

Recent Applications of the NCRP Public Dose Limit Recommendation for Ionizing Radiation

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The purpose of this Statement is to describe recent applications by the National Council on Radiation Protection and Measurements (NCRP) of its public dose limit recommendation to specific radiation protection issues that have arisen since publication of NCRP Report No. 116, *Limitation of Exposure to Ionizing Radiation* (NCRP, 1993). The basis for the public dose limit recommendation is presented in the discussion of radiation protection goals and philosophy in Section 15 of NCRP Report No. 116 (NCRP, 1993). The principles of justification and “as low as reasonably achievable” (ALARA), as described by NCRP (1993), continue to be the overriding considerations of NCRP. However, NCRP has observed that application of its public dose limit recommendation occasionally has required additional radiation protection judgments based on the specifics of a particular radiation exposure situation. These judgments have involved exposure of members of the public to medical, dental and veterinary sources of radiation (NCRP, 1995; 2003a; 2004a; 2004b), and also appropriate controls on radiation exposure due to new security technologies for cargo surveillance at U.S. borders and screening of individuals in public venues (NCRP, 2003b; 2003c). Notwithstanding the justified exceptions that NCRP has made to its public dose limit recommendation, it is expected that reasonable efforts will be made to apply the ALARA principle to these radiation exposures.

Public Dose Limit Recommendation

As published in Report No. 116 (NCRP, 1993), the annual radiation dose limit recommendation for individual members of the public from all radiation sources other than natural background and the individual's medical care¹ is:

- For members of the public who are exposed continuously or frequently, the recommended annual effective dose limit is 1 mSv.²
- On an infrequent basis, a member of the public may receive more than 1 mSv y^{-1} . In such a case, the annual effective dose may exceed 1 mSv up to a value of 5 mSv. This Statement recommends that the term “infrequent,” in the context used here, should refer to a justified exposure that is not likely to occur often in an individual's lifetime, with each occurrence justified independently of any other.

Exceptions to the Public Annual Dose Limit Recommendation of 1 mSv

NCRP recognizes that exceptions to the 1 mSv y^{-1} public dose limit might be justified in some circumstances on the basis of infrequent exposure or significant benefit to those exposed or to society as a whole. The following are brief summaries of exceptions that have been recommended by NCRP since the publication of Report

¹The average effective dose to an individual from natural background in the United States is on the order of 1 mSv y^{-1} (excluding radon) (NCRP, 1993). The absorbed tissue doses to individuals undergoing medical care can vary from no exposure to significant tissue doses, depending on an individual's medical need for diagnostic, interventional and therapeutic radiation procedures.

²The dose limit for an embryo-fetus given in the Public Dose Limits section of Table 1.1, in Section 10, and in Section 19 and Table 19.1 of Report No. 116 (NCRP, 1993) is for the case where a pregnant radiation worker is occupationally exposed. Although not stated explicitly in Report No. 116 (NCRP, 1993), it should be understood that for the nonoccupationally exposed pregnant woman, the embryo-fetus is adequately protected by the public dose limit of 1 mSv annual effective dose that is applied to the pregnant woman.

No. 116 (NCRP, 1993), and more detailed accounts are published in the cited NCRP report or commentary:

- For members of the public employed at the same place of business, and who come into contact with a coworker who is a patient receiving radionuclide therapy, the annual effective dose limit of 1 mSv may be exceeded under controlled conditions that minimize the radiation exposure of the small number of such individuals who might receive up to 5 mSv annually (NCRP, 1995).
- For nonpregnant adults exposed to a family member who is a patient receiving radionuclide therapy, the annual effective dose limit is 5 mSv, but this limit may be exceeded up to 50 mSv on the recommendation of the treating physician (NCRP, 1995). Anyone whose annual effective dose is likely to exceed 5 mSv due to this exception should receive appropriate training and individual monitoring (NCRP, 1995).
- For inadvertent irradiation of a clandestine stowaway in a cargo container irradiated with a pulsed fast neutron analysis system to assess the contents of the container, NCRP has recommended that the pulsed fast neutron analysis system be designed and operated in such a manner that an exposure to the stowaway would result in an effective dose of no more than 1 mSv for that occurrence (NCRP, 2003b). However, an effective dose up to 5 mSv would be permissible for such an occurrence if a higher dose were necessary to achieve national security objectives (NCRP, 2003b). This recommendation should be reviewed for its applicability to any additional radiation technology designed to assess the contents of cargo containers for security purposes.

Control of Individual Sources (or Sets of Sources)

The current advice on control of individual sources (or sets of sources) from NCRP Report No. 116 (NCRP, 1993) is:

“In the application of the Council’s recommendations to sources irradiating members of the public, the overriding considerations are those of JUSTIFICATION and ALARA. Normally, application of these two principles will insure that individuals are adequately protected. However, the NCRP reaffirms its previous recommendations (NCRP, 1984) that

whenever the potential exists for exposure of an individual member of the public to exceed 25 percent of the annual effective dose limit as a result of irradiation attributable to a single site, the site operator should ensure that the annual exposure of the maximally exposed individual, from all man-made exposures (excepting that individual's medical exposure), does not exceed 1 mSv on a continuous basis. Alternatively, if such an assessment is not conducted, no single source or set of sources under one control should result in an individual being exposed to more than 0.25 mSv annually.”

The following cases regarding radiation exposure to members of the public from specific sources with unique characteristics have recently been evaluated by NCRP and recommendations have been published in an NCRP report or commentary.

Shielded Medical, Dental and Veterinary Radiation Facilities

Medical, dental and veterinary radiation facilities shielded in accordance with recommendations contained in NCRP Reports No. 145, No. 147, and No. 148 (NCRP, 2003a; 2004a; 2004b) (*i.e.*, designed to not exceed an effective dose of 1 mSv y^{-1} to the maximally exposed individual in an uncontrolled area³) will provide adequate protection to employees and members of the public that access the uncontrolled areas.⁴ An effective dose for uncontrolled areas that does not exceed 1 mSv y^{-1} is justified by the conservatively safe

³A controlled area is a limited-access area in which the occupational exposure of personnel to radiation is under the supervision of an individual in charge of radiation protection. An uncontrolled area is any space not meeting the definition of controlled area, such as a waiting room or office of a radiology facility, or an adjacent area with uncontrolled access (NCRP, 2004a).

⁴The specific recommendation for shielded medical radiation facilities in NCRP Report No. 147 (2004a) is: “Based on ICRP (1991) and NCRP (1993) recommendations for the annual limit of effective dose to a member of the general public, shielding designs *shall* limit exposure of all individuals in uncontrolled areas to an effective dose that does not exceed 1 mSv y^{-1} . After a review of the application of the guidance in NCRP (1993) to medical radiation facilities, NCRP has concluded that a suitable source control for shielding individuals in uncontrolled areas in or near medical radiation facilities is an effective dose of 1 mSv in any year.” This recommendation has also been applied to dental and veterinary radiation facilities (NCRP, 2003a; 2004b).

assumptions used in the recommended shielding design methodology.⁵ An additional NCRP report on “Structural Shielding Design and Evaluation for Megavoltage Radiotherapy Facilities,” which is currently in preparation, will contain shielding design recommendations consistent with the previously cited reports.

X-Ray Security Screening of Humans

Recent developments in security screening technology utilize low-energy x rays. Implementation of this technology could result in large numbers of the public being exposed to very low doses of radiation. NCRP has recommended that the cumulative effective dose to an individual member of the public from such x-ray systems used in security screening of humans should not exceed a control level of 0.25 mSv y⁻¹ at a given venue (NCRP, 2003c). Further advice for implementation of this control level is given by NCRP (2003c) for two categories of scanning systems:

- general-use systems with effective doses per scan of 0.1 μSv or less, and
- limited-use systems with effective doses per scan >0.1 μSv and ≤10 μSv per scan.

This is a reasonable control level since the effective dose per scan from a general-use system is far less than 10 μSv, the NCRP negligible individual dose that is defined as an annual value for a particular radiation source or set of sources (NCRP, 1993). For limited-use systems, some form of record keeping may be necessary to ensure that the control level is not exceeded. This record keeping is the responsibility of the facility using the system (NCRP, 2003c).

Conclusion

NCRP concludes that there are public radiation exposure situations where it is necessary to use consensus professional judgment when applying the following recommendations that appear in

⁵To confirm that the conservatively safe shielding design assumptions result in an effective dose that does not exceed 1 mSv y⁻¹, a performance assessment by a qualified expert shall be done after construction (including measurements in the uncontrolled area), and periodic monitoring is conducted during facility operation (NCRP, 2004a).

NCRP Report No. 116 (NCRP, 1993) to a specific radiation exposure situation:

- the 5 mSv annual effective dose value for infrequent exposures of members of the public; and
- a source control of 25 percent of the 1 mSv annual effective dose limit for the maximally exposed member of the public in accordance with the NCRP advice quoted in the section “Control of Individual Sources (or Sets of Sources).”

As other unique radiation exposure situations arise, NCRP will continue to utilize its scientific committee report development process and review procedure to arrive at appropriate recommendations such as those given in the examples above. These recommendations will draw from the basic guidance provided in NCRP Report No. 116 (NCRP, 1993), and also from the experience gained in the process of preparing recommendations subsequent to the publication of NCRP (1993) on radiation protection of members of the public as applied in specific situations.⁶

References

- ICRP (1991). International Commission on Radiological Protection. *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Annals of the ICRP **21** (1–3) (Elsevier Science, New York)
- NCRP (1984). National Council on Radiation Protection and Measurements. *Control of Air Emissions of Radionuclides*, NCRP Statement No. 6 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (1993). National Council on Radiation Protection and Measurements. *Limitation of Exposure to Ionizing Radiation*, NCRP Report No. 116 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).

⁶It is not the mission or intent of NCRP to provide guidance on all new sources of radiation exposure to members of the public. However, in circumstances involving the exposure of a large number of individuals in public venues that require special radiation protection judgments, or in circumstances that could potentially lead to exposure of certain individuals to effective doses significantly above the public effective dose limit of 1 mSv y⁻¹, NCRP will provide recommendations on appropriate exceptions or radiation source controls as needed.

- NCRP (1995). National Council on Radiation Protection and Measurements. *Dose Limits for Individuals Who Receive Exposure from Radionuclide Therapy Patients*, NCRP Commentary No. 11 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (2003a). National Council on Radiation Protection and Measurements. *Radiation Protection in Dentistry*, NCRP Report No. 145 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (2003b). National Council on Radiation Protection and Measurements. *Pulsed Fast Neutron Analysis System Used in Security Surveillance*, NCRP Commentary No. 17 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (2003c). National Council on Radiation Protection and Measurements. *Screening of Humans for Security Purposes Using Ionizing Radiation Scanning Systems*, NCRP Commentary No. 16 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (2004a). National Council on Radiation Protection and Measurements. *Structural Shielding Design for Medical X-Ray Imaging Facilities*, NCRP Report No. 147 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
- NCRP (2004b). National Council on Radiation Protection and Measurements. *Radiation Protection in Veterinary Medicine*, NCRP Report No. 148 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).