The Influence of ICRP 103 on Current Actions of the U.S. Environmental Protection Agency

Michael A. Boyd, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Mail Code 6608J, Washington, DC, 20460, USA

Abstract- The U.S. Environmental Protection Agency (EPA) is considering adopting certain recommendations from ICRP Publication 103 into new regulations and guidance documents. When some of the older EPA regulations were issued, the dose assessment tools of the day calculated doses to adult organs and to the whole body, with only minimal consideration given to gender differences. Newer dosimetry models allow us to account for age and gender differences in calculating organ doses from both external sources and from intakes of radionuclides. While the reference person as defined in ICRP 103 is adequate for occupational protection purposes, EPA is keenly interested in the proposed age-specific reference individuals under consideration by the ICRP. Updating regulations and guidance to be consistent with these age-specific reference individuals will provide a more defensible standard of protection for all members of society.

Keywords: Publication 103, Reference person, Effective dose

1. CURRENT EPA STANDARDS SPAN ICRP 2 TO ICRP 60

The U.S. Environmental Protection Agency (EPA) issued radiation protection standards for the uranium fuel cycle on January 13, 1977 (EPA, 1977). These standards require that nuclear fuel cycle operations provide reasonable assurance that the "annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as the result of planned discharges of radioactive material, radon and its daughters excepted, to the general environment …" (EPA, 1977). This standard was based on the dosimetry of ICRP *Publication 2* (ICRP, 1959). On January 17, 1977, just 4 days after EPA issued this standard, the newer concept that was to be called effective dose equivalent was introduced by ICRP in *Publication 26* (ICRP, 1977). Because EPA's 1977 standards are still in force, generations of new health physicists are required to continue to use traditional units and to become acquainted with the *Publication 2* methodology for calculating critical organ doses and maximum permissible body burdens (ICRP, 1959). Furthermore, even though the nuclear fuel cycle standard specified dose limits for members of the public, the methodology in *Publication 2* relies on the adult dosimetry for Standard Man as defined by the Chalk River Conference on Permissible Dose (Chalk River, 1950).

On January 20, 1987, President Reagan approved recommendations to all U.S. federal agencies for controlling occupational exposure to radiation (EPA, 1987). These recommendations, developed by EPA under its Federal Guidance authority, were consistent with the recommendations of ICRP in *Publication 26*. In 1988, EPA issued Federal Guidance Report No. 11 (FGR 11), *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA, 1988). FGR 11 includes tables for derived air concentrations (DACs) and annual limits on intake (ALIs) for over 800 radionuclides, similar to the tables in *Publication 30* (ICRP, 1982). The dose conversion factors in FGR 11 provide effective dose equivalent per unit intake (Sv/Bq) for inhalation and ingestion

of radionuclides, using the tissue weighting factors in *Publication 26*. A number of current regulations in the U.S. have codified the *Publication 26* weighting factors, including EPA's *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Waste* (EPA, 1993) and the Nuclear Regulatory Commission's *Standards for Protection Against Radiation* (NRC, 1991). These standards are all based on the adult Reference Man as defined in ICRP *Publication 23* (ICRP, 1975).

ICRP approved new recommendations for radiation protection that were issued in 1991 as *Publication 60* (ICRP, 1991). Following *Publication 60*, the ICRP began developing, for the first time, age-dependent dose coefficients for ingestion and inhalation of radionuclides. These dose coefficients are summarized in *Publication 72* (ICRP, 1995) and are provided for 6 ages – 3 months, 1 year, 5 years, 10 years, 15 years, and adult. When EPA developed environmental standards for the proposed nuclear waste repository at Yucca Mountain in Nevada, *Publication 72* methodology was specified for calculating doses to the public and the tissue weighting factors from *Publication 60* were included in the rule (EPA, 1993).

Thus, over the past 4 decades, EPA has developed rules and guidance for radiation protection and waste management that have incorporated dosimetric methods from ICRP Publications 2, 26, and 60. Efforts are now underway at EPA to revise many of the older radiation protection regulations and the possibility exists for moving towards compliance with the latest methods and recommendations from *Publication 103* (ICRP, 2007).

2. DEMONSTRATING PROTECTION FOR ANY MEMBER OF THE PUBLIC

When EPA issued uranium fuel cycle regulations in 1977, the standards specified dose limits for any member of the public. However, by using the older system of dosimetry specified in *Publication* 2, the organ and whole body doses were actually calculated for the adult male. At the time, age- and gender- specific differences in dose were not being considered, since the tools for doing so were not yet available.

The series of reports on the *Biological Effects of Ionizing Radiation* (BEIR reports) from the U.S. National Academy of Sciences (NAS) have provided consensus radiobiological and epidemiological evidence for setting dose and risk based standards for radiation protection. These reports rely on data from the follow-up of Japanese survivors of the atomic bombs in Hiroshima and Nagasaki and other important cohorts of exposed individuals for estimating the influence of age at exposure and gender on the excess risk of cancer from radiation exposure.

Relying in part on the NAS BEIR V report (NAS, 1990) and biokinetic and dosimetric information developed by ICRP, EPA produced Federal Guidance Report 13 (FGR 13), *Cancer Risk Coefficients for Environmental Exposure to Radionuclides* (EPA, 1999). FGR 13 provides cancer risk estimates (incidence and mortality risk per becquerel) for external exposure, inhalation, food ingestion, and water ingestion for over 1000 radionuclides. FGR 13 risk coefficients are used by EPA for risk-based decision making and for determining risk-based cleanup objectives at sites being remediated under EPA's Superfund program. Beginning with FGR 13, EPA has calculated excess cancer incidence and mortality risk for an age-averaged member of the U.S. population chronically exposed to environmental levels of ionizing radiation.

The background material underlying FGR 13 provide tables of age- and gender-specific risk. The age-averaged risks for over 1000 radionuclides are determined by integrating the age- and gender-specific risks and taking into account age- and gender-dependent usage factors. Efforts to revise FGR 13 to be consistent with the latest NAS report, BEIR VII, and other current scientific information are now underway (NAS, 2006). This work will be informed by age-specific anatomical and physiological data provided by ICRP in *Publication 89* (ICRP, 2002). Similar to the ICRP *Publication 103* definition for the Reference Person (ICRP, 2007, p.70), i.e. an average of the Reference Male and Reference Female, EPA is considering providing separate age-averaged risk coefficients for males and females along with the population-weighted, age- and gender-averaged ones.

3. NEXT STEPS

As EPA considers revising a number of its older radiation protection regulations, the options for demonstrating protection of any member of the public are under discussion. One possibility would be to develop age-averaged dose coefficients similar to the methods used in FGR 13. Within a few years, ICRP is expected to have replaced the dose coefficients in *Publication 72* with new ones that are consistent with the dosimetry changes introduced in *Publication 103*. If the 6 ages defined for *Publication* 72 are retained, ICRP should consider addressing whether the adult tissue weighting factors as defined in P*ublication 103* are appropriate for children. There are reliable data that demonstrate that cancer risks per unit dose vary with age. For example, the risk of radiogenic thyroid cancer is much higher for childhood exposures than for adult exposures. It should be possible to provide age-specific as well as age-averaged dose coefficients that are derived from age-dependent usage factors, biokinetics, and dosimetry. An age-averaged dose coefficient thus defined would be more suitable for determining compliance with dose-based limits for the general public than the adult Reference Person.

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