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INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH

6935 Laurel Avenue, Suite 201
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
http://www.ieer.org

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Richard R. Monson M.D., Chair
c/o Rick Jostes, Staff Officer
Committee on the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII)
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, D.C. 20418

Dear Dr. Monson,

We are writing for several reasons:

1. To inquire as to the specific progress of the BEIR VII Committee's work in considering the issues that we raised in the letter of September 3, 1999.
2. To request that you consider recent evidence regarding the RBE of tritium for adults and children, if you are not already doing so.
3. To ask you to review the RBE of low-energy X-rays.

1. Letter of September 3, 1999

In addition to a general query about your progress on each of the questions that the signatories raised in the letter of September 3, 1999, I would like to request specifically to know whether and how the Committee is dealing with the issue of synergistic effects of hormonally-active compounds and radionuclides. As you know, there is literature on both human and animal studies that addresses the question of hormonal status of females and cancer risk from exposure to directly and indirectly ionizing radiation. For instance, Yokoro *et al.* have reported that low doses of fission neutrons were more effective in inducing breast cancer in female rats in combination with prolactin than without it.[1] One implication of such studies is that interactions between hormonally-active chemicals and ionizing radiation may increase at least some types of cancer risk, possibly differentiated by sex. We hope that you will make a careful evaluation of the important topic of possible synergisms between hormonally-active compounds and various kinds of radiation dose, both directly ionizing as well as neutron radiation. Obviously, should there be a finding that synergistic effects may exist, it would mean that guidelines and standards may have to be tightened when there is exposure to both radiation and hormonally-active compounds.

We would also like to request some specific information about how you are considering the issue of radionuclides like tritium and C-14 that cross the placenta and can disrupt fetal development

at critical times or create second generation effects, especially when girls are exposed in utero at times when the ova are being formed.

2. Tritium

We want to call the attention of the committee to a very important paper on tritium doses and the relative biological effectiveness of tritiated water (HTO) and organically-bound tritium (OBT) to both adults and fetuses:

> Harrison, J.D., A. Khursheed, and B.E. Lambert, "Uncertainties in Dose Coefficients for Intakes of Tritiated Water and Organically Bound Forms of Tritium by Members of the Public," *Radiation Protection Dosimetry*, Vol. 98, No. 3, 2002, pp. 299-311.

Based on a thorough and, to us, quite persuasive evaluation of the evidence, this paper finds that it is no longer justifiable to use the ICRP recommended weighting factor of 1 for beta particles from tritium. The RBE and dose are highly dependent on the form of tritium (HTO or OBT, and the specific form of OBT) as well as on whether the tritium intake is by a fetus or an adult. The stage of fetal development is also a factor.

Table 8 in this paper shows the central estimates of the HTO dose conversion factor (DCF) as $3.9*10^{-11}$ Sv/Bq and $7.6*10^{-11}$ Sv/Bq for adults and 10 week fetuses respectively. These estimates are more than a factor of two and a factor of four, respectively, greater than the current dose conversion factor of $1.73*10^{-11}$ Sv/Bq specified in EPA's Reg. Guide 11 which is used in U.S. radiation protection regulations. Further, the doses from OBT are estimated at more than twice the HTO numbers. The 95 percentile confidence numbers are about twice again as large. This makes the 95 percentile DCF for fetuses from OBT about a factor of 23 higher than the DCF in Reg. Guide 11.

When we consider a combination of HTO and OBT, it is apparent that the central estimate of fetal dose per unit of tritium intake is almost an order of magnitude greater than the current regulatory DCF.

We request you to provide a detailed assessment of the evaluation of tritium doses in this paper. Further, we also request you to evaluate doses to ovaries and ova as they develop in female fetuses (between week nine and nineteen). It is possible that dose conversion factors for ova may be even higher than for fetuses at 10 weeks.

Finally, this paper points out that HTO and OBT are not uniformly distributed, so that the RBE factor will be organ dependent. I expect that the Committee will also be examining this factor.

Whatever the specific numbers, it is clear that when a woman pregnant with a girl ingests HTO or OBT in a certain period of her pregnancy, the risks attendant upon tritium exposure would be expected to endure for three generations (the woman herself, the fetal female, and the children of that girl). The Committee should evaluate these effects for cancer as well as non-cancer risks.

Specifically, the risk of miscarriages and birth defects for the two generations (exposed female fetus and her children) should be evaluated.

3. X-rays

The Committee should evaluate RBE factors for medical X-rays (down to photons of a few KeV and a few tens of KeV) relative to gamma rays (reference cobalt-60 1.25 MeV photons) for adults as well as fetuses. Considerable research indicates that medical X-rays have an RBE of greater than one.[2] The uncertainties in this area are no longer so large that an RBE of 1 can simply be adopted for the whole range of X-rays, gamma rays and photons without careful scrutiny. We urge the committee to make a photon-energy dependent evaluation of the RBE for X-rays and gamma rays in case it is not already doing so. As you know, this is a public health issue of considerable importance since medical X-rays are the largest routine source of non-natural, non-radon radiation to the general public.

Evidence, such as the paper cited above, indicates that the RBE of medical X-rays varies a good deal, but that a figure of about 2 relative to cobalt-60 gamma rays may be more appropriate as a quality factor than the 1 currently used in regulations. Does the Committee have substantial evidence that a quality factor of 2 would be wrong or inappropriate if one had to choose a single RBE as a quality factor for medical X-rays? If the Committee believes that the present quality factor of 1 for medical X-rays should not be changed, it would be very helpful if the Committee would set forth the evidence and its reasoning for such a stance.

In this context, we wonder if the committee should not explicitly address the work of Dr. John Gofman (in case it is not already doing so). A great many people trust and refer to his work, while others reject it vehemently. Whatever the controversies around the details of his work, it would appear that one of his recommendations - that the RBE used for low energy X-rays should be greater than one relative to the hard gamma rays that characterize Hiroshima and Nagasaki -- has considerable independent support.

Besides addressing the medical X-ray RBE issue, it would also be very helpful if the Committee would also give its view of Dr. Gofman's research on this issue. We are of this view because it would allow the public an explicit look at how the most influential scientific committee on the subject views Dr. Gofman's work on medical X-rays, which is trusted by many. We think that that may enable a more enlightened public discourse on the subject. It may not, but we believe it is at least worth a try.

We want to thank you in anticipation for considering these requests. We are enclosing the three papers cited here for your convenience. We look forward to your evaluation of these issues in the BEIR VII report. If you have any questions or need further clarification of any of the issues discussed here, please contact Arjun Makhijani or Lisa Ledwidge at ieer@ieer.org.

Yours sincerely,

Arjun Makhijani, Ph.D.
President

David Close, Ph.D.
Professor of Physics
East Tennessee St. Univ.

Lisa Ledwidge
U.S. Outreach Director and Editor, *Science for Democratic Action*

Enclosures

cc: Dr. John Gofman

Notes:

1. Kenjiro Yokoro, Toshio Seyama, and Kazuyoshi Yanagihara, "Experimental Radiation Carcinogenesis in Rodents," in *Cancer in Atomic Bomb Survivors*, edited by Itsuzo Shigematsu and Abraham Kagan, GANN Monograph on Cancer Research ; 32 (Tokyo: Japan Scientific Societies Press: New York: Plenum, 1986), pp. 89-112.

2. See, for instance, David J. Brenner, Cheng-Shiun Leu, John F. Beatty, and Ruth E. Shefer, "Clinical Relative Biological Effectiveness of Low-Energy X-Rays Emitted by Miniature X-Ray Devices, *Phys. Med. Biol*., Vol. 44, 1999, pp. 323-333.