the nuclear industry. The purpose of radiation protection is to protect people from the potentially harmful effects of high doses at high dose rates, not to exploit the potential benefits of exposure to low doses and low dose rates. I see the importance of hormesis in this field as being to demonstrate that, and explain why, low level radiation is not harmful. Its benefits are a matter for the medical profession to explore.

Yours sincerely

Don Higson

Summary of my qualifications and relevant experience

- I have a BSc and PhD in chemical engineering from Imperial College, London.
- After working on the development of nuclear submarine propulsion for Rolls-Royce & Associates, I joined the Australian Atomic Energy Commission (now the Australian Nuclear Science and Technology Organisation, ANSTO) in 1964 and specialised in nuclear reactor safety assessment.

- I have worked as a consultant to the UN International Atomic Energy Agency (IAEA) on nuclear safety assessment criteria.
- In 1997/8, after retiring from ANSTO, I was appointed Chairman of the International Nuclear Societies Council's Task Group on Low Doses and was principal author of the Task Group's report [reference 1].
- In 2006, I was joint author of the Australasian Radiation Protection Society's Position Statement on Risks from Low Levels of Ionizing Radiation.
- In 2006, I was principal author of a joint statement "Effects of Low Doses of Radiation" from participants at the 15th Pacific Basin Nuclear Conference, sessions held in Sydney, Australia, on Wednesday 18 October 2006 [reference 2].
- I have made many presentations at national and international conferences and published many papers and articles on the radiological risks from the nuclear industry and the biological effects of exposure to ionising radiation. [see references 3 to 14];
- I am a Fellow, Life Member and former Secretary of the Australasian Radiation Protection Society (ARPS) and former Editor of the ARPS Newsletter, which I founded in 1995 after my retirement from ANSTO.

References to my principal publications in the field of radiation protection

[1] "Low Doses of Ionising Radiation Incurred at Low Dose Rates" (Report of the International Nuclear Societies Council, Task Group on Low Doses; Chairman of Task Group and principal author: D. J. Higson; co-authors: J Graham, Jae-Shik Jun, S Kobayashi and R E J Mitchel). Invited paper, presented at a Special Session of the ENC'98 World Nuclear Congress held in Nice, France, 25th October 1998. Also published by the European Nuclear Society in *"Worldwide Integrated View on Main Nuclear Energy Issues"* (October 1998). An updated version of this report was published at the request of the British Nuclear Energy Society in its Journal, *Nuclear Energy*

[2] "Effects of Low Doses of Radiation" (principal author: D. J. Higson; co-authors: D R Boreham, A L Brooks, R E J Mitchel *et al*). Joint statement from participants at the 15th Pacific Basin Nuclear Conference, sessions held in Sydney, Australia, Wednesday 18 October 2006. *Dose-Response*, **5**(4), 2007, 259-262.

[3] "Reactor Safety Goals and Assessment Principles". *Nuclear Safety*, Vol. 26, No. 1, January - February 1985, p. 1.

[4] "Are there Risks from Low Level Radiation?" Proceedings of the Ninth International Congress of the International Radiation Protection Association (IRPA9); Vienna, Austria; April 14-19, 1996; pp.22-23.

[5] "It's Time to do Something about the LNT Controversy". Guest Editorial for the *Newsletter of the US Health Physics Society*, May 2000:

[6] "Resolving the Controversy on Risks from Low Levels of Radiation". *The Nuclear Engineer*, Vol.43, No.5, pp.132/7, 2002.

[7] "Healthy Radiation Workers". Presented at the European IRPA Congress, Florence, Italy; 8-11 October 2002

[8] "The Bell Tolls for LNT". *Operational Radiation Safety*, 87(5), November 2004, S47-S50; Republished with up-dating as "The Bell Should Toll for the Linear No-threshold Model". *Journal of Radiological Protection*, 24(3), September 2004, 315-319.

[9] "Is there a Need for Protection against Exposure to Low Levels of Ionizing Radiation?" Presented at the 32nd annual conference of the Australasian Radiation Protection Society, held at Stamford Plaza in Brisbane, Queensland, 21-24 October 2007. Published in the *Journal of the Australasian Radiation Protection Society*.

[10] "The Significance of Thyroid Cancer in Reactor Safety Assessment". Presented at the 8th International LOWRAD Conference, held in Rio de Janeiro, Brazil, 28-30 September 2009; Published in *Int. J. Low Radiation*, **7**(3), 2010, 217-222.

[11] "The Japanese Nuclear Emergency". Presented at the 36th annual conference of the Australasian Radiation Protection Society held at the Crown Promenade Hotel in Melbourne, Victoria, 16-19 October, 2011.

[12] "Risks from Radon". Presented at the Thirteenth International Congress of the International Radiation Protection Association (IRPA-13), held in Glasgow, Scotland, 13-18 May 2012.

[13] "Whither LNT?" Presented at the Pacific Basin Nuclear Conference in Vancouver, Canada, 24-28 August 2014; Published in *Radiation Protection in Australasia*, April 2014, **31**(1), 59-63.

[14] "Fear of Nuclear Power Generation". Presented at the Pacific Basin Nuclear Conference in Vancouver, Canada, 24-28 August 2014; Published in *Radiation Protection in Australasia*, November 2014, **31**(2), 37-45.

INEA and the problem of LNT

Donald J. Higson, PhD
Member of the International Nuclear Energy Academy (INEA)
Fellow of the Australasian Radiation Protection Society (FARPS)
Fellow of the Institution of Engineers, Australia (FIEAust)

The nuclear energy industry offers a proven and safe means for generating most of the electricity we need at a reasonable cost, with minimal damage to the environment. Other uses of nuclear science and technology in industry and in medicine also provide enormous benefits to society.

However, for many people, fear of radiation – essentially the mistaken belief that there is no safe radiation dose – is a significant deterrent to the wider use of these technologies. This misconception stems largely from the early recommendation by the International Commission of Radiological Protection (ICRP), adopted by authorities in most countries, that the carcinogenic and mutagenic risks from exposure to ionising radiation should be assumed to be proportional to the dose without a threshold – the "linear no-threshold (LNT) model" – which is based on extrapolation to zero dose and to low dose rates from risks observed at high doses that were incurred from the explosion of atomic bombs.

For low doses, there is abundant evidence that conflicts with the LNT model. This includes some of the data from studies of atomic bomb survivors themselves.

Even after the worst nuclear plant accidents, no member of the public and very few workers in this industry have been exposed to anything remotely approaching the radiological conditions of an atomic bomb explosion. For the most highly exposed members of the public, total doses have been comparatively low and have been spread over prolonged periods of time. Public exposures have mainly been within the range of naturally occurring radiation, to which the human race (indeed, all life on Earth) has been exposed throughout evolution and to which our bodies would necessarily have adapted.

The rate of exposure is a vitally important factor. A dose greater than 1 Sv (1000 mSv) incurred in a short space of time, as in an atomic bomb explosion and for some workers during the Chernobyl reactor accident, causes a very nasty sickness called "acute radiation syndrome" (ARS). At 5 Sv, there is about 50% probability of death within a few weeks from ARS and an estimated 50% excess cancer risk later in the lives of survivors. A dose of 5 Sv spread uniformly over a lifetime, as occurs in some areas of high natural background radiation in some parts of the world, causes no discernible harm.

There is no reason, apart from the LNT assumption itself, to suppose that natural background radiation is harmful. In fact, it appears to be essential for normal life and health. Like most (perhaps all) potentially harmful agents to which we are exposed in our environment, radiation exhibits thresholds to its harmful effects. Incidences of cancer, other diseases and genetic damage are not elevated due to the high levels of ionising radiation that occur naturally. If anything, the reverse occurs. The dose rate from natural background radiation at Ramsar in Iran ranges up to at least 100 times the global average and no significant detrimental effect, such as increased incidence of cancer, has been observed amongst the resident population. Ramsar is a spa resort where people actually go for the good of their health.

Fundamental research and experiments on animals have shown that different biological responses to radiation predominate at doses and dose rates that are substantially lower than those at which risks have been observed. We now know that health benefits instead of risks can and do occur at low levels of exposure. This has been explained as being due to the stimulation of the body's protection systems, not just against radiation but against all potentially carcinogenic and mutagenic damage, including that which occurs every day in our normal lives. More research is needed but enough is known for us to say that the LNT model is wrong and can be seriously misleading.

Recommendations

For all of the above reasons, it is recommended that use of the linear no-threshold (LNT) model be abandoned and replaced by a more realistic approach to the estimation of radiological risks. A new model to replace LNT should be based on thresholds below which risks are considered to be zero. In accordance with present knowledge and data, thresholds are considered to be within the following ranges depending on circumstances. These figures are proposed as a basis for further discussion:

- Within the range 50-300 mSv for acute single doses to adults;
- Within the range 100-700 mSv per year for continuous chronic exposures; and

- Within the range 50-200 Bq/m^3 for naturally occurring radon in the air breathed in confined spaces, which causes about half the exposure to background radiation for many people.

Thresholds also need to be developed for the sum totals per year, per month or per week of intermittent and protracted exposures, and for acute single doses to embryos, foetuses and infants.

Risks might be assumed to depend on, or be proportional to, the incremental dose or dose rate over limited ranges above the relevant threshold. Simple explanations of the meaning and level of actual risk and benefits should be developed.

Health benefits that might be derived from exposure to ionising radiation are a matter for the medical profession to pursue. As a professional body itself, the International Nuclear Energy Academy is concerned with the appropriate control of potential adverse health effects and the advancement of science and technology in the service of humankind.