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Technical Bulletins provide information to States, compact regions, and other interested parties on issues related to the development of low-level radioactive waste disposal facilities. The Bulletins distribute information that is either of immediate concern to the States and compact regions, or not suited to more formal reports. These Bulletins are published on an as-needed basis.

The objective of this Technical Bulletin is to provide States and compact regions with information regarding the impacts of the revision to 10 CFR 20 on performance assessment computer codes used for predicting performance of proposed low-level radioactive waste disposal facilities.

IMPACT OF REVISED 10 CFR 20 ON EXISTING PERFORMANCE ASSESSMENT COMPUTER CODES USED FOR LLW DISPOSAL FACILITIES

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Executive Summary

The U.S. Nuclear Regulatory Commission (NRC) recently announced a revision to Chapter 10 of the Code of Federal Regulations, Part 20 (10 CFR 20), "Standards for Protection Against Radiation,"¹ which incorporates recommendations contained in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP), issued in 1977² and 1979,³ respectively. The revision to 10 CFR 20 was also developed in parallel with Presidential Guidance on occupational radiation protection published in the *Federal Register*.⁴

Questions have been raised regarding the impacts of the revision to 10 CFR 20 (i.e., incorporation of recommendations included in ICRP 26/30) on performance assessment computer codes used for predicting performance of existing and proposed low-level radioactive waste disposal facilities. A study was conducted that (a) compared to the contents of the revised 10 CFR 20 to the previous version, (b) investigated the basis for the data files used in computer codes AIRDOS-EPA,⁵ CAP-88,⁶ RSAC-4,⁷ GENII,⁸ PRESTO-EPA,⁹ and PATHRAE-EPA,¹⁰ and (c) investigated the basis for the annual limit on intake, derived air concentration, and dose conversion factor values found in U.S.

Environmental Protection Agency (EPA) Federal Guidance Report No. 11¹¹ and U.S. Department of Energy (DOE) publications DOE/EH-0070¹² and DOE/EH-0071.¹³

The results of the three activities are used to illustrate that the changes to approaches for assessing radiation hazards discussed in the revision to 10 CFR 20 have been previously incorporated into radiological assessment computer codes, as well as into regulatory guidance for radiological assessments provided by the EPA and DOE. In this regard, the revision to 10 CFR 20 is simply a formalization of changes that have been standard practice in radiological assessments for a number of years. Thus, this study concludes that the issuance of the revised 10 CFR 20 will not affect calculations using the computer codes considered in this report. In general, the computer codes and EPA and DOE guidance on which computer codes are based were developed in a manner consistent with the guidance provided in ICRP 26/30, well before the revision of 10 CFR 20.

Introduction

On May 21, 1991, the U.S. Nuclear Regulatory Commission published a *Federal Register* notice announcing a revision to Chapter 10 of the Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation." The revision incorporates recommendations from the International Commission on Radiological Protection in Publications 26 and 30, published in 1977 and 1979, respectively. The ICRP 26/30 recommendations had also been previously included in Federal radiation protection guidance (Reference 4) that was developed in parallel with the revision to 10 CFR 20.

The revision to 10 CFR 20 incorporates significant changes to dose limits and to the way in which doses are calculated. The more important changes promulgated in the revision include:

1. Deleting the 3 rem/quarter "whole body" dose limit and the 5(N-18) rem age-prorated cumulative whole body

dose limit. These limits were replaced with an annual limit of 5 rem total effective dose equivalent. An annual limit of 50 rem was also specified for the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye. [10 CFR 20.1201(a)(1)]

2. Replacing the previous quarterly dose limits for extremities and skin with annual shallow-dose equivalent limits of 50 rem. An annual dose limit for the lens of the eye (15 rem) was also specified. [10 CFR 20.1201(a)(2)]
3. Replacing Appendix B, "Concentrations in Air and Water Above Natural Background," with a new Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."

A study was undertaken to determine how these changes would affect current guidelines and computer models used to evaluate the health effects of existing and proposed low-level radioactive waste disposal facilities. The new requirements were compared to the requirements that were used as the basis for data files and models used in several performance assessment computer codes. AIRDOS-EPA and CAP-88 assess airborne radionuclide releases. RSAC-4 performs radiological safety analyses, and GENII models radiation dosimetry. PRESTO-EPA and PATHRAE-EPA evaluate the risk to the public from environmental transport of buried low-level radioactive waste. The basis for the annual limit on intake, derived air concentration, and dose conversion factor values found in Federal Guidance Report No. 11 and Department of Energy publications DOE/EH-0070 and DOE/EH-0071 was also reviewed for consistency with ICRP 26/30, and thus, 10 CFR 20.

Basis of Revised 10 CFR 20 Models and Limits

Expository material contained in the NRC *Federal Register* notice announcing the revision to 10 CFR 20 states that the revision was prepared to reflect the improved understanding of principles underlying the biological effects of ionizing radiation and developments in scientific knowledge that have occurred in the 35 years since the original issue of 10 CFR 20. The revised version of 10 CFR 20 incorporates the models and recommendations contained in ICRP 26/30. The previous issue of 10 CFR 20 and its amendments were based on the outdated models of ICRP Publication 2,¹⁴ published in 1959.

Basis of Present Dose Conversion Factors

The new models, described in ICRP publications since 1977, are now in universal use and are widely accepted by the scientific community. An EPA guidance document (Reference 11) states, "The ALI and DAC values tabulated in this first edition of Federal Guidance Report No. 11 are identical to those of ICRP 30, except . . .," with the exceptions taken from data contained in ICRP 38¹⁵ and ICRP 48.¹⁶ Document DOE/EH-0071 states, "The series of ICRP publications starting with Publication 26 provides the technical base used in calculating the committed dose equivalent factors in these tables." And DOE/EH-0070 contains the information that "Effective dose-rate factors for external exposure to photons have been calculated using the weighting factors for specific body organs recommended by the International Commission on Radiological Protection" (ICRP 26/30). The results of the study indicated that models and recommendations of ICRP 26/30 have been in general use for some time and are, in fact, the basis for existing EPA and DOE tables of derived limits and conversion factors.

A line-by-line comparison of annual limits on intake and derived air concentrations listed in Appendix B of the new 10 CFR 20 with those

tabulated in the EPA Federal Guideline Report No. 11 reveals them to be the same in most cases.

The models and data in ICRP 26/30, et seq., were used to establish the RADRISK¹⁷ data base used in AIRDOS-EPA, PRESTO-EPA, and CAP-88. Therefore, calculations performed by these codes have reflected ICRP 26/30 models since the time they were written. This is also the case with RSAC-4. The April 10, 1990, revision of the RSAC-4 user's manual states, "The RSAC-4 program allows calculation of inhalation doses using the ICRP 30 model with dose conversion factors taken from DOE/EH-0071." Furthermore, GENII documentation states, "Internal radiation dose calculations are performed using the methods recommended by the ICRP as described in ICRP 26 and 30." PATHRAE-EPA was developed based on the PRESTO family of codes, and the methodology is based on recommendations in ICRP 26/30. One difference in PATHRAE-EPA is that the user must input the values for dose conversion factors, while the other codes have built-in data bases (e.g., the RADRISK data base) that contain the necessary information. The user is responsible for providing appropriate inputs for PATHRAE-EPA.

Conclusions

Existing, commonly used computer programs such as AIRDOS-EPA, CAP-88, RSAC-4, PATHRAE-EPA, PRESTO-EPA, and GENII are all based on the recommendations in ICRP 26/30, et seq. Existing, commonly used tables of dose conversion factors, ALIs, and DACs are based on ICRP 26/30, et seq. The revised (as of May 21, 1991) issue of 10 CFR 20 is based on ICRP 26/30, et seq. Therefore, the existing codes were developed consistent with currently accepted ICRP models and recommendations, and are not impacted by the revisions to 10 CFR 20.

References

1. Nuclear Regulatory Commission, "10 CFR 20 et al., Standards for Protection Against

Radiation: Final Rule," *Federal Register* 56, No. 98, 23360, May 21, 1991.

2. International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 26, Annals of the ICRP Vol. 1, No. 3, New York: Pergamon Press, 1977.
3. International Commission on Radiological Protection, "Limits for Intake by Workers," ICRP Publication 30, Part 1, Annals of the ICRP Vol. 2, No. 3/4, New York: Pergamon Press, 1979.
4. "Recommendations Approved by the President: Radiation Protection Guidance to Federal Agencies for Occupational Exposure," *Federal Register* 52FR2822, January 27, 1987.
5. Oak Ridge National Laboratory, *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides*, ORNL 5532, June 1979.
6. Environmental Protection Agency, *The Clean Air Act Assessment Package-1988 (CAP-88); A Dose and Risk Assessment Methodology for Radionuclide Emissions to Air*, October 1990.
7. Westinghouse Idaho Nuclear Company, Inc., *RSAC-4, Radiological Safety Analysis Computer Program, Version 4.03*, April 10, 1990.
8. Pacific Northwest Laboratory, Battelle Memorial Institute, *GENII-The Hanford Environmental Radiation Dosimetry Software System*, PNL 6584 UC-600, November 1988.
9. Environmental Protection Agency, *PRESTO-EPA-CPG: A Low-Level Radioactive Waste Environmental Transport and Risk Assessment Code, Documentation, and User's Manual*, EPA 520/1-87-026, Washington, D.C.
10. Rogers, Vern and Cheng Hung, *PATHRAE-EPA: A Low Level Radioactive Waste Environmental Transport and Risk Assessment Code-Methodology and Users Manual*, EPA 520/1-87-028, 1987.
11. Environmental Protection Agency, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, September 1988.
12. Department of Energy, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, July 1988.
13. Department of Energy, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1988.
14. International Commission on Radiological Protection, "Permissible Dose for Internal Radiation," ICRP Publication 2, New York: Pergamon Press, 1979.
15. International Commission on Radiological Protection, "Radionuclide Transformations: Energy and Intensity of Emissions," ICRP Publication 38, New York: Pergamon Press, 1983.
16. International Commission on Radiological Protection, "The Metabolism of Plutonium and Related Elements," ICRP Publication 48, New York: Pergamon Press, 1986.
17. Dunning, D. E. Jr., R. W. Leggett, and M. G. Yalcintas, *A Combined Methodology for Estimating Dose Rates and Health Effects from Radioactive Pollutants*, ORNL/TM-7105, Oak Ridge National Laboratory, 1980.

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