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Docket ID NRC-2015-0057 Agency: Nuclear Regulatory Commission
Petition Number: PRN-20-28,29,30

“Linear No-Threshold Model and Standards for Protection Against Radiation”

On June 23, 2015, the U.S. Nuclear Regulatory Commission (NRC) requested public comment on three petitions for rulemaking [Federal Register Volume 80, Number 162; Friday, August 21, 2015; Proposed Rules; Page 50805]

From:
Physicians For Social Responsibility (www.psr.org)

Dear Secretary,

The Nuclear Regulatory Commission (NRC) should **reject** the concept of radiation hormesis as a scientifically sound basis for radiation safety standards related to commercial nuclear power production.

Concept of a Threshold is Elusive

The term, radiation hormesis, refers to the idea that small ionizing radiation exposures comparable in magnitude to natural background radiation may have health benefits for humans. Ionizing radiation is known to be harmful to humans by interfering with early life development, to cause cancer (radiation is a Class 1A carcinogen), and be associated with acceleration of selected chronic non-neoplastic diseases. Hormesis proponents conceive of a threshold of ionizing radiation dose below which there is not only no harm but actual health benefit. Proving that there is such a clearly identifiable threshold has been an insurmountable challenge. Yet the petitioners are proposing that a clear threshold exists and further propose that the idea of radiation hormesis inform a new paradigm as a basis to change protective radiation standards used by the NRC; the dual jurisdiction of the NRC and the Environmental Protection Agency (EPA) in this matter notwithstanding.

Established Science

The great body of literature that is relied upon to establish ionizing radiation safety standards by national and international scientific expert consensus groups indicates that a clear threshold of exposure has not been identified above which there is always harm and below which there is either no human health harm or there may even be human health benefit. Identifying a single threshold is confounded by differing individual susceptibility to harm from ionizing radiation. Individual susceptibility varies among those of a given demographic of healthy individuals. Susceptibility clearly is greater for those who are chronically ill or have compromised immune systems within similar age and sex demographics. Most important on yet another axis, susceptibility clearly varies by age and sex across the entire population. This latter trend is most remarkable in that females are twice as susceptible to cancer

caused by ionizing radiation than males across all ages and that the youngest children are several-fold more susceptible than adults. These age and sex susceptibilities are clearly laid out in the National Academy of Sciences BIER VII report.¹

Lack of Proof

The petitioners for this Docket provide statements in support of radiation hormesis. The petitioners' arguments suggest high reliance on *in vitro* cellular-level research on radiation effects on cells in tissue cultures. The petitioners interpret some effects as possibly protective and/or reparative rather than harmful. It is not surprising that stressed cells exhibit a multitude of responses. Interpreting the exact purpose of the various cellular responses can be subjective and deceptive. For example, an alternative interpretation could be that *in vitro* cellular responses activated by ionizing radiation are more consistent with the larger context of premature cellular aging rather than being simply protective or reparative.

In any case, whether or not the cellular response mechanisms touted by the petitioners are truly protective or reparative, they are about half as strong or protective in human females than males and about one fifth as strong or protective in the youngest human children. In other words, hormesis does not explain the known increased susceptibility of females and children to ionizing radiation. Science is along way from being able to prescribe the optimal radiation dose that "immunizes" against harmful effects of ionizing radiation.

Discrediting Established Science

The petitioners attempt to discredit, in broad strokes, large epidemiological studies highly pertinent to assessing performance of existing protective radiation exposure standards in the commercial nuclear power industry. Epidemiological studies that show harm from low level ionizing radiation fall into three important groups: (1) leukemia incidence in children living near commercial nuclear power stations,^{2,3,4} (2) cancer rates in nuclear power industry workers for whom dose measurements have been compiled,^{5,6} and (3) studies of health outcomes in populations as a function of prevailing natural background radiation.^{7,8,9} Published research in each of these areas gives a general picture of no threshold below which there is no harm. Further, the detectable adverse effects of low dose ionizing

¹ Committee to Assess Health Risks from Exposure to Low Levels of Ionizing

Radiation, National Research Council, Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2, The National Academy Press, 2006, 424 pp. <http://nap.edu/11340>

² P. Kaatsch, et al., Childhood Leukemia in the Vicinity of Nuclear Power Plants in Germany. *Int J Cancer* (2008) 1220, 721-726.

³ C. Sermage-Faurel, et al., Childhood Leukemia around French nuclear power plants. *Int J Cancer* (2012).

⁴ Fairlie. A hypothesis to explain childhood cancers near nuclear power plants. *Journal of Environmental Radioactivity* 133 (2014) 10-17. <http://www.sciencedirect.com/science/article/pii/S0265931X13001811>

⁵ E. Cardis, et al., The 15-Country Collaborative Study of Cancer Risk Among Radiation Workers in the Nuclear Industry: Estimates of Radiation-Related Cancer Risks. *Radiation Res* 167 (2007) 396-416.

⁶ D. B. Richardson, et al., Risk of cancer from occupational exposure to ionising radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS). *BMJ* (2015) 351: 8 pp. <http://www.bmj.com/content/351/bmj.h5359>

⁷ A.P. Moller and T. A. Mousseau, The effects of natural variation in background radioactivity on humans, animals and other organisms. *Biol Rev* (2013) 88: 226-54.

⁸ G. M. Kendall, et al., A record-based case-control study of natural background radiation and the incidence of childhood leukaemia and other cancers in Great Britain during 1980-2006, *Leukemia* (2013) 27: 3-9.

⁹ B. D. Spycher, et al., Background Ionizing Radiation and the Risk of Childhood Cancer: A Census-Based Nationwide Cohort Study, *Environ Health Perspect* (2015) 123: 622-628. <http://ehp.niehs.nih.gov/wp-content/uploads/123/6/ehp.1408548.alt.pdf>

radiation delivered at low dose rates adds important information to the Atomic Bomb Survivor study, now in its seventh decade.^{10,11}

Ethics of Consent

The public is promised radiation standards that are not only protective but, as stipulated by the EPA, protective by an additional safety margin. Safety factors of 2 to 6 and redundancy are often used in engineering design as an acknowledgement that we are not all-knowing. Implicit public consent is based on trust that operation of commercial nuclear power stations is safe. Medical radiation has become a major source of exposure in the U.S. But take note: consent is individually explicitly made before accepting exposure to radiation for medical purposes. Consent is based on the idea of individualized informed understanding and acceptance that the benefits of the exposure outweigh the attendant risks.

Substantially loosening protective radiation standards in the case of commercial nuclear power generation in favor of the idea of radiation hormesis would be, from the standpoint of bioethics, betrayal.

¹⁰ P. Jacob, et al., Is cancer risk of radiation workers larger than expected? *Occup Environ Med* (2009) 66: 789-796.

¹¹ D. B. Richardson, Cancer risks and radiation (editorial). *Occup Environ Med* (2009) 66: 785-786.