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CONSTRAINT ON RELEASES OF AIRBORNE RADIOACTIVE MATERIALS TO THE ENVIRONMENT FOR LICENSEES OTHER THAN POWER REACTORS

A. INTRODUCTION

This regulatory guide provides guidance on methods that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for meeting the constraint on airborne emissions of radioactive material to the environment as described in Title 10, Section 20.1101(d), of the *Code of Federal Regulations* (10 CFR 20.1101(d)) (Ref. 1). In 1996, the NRC added a constraint to 10 CFR Part 20, "Standards for Protection against Radiation," to remove dual regulation by the NRC and the U.S. Environmental Protection Agency (EPA) and to provide an "ample margin of safety" to members of the public from airborne emissions of radioactive material to the environment.

The regulation at 10 CFR 20.1101(d) states the following:

> To implement the ALARA [as low as is reasonably achievable] requirements of § 20.1101 (b), and notwithstanding the requirements in § 20.1301 of this part, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, shall be established by licensees other than those subject to § 50.34a, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem [millirem] (0.1 mSv [millisievert]) per year from these emissions. If a licensee subject to this

requirement exceeds this dose constraint, the licensee shall report the exceedance as provided in § 20.2203 and promptly take appropriate corrective action to ensure against recurrence.

This regulatory guide contains information collection requirements covered by 10 CFR Part 20 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0014. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

B. DISCUSSION

Background

In 1996, the NRC added regulations regarding a constraint on airborne emissions of radioactive materials to the environment as part of an agreement with EPA to resolve dual regulation of airborne emissions of radioactive material under both the Atomic Energy Act of 1954, as amended (Ref. 2), and the Clean Air Act of 1970, as amended (Ref. 3). EPA subsequently rescinded its Clean Air Act regulations in Subpart I, "National Emission Standards for Radionuclide Emissions from Federal Facilities Other Than Nuclear Regulatory Commission Licensees Not Covered by Subpart H," of 40 CFR Part 61, "National Emission Standards for Hazardous Air Pollutants" (Ref. 4), as they applied to NRC licensees other than power reactors.

As Low As Reasonably Achievable

Components of an effective radiation protection program, as required by 10 CFR 20.1101, "Radiation Protection Programs," include, in part, radiation exposure control, written procedures and policies, control of radioactive materials, radioactive contamination control, radioactive waste management, training, program reviews, and audits.

The NRC staff examines licensee programs to determine whether they comply with the requirements in 10 CFR Part 20. This guide addresses only a part of a licensee's overall radiation protection program. Specifically, it addresses methods that licensees can use to demonstrate that they meet the constraint on airborne emissions of radioactive material to the environment. In addition to controlling doses from airborne emissions of radioactive material to the environment, licensees must implement a radiation protection program that controls liquid effluents and dose rates in unrestricted areas.

Many NRC licensees possess source, byproduct, or special nuclear materials in a form that would not result in airborne emissions of radioactive material to the environment. These licensees include radiographers, well loggers, and other users of sealed sources. These licensees do not need to take any actions to demonstrate that they meet the constraint on airborne emissions of radioactive material to the environment.

The dose limits in 10 CFR Part 20 are based on limiting dose to an acceptably low level of risk to the exposed individual. However, any radiation dose may carry some risk; therefore, the NRC requires licensees to take actions, to the extent practicable, using procedures and engineering controls to further reduce risk below the levels implicit in the dose limits in keeping with the ALARA principle. This is one

goal of radiation protection programs. To achieve this goal, licensees must control the way radioactive materials are handled from receipt through disposal.

Guidance on ALARA programs is available outside of this regulatory guide. Some generically applicable guidance that contains programmatic information includes the following:

a. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable" (Ref. 5),

b. Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities" (Ref. 6),

c. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" (Ref. 7),

d. National Council on Radiation Protection and Measurements (NCRP) Report No. 127, "Operational Radiation Safety Program," issued June 1998 (Ref. 8), and

e. NCRP Statement No. 8, "The Application of ALARA for Occupational Exposures," dated June 8, 1999 (Ref. 9).

Constraints

A dose limit is a basic radiation protection standard that is the upper acceptable bound of radiation dose and should not be exceeded. The dose limit to members of the public (100 mrem per year (1 mSv per year)) includes doses from all pathways, including direct radiation, liquid effluents, and airborne effluents. The constraint, in this case, may be interpreted as that fraction of the public dose limit allocated to airborne emissions to ensure that doses are ALARA through this particular release pathway. Licensees are required to design their facilities and structure operations such that airborne emissions of radioactive materials generated from operations result in doses to the public that are below the constraint. The constraint serves as a starting point, or upper level, for ALARA assessments. If licensees exceed the constraint on airborne emissions, they are required to report the radiation dose to the NRC and to take corrective actions to lower the dose below the constraint value. Enforcement action would occur only if a licensee fails to report an exceedance of the constraint or fails to take appropriate and timely corrective actions.

C. STAFF REGULATORY GUIDANCE

The following paragraphs describe when the requirements to meet the constraint on airborne emissions of radioactive materials to the environment apply and the methods that a licensee can use to demonstrate that it meets the constraint. The methods described below are acceptable to the NRC staff for use by NRC licensees other than power reactors to determine the dose resulting from airborne emissions of radioactive material to the environment. Licensees should choose a monitoring period (i.e., a year, month, or quarter) to demonstrate that they meet the airborne emissions constraint in accordance with 10 CFR 20.1101(d). For most licensees, the monitoring period will be 1 year.

1. Applicable Exclusions to the Constraint on Environmental Airborne Emissions

The NRC may grant licensees an exemption, on a case-specific basis, to use guidance and methods that have been developed since the release of 10 CFR Part 20. (See SECY-01-0148, "Process for Revision of 10 CFR Part 20 regarding Adoption of International Commission on Radiological Protection (ICRP) Recommendations on Occupational Dose Limits and Dosimetric Models and Parameters," dated August 2, 2001 (Ref. 10), for background information.) Licensees granted exemptions to use dosimetry guidance other than that on which 10 CFR Part 20 is based may use that guidance and associated methods to demonstrate that they meet the dose constraint.

The following information provides types of licensees and sources of radioactive material that may be excluded from consideration in determining whether the dose constraint is met:

a. Licensees do not need to take any actions to demonstrate that they meet the dose constraint if they (1) operate a nuclear power reactor subject to 10 CFR 50.34a, "Design Objectives for Equipment To Control Releases of Radioactive Material in Effluents—Nuclear Power Reactors" (Ref. 11), or (2) possess and use radionuclides only in the form of sealed sources.

b. Calculations do not need to include radioactive materials in sealed containers that remain unopened and that have not leaked during the assessment period. Radiopharmaceuticals in unopened manufacturers' packages that are not leaking and materials in undamaged shipping containers are examples of sealed containers. Independent spent fuel storage canisters that do not have vents to the atmosphere may also be considered sealed containers.

c. Effluents from patients who have received radiopharmaceuticals do not need to be included if the licensee uses an inventory approach to demonstrate that it has met the constraint. If the licensee uses measured or calculated concentrations of radioactive materials in the environment to demonstrate that it has met the constraint, the contribution from patients is deemed insignificant and does not need to be considered.

d. If a determination can be made that some detected materials did not result from the licensed activities of the licensee, only radioactive materials from the licensed activity need to be considered. Materials that are windblown from other facilities do not need to be considered.

e. In determining the member of the public likely to receive the highest dose from airborne emissions of radioactive material to the environment from licensed operations, licensees do not need to consider nonresidents within the facility boundary. Although the constraint of 10 mrem (0.1 mSv) per year does not apply within the facility boundary, the public dose of 100 mrem (1 mSv) per year and ALARA would continue to apply to members of the public within the facility.

2. Calculation of Dose to the Member of the Public Likely To Receive the Highest Dose from Airborne Effluents

In demonstrating compliance with 10 CFR 20.1101(d), licensees should determine whether there have been any facility or design modifications, increases in radionuclide inventories, or operational changes and whether any of these factors resulted in variations in airborne emissions since the last monitoring period. If the licensees' operations have not changed, the review of licensed operations and the demonstration of meeting the constraint will be relatively straightforward.

Estimates of emissions may either be based on measurements of effluents (see Regulatory Guide 4.16, "Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants" (Ref. 12)) or calculated using the inventory of radioactive materials present at a facility. Estimates of actual emissions that do not involve a measured effluent quantity should take into consideration the physical state and inventory of licensed radioactive materials, emissions controls (if applicable), and atmospheric conditions. Release estimates should include licensed material that is not otherwise excluded from consideration as discussed in Regulatory Position C.1. American National Standards Institute/Health Physics Society (ANSI/HPS) N13.1-1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities" (Ref. 13), proposes a simple method to estimate potential releases. This method involves the multiplication of the physical inventory of material by a release fraction based on the state of the material. Emission controls affecting the release of materials may either be assumed to have been functional, if there is reasonable assurance the controls were reliable during the release period, or otherwise considered ineffectual during the release. Atmospheric conditions and dose estimates can be addressed consistent with the remainder of this section.

The methods described below represent a graded approach for demonstrating that the constraint has been met, from the method requiring the fewest site-specific data and, therefore, the most conservative, to more rigorous methods with more realistic results. All methods are acceptable for demonstrating compliance with 10 CFR 20.1101(d). The graded approach is intended to allow users to pick the method that most closely corresponds to the amount of site-specific information that they want to collect. The accuracy of the dose estimate should only increase as the licensee uses more site-specific information and the resulting dose estimate becomes less conservative, but it should not be underestimated.

a. The simplest screening technique is to assume that the airborne concentration at the receptor is equal to the airborne concentration measured or calculated at the point of release.

   The derivation of concentrations in Column 1 of Table 2 of Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20, are presented in the discussions preceding the tables in Appendix B. For radionuclides governed by the stochastic ALI, the occupational stochastic inhalation ALI was divided by 2.4×10^9 milliliters, relating the inhalation ALI to the occupational DAC, and was then divided by a factor of 300. The factor of 300 includes (1) a factor of 50 to relate the 5-rem annual occupational dose limit to the 0.1-rem limit for members of the public, (2) a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and for members of the public, and (3) a factor of 2 to adjust the occupational values (derived for adults) so that they are applicable to other age groups.

   For radionuclides limited by submersion (external dose), the occupational DAC in Table 1, Column 3, was divided by 219. The factor of 219 is composed of a factor of 50, as described previously, and a factor of 4.38, relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year).

   The concentrations of radionuclides limited by the stochastic ALI in Table 2, Column 1, would produce an annual dose of 0.5 mSv (50 mrem) to a reference adult if the radionuclides are inhaled or ingested continuously over the course of a year. The licensee can thus demonstrate that it meets the constraint if the annual average radionuclide concentration at the point of release is less than 20 percent of the "air" values in Table 2 and if the radionuclides present in effluent are limited by the stochastic ALI.

However, the concentrations of radionuclides limited by submersion dose in Table 2, Column 1 (mostly noble gases), would produce an annual dose of 1.0 mSv (100 mrem). In that case, the licensee can demonstrate that it meets the constraint if the annual average radionuclide concentration at the point of release is less than 10 percent of the "air" values in Table 2.

If the radionculides present include a combination of those limited by the stochastic ALI and submersion dose, the licensee should either show the concentrations are less than 10 percent of the values in Table 2, Column 1 or use other methods discussed (e.g., computerized modeling described in Regulatory Position C.2.e) to demonstrate compliance.

The "sum of the fractions" technique can be used to assess effluents that contain multiple radionuclides or multiple release points or both. With this technique, if radionuclides *a*, *b*, and *c* are present in concentrations C_a, C_b, and C_c and if the applicable effluent concentrations in Table 2, Column 1, in Appendix B to 10 CFR Part 20 are EC_a, EC_b, and EC_c, respectively, satisfying the inequality below is sufficient to demonstrate that the licensee has met the constraint. For the situation of multiple release points, licensees should consider using only the highest concentration of a particular radionuclide among all release points.

$$\frac{C_a}{EC_a} + \frac{C_b}{EC_b} + \frac{C_c}{EC_c} < 0.1$$

Note: If the radionuclides evaluated are only those limited by the Stochastic ALI, then the inequality condition can be revised to "< 0.2."

The licensee may develop an annual dose estimate from this method by multiplying the calculated ratio by 1.0 mSv (100 mrem, or 0.5 mSv [50 mrem] if only considering those radionuclides limited by the Stochastic ALI), which, as previously discussed, is the dose estimated from exposure to radionuclide concentrations in Table 2, Column 1, in Appendix B to 10 CFR Part 20.

b. To demonstrate that it meets the constraint on airborne emissions, the licensee should show, by measurement or calculation, that the annual average concentration of airborne radioactive material released to the environment (including radionuclides that are limited by submersion dose) does not exceed 10 percent of the values in Table 2, Column 1, in Appendix B to 10 CFR Part 20. The following formula demonstrates this technique:

$$C = \frac{fQ}{V},$$

where:

C = average airborne concentration at the receptor (curies per cubic meter or microcuries per milliliter),

f = fraction of the time the wind blows toward the receptor of interest (dimensionless),

Q = effluent release rate (curies per second), and

V = volumetric flow rate at the point of release (cubic meters per second (m^3/s)).

Default values of f and V have been developed for NCRP Report No. 123, "Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground," dated January 22, 1996 (Ref. 14), and may be used if needed. Default values for f are 0.25 for long- and intermediate-term releases greater than 24 hours in duration and 1 for "puff" releases or releases of less than 24 hours. The default value for V is 0.3 m^3/s. Site-specific values for these parameters should be used when available. Multiple radionuclides or release points or both should also be addressed using the "sum of fraction" technique previously discussed in Regulatory Position C.2.a.

If the radionuclides in effluent exclude those limited by submersion dose, the licensee can demonstrate meeting the constraint if the annual average concentration of airborne radioactive material released to the environment does not exceed 20 percent of the values in Table 2, Column 1, in Appendix B to 10 CFR Part 20. Alternatively, the licensee can use other methods discussed (e.g., computerized modeling described in Regulatory Position C.2.e) to demonstrate compliance.

c. Licensees may also use site-specific meteorological data to generate more realistic estimations of airborne radionuclide concentrations at the receptor. If site-specific data are available, the following equation can be used to estimate the airborne concentration of radionuclides:

$$C = \left[\frac{\overline{\chi}}{Q'}\right] Q,$$

where $\overline{\chi}/Q'$ (chi-bar over Q prime or simply chi over Q) is the average annual atmospheric dispersion factor in seconds per cubic meter, and C and Q are as defined in Regulatory Position C.2.b. The atmospheric $\overline{\chi}/Q'$ at a receptor location could be determined using several different types of meteorological models. The most common is the straight-line Gaussian model, which is conservative and the basis of meteorological dispersion estimates in most common radionuclide transport and dispersion programs. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors" (Ref. 15), describes methods acceptable to the NRC staff for calculation models and assumptions for estimating atmospheric transport and dispersion of airborne emissions from power reactors. These methods would be acceptable for nonreactor facilities that use this guide.

Licensees can also use more complex models, such as Lagrangian puff dispersion models; however, unless they already have a model in place, the additional effort and expense of implementation would not likely provide a significant benefit.

Concentrations determined in this manner should be compared to either 10 percent or 20 percent of the applicable effluent concentrations in Table 2, Column 1, in Appendix B to 10 CFR Part 20 similar to the method presented in Regulatory Position C.2.a. However, in the case of multiple release points, the concentrations of individual radionuclides (or dose) derived from individual

release points would be summed to determine a total concentration (or dose) after dispersion to a receptor. Also, if the radionuclides in effluent include a mixture of those limited by the stochastic ALI and submersion dose, the licensee should either compare to 10 percent of the concentrations presented in Table 2, Column 1 or use other methods discussed (e.g., computerized modeling described in Regulatory Position C.2.e) to demonstrate compliance.

d. Another method that the NRC staff considers acceptable for demonstrating compliance with the dose constraint in 10 CFR 20.1101(d) appears in the worksheets in either NCRP Commentary No. 3, "Screening Techniques for Determining Compliance with Environmental Standards," issued January 1989 (with an addendum in October 1989) (Ref. 16); EPA 520/1-89-002, "A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities," Revision 2, issued October 1989 (Ref. 17); or NCRP Report No. 123 (Ref. 14).

e. Another method that the NRC staff considers acceptable for demonstrating compliance with 10 CFR 20.1101(d) is the use of computer codes. The computer code COMPLY assesses dose from airborne releases using varying amounts of site-specific information in four screening levels. In Level 1, the simplest level, only the quantity of radioactive material possessed during the monitoring period is entered. The calculations are based on generic parameters. Level 4 produces a more representative dose estimate and provides for a more complete treatment of air dispersion by requiring the greatest amount of site-specific information. Licensees that do not pass at the lowest level in COMPLY must move to the next higher level until they can demonstrate compliance. If licensees fail to show compliance at Level 4, they should consider the possibility that their air emissions do not meet the constraint. The bases for the methods in COMPLY appear in EPA 520/1-89-003, "Users Guide for the COMPLY Code," Revision 2, issued October 1989 (Ref. 18), and in EPA 520/1-89-002 (Ref. 17).

If a licensee has been granted permission to use dosimetry models or dose conversion coefficients other than those described in ICRP Publication Nos. 26 and 30 (e.g., ICRP Publication No. 68, "Dose Coefficients for Intake of Radionuclides by Workers" (Ref. 19)), it may also use the computer code CAP88 PC. The version of CAP88 PC used should either incorporate the approved guidance methods or be conservative relative to the approved guidance. COMPLY and CAP88 PC, together with their documentation, are available for download from the EPA Web site at http://www.epa.gov/radiation/assessment/software.

If the licensee uses a computer code other than those listed above to demonstrate that it meets the constraint, it should be prepared to demonstrate that the code has received appropriate software quality assurance such as that expected for commonly accepted computer programs. Licensees should perform and document software quality assurance if they develop their own programs or use spreadsheets for calculations.

3. Reports to the NRC If a Constraint Has Been Exceeded

If measurements or calculations determine that a facility has exceeded the constraint of 10 mrem (0.1 mSv) per year to the member of the public likely to receive the highest dose, the licensee must send a report to the NRC within 30 days after learning of the excess dose, as required by 10 CFR 20.2203(a)(2)(vi), and must describe the extent of the exposure in accordance with 10 CFR 20.2203(b)(1). The report should include the following information:

(1) an estimate of the dose, including the methods used to perform the estimate,
(2) the concentrations of the radioactive material released,

(3) the cause of the elevated concentrations in effluents,
(4) the corrective steps taken or planned to ensure against a recurrence, and
(5) a schedule for completing the corrective steps.

The report should contain enough information to allow the NRC staff to verify the measurements or calculations. It should be sent to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, DC 20555-0001, with a copy to the appropriate NRC regional office listed in Appendix D, "United States Regulatory Commission Regional Offices," to 10 CFR Part 20. Alternative means of submission include hand delivery to the NRC offices at 11555 Rockville Pike, Rockville, MD, and, where practicable, electronic submission.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

In some cases, applicants or licensees may propose or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations for license applications, license amendment applications, and amendment requests.

REFERENCES[1]

1. 10 CFR Part 20, "Standards for Protection against Radiation," U.S. Nuclear Regulatory Commission, Washington, DC.

2. Atomic Energy Act of 1954, as amended, Public Law 83-703, 68 Stat. 919, August 30, 1954.

3. Clean Air Act of 1970, as amended, Public Law 91-604, 84 Stat. 1676, 1970.[2]

4. 40 CFR Part 61, "National Emission Standards for Hazardous Air Pollutants," U.S. Environmental Protection Agency, Washington, DC.

5. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," U.S. Nuclear Regulatory Commission, Washington, DC.

6. Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

7. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, Washington, DC.

8. NCRP Report No. 127, "Operational Radiation Safety Program," National Council on Radiation Protection and Measurements, Bethesda, MD, June 1998.[3]

9. NCRP Statement No. 8, "The Application of ALARA for Occupational Exposures," National Council on Radiation Protection and Measurements, Bethesda, MD, June 8, 1999.

10. SECY-01-048, "Processes for Revision of 10 CFR Part 20 regarding Adoption of ICRP Recommendations on Occupational Dose Limits and Dosimetric Models and Parameters," U.S. Nuclear Regulatory Commission, Washington, DC, August 2, 2001. ML011580374

11. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

12. Regulatory Guide 4.16, "Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

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[1] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed on-line or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail pdr.resource@nrc.gov.

[2] EPA Library Services Web page: http://www.epa.gov/libraries/library_services.html or National Service Center for Environmental Publications (NSCEP) - EPA's Gateway to Free Digital & Paper Publications: http://www.epa.gov/nscep/

[3] The National Council on Radiation Protection and Measurements (NCRP) Could be available online http://www.ncrponline.org/Publications/Publications.html]

13. ANSI/HPS N13.1-1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities," American National Standards Institute/Health Physics Society, McLean, VA, 1999.[4]

14. NCRP Report No. 123, "Screening Models for Releases of Radionuclides to Atmosphere, Surface Water, and Ground," National Council on Radiation Protection and Measurements, Bethesda, MD, January 22, 1996.[5]

15. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," U.S. Nuclear Regulatory Commission, Washington, DC.

16. NCRP Commentary No. 3, "Screening Techniques for Determining Compliance with Environmental Standards," National Council on Radiation Protection and Measurements, Bethesda, MD, January 1989 (with October 1989 addendum).

17. EPA 520/1-89-002, "A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities," Revision 2, U.S. Environmental Protection Agency, Washington, DC, October 1989.

18. EPA 520/1-89-003, "Users Guide for the COMPLY Code," Revision 2, U.S. Environmental Protection Agency, Washington, DC, October 1989.

19. ICRP Publication No. 68, "Dose Coefficients for Intakes of Radionuclides by Workers," Annals of the ICRP, Volume 224(4), International Commission on Radiological Protection, Ottawa, Ontario, Canada.[6]

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4 Copies of American National Standards Institute (ANSI) standards may be purchased from ANSI, 1819 L Street, NW., Washington, DC 20036, on their Web site at http://webstore.ansi.org/; telephone (202) 293-8020; fax (202) 293-9287; or e-mail storemanager@ansi.org.

5 The National Council on Radiation Protection and Measurements (NCRP)
Could be available online http://www.ncrponline.org/Publications/Publications.html

6 International Commission on Radiological Protection (ICRP)
http://www.icrp.org/