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# DRAFT REGULATORY GUIDE

Contact: G. Chapman
(301) 492-3106

## DRAFT REGULATORY GUIDE DG-4018

*(Proposed Revision 1 of Regulatory Guide 4.20, dated December 1996)*

# 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 acceptable to the U.S. Nuclear Regulatory Commission (NRC) staff for meeting the constraint on air 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)). In 1996, the NRC added a constraint to 10 CFR Part 20, "Standards for Protection against Radiation" (Ref. 1), 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 air emissions of radioactive material to the environment.

In 10 CFR 20.1101(d), the NRC 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

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This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position.

Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rulemaking and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; submitted through the NRC's interactive rulemaking Web page at http://www.nrc.gov; or faxed to (301) 492-3446. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by June 14, 2010.

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML092590180.

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

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required.

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.

# B. DISCUSSION

## Background

In 1996, the NRC added regulations regarding a constraint on air emissions of radioactive materials to the environment as part of an agreement with EPA to resolve dual regulation of air emissions of radioactive material under both the Atomic Energy Act of 1954, as amended (Ref. 2), and the Clean Air Act, 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 and 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 of 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 air emissions of radioactive material to the environment. In addition to controlling doses from air emissions of radioactive material to the environment, licensees must, in accordance with 10 CFR Part 20, 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 air emissions of radioactive material to the environment. These licensees, which include radiographers, well loggers, and other users of sealed sources, do not need to take any actions to demonstrate that they meet the constraint on air 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 exposure may carry some risk. Thus, the NRC requires

licensees to take actions, to the extent practicable, using procedures and engineering controls to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA) (10 CFR Part 20.1101(b)). This is the goal and purpose of radiation protection programs. To achieve this goal, licensees have to control the way radioactive material is 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 includes doses from all pathways, including direct radiation, liquid effluents, and gaseous effluents. The constraint, in this case, may be interpreted as a fraction of the limit allocated to air emissions to assure exposures are ALARA through this particular release pathway. Licensees should design their facilities and structure operations such that air emissions of radioactive materials generated from operations result in doses to the public that are below the constraint. If licensees exceed the constraint on air emissions, they are required (10 CFR 20.1101(d) and 20.2203(a)(2)(vi)) 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. REGULATORY POSITION

The following paragraphs describe when the requirements to meet the constraint on air emissions of radioactive materials to the environment apply and methods that a licensee may use to demonstrate that it meets the constraint. The NRC staff considers the methods described below acceptable for use by its licensees other than power reactors to determine the exposure resulting from air 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). Most licensees will have a 1-year monitoring period.

### 1. Applicable Exclusions to the Constraint on Environmental Air 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 ICRP [International Commission on Radiological Protection] Recommendations on Occupational Dose Limits and Dosimetric Models and Parameters,"

dated August 2, 2001 (Ref. 10), for background). Licensees granted exemptions to use dosimetry guidance other than that on which 10 CFR Part 20 is based may use that guidance and the associated methods to demonstrate that they meet the dose constraint.

The following types of licensees and sources of radioactive material 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), (see 10 CFR 20.1101(d)), or (2) possess and use radionuclides only in the form of sealed sources which would not contribute to radioactive material in effluent.

b. Calculations do not need to include radioactive materials in sealed containers that remain unopened and have not leaked during the assessment period as this would not have contributed to radioactive material in effluents. Radiopharmaceuticals in unopened manufacturers' packages 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 (see 10 CFR 20.2003(b)). If the licensee uses measured or calculated concentrations of radioactive materials in the environment to demonstrate that it meets the constraint, the contribution from patients is deemed insignificant and does not need to be considered.

d. If it can be determined 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 which is consistent with the definition of background radiation (see 10 CFR 20.1003). 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 air emissions of radioactive material to the environment from licensed operations, licensees do not need to consider nonresidents within the facility boundary because these individuals' exposures should be determined under the facility's radiation protection and monitoring program.

**2. Calculation of Dose to the Member of the Public Likely To Receive the Highest Dose from Air 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 a licensee's operations have not changed, the review of its licensed operations and the demonstration that it has met the constraint will be relatively straightforward.

The following methods represent a graded approach, from the method involving the fewest site-specific data and, therefore, the most conservative to more rigorous methods, with more realistic results, for demonstrating that the constraint has been met. All of these methods are acceptable for demonstrating compliance with 10 CFR 20.1101(d):

a. The simplest screening technique is to assume that the air concentration at the receptor is equal to the air concentration measured at the point of release. The concentrations in 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 produce an annual exposure of 50 mrem (0.5 mSv) to an adult if inhaled or ingested continuously over the course of a year. The concentrations assume a factor of 2 to account for the exposure parameters applicable to age groups other than adults such that the resulting exposure for these groups would be estimated at 100 mrem (1 mSv). The licensee can demonstrate that it meets the constraint if the radionuclide concentration at the point of release is less than 10 percent of the "air" values in Table 2.

The "sum-of-fractions" technique should be used to assess effluents containing multiple radionuclides. If multiple release points are present, the maximum concentration of each radionuclide among all points of release should be used. 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 Column 1 of Table 2 in Appendix B to 10 CFR Part 20 are $EC_a$, $EC_b$, and $EC_c$, respectively, satisfying the following inequality is sufficient to demonstrate that the licensee has met the constraint:

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

b. To demonstrate that it meets the constraint on air emissions, the licensee may choose to show, by measurement or calculation, that the annual average concentration of airborne radioactive material released in the direction of the receptor does not exceed 10 percent of the values in Column 1 of Table 2 in Appendix B to 10 CFR Part 20. The following formula demonstrates this technique:

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

where:

C = Average air 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).

Default values of *f* and *V* have been developed for NCRP Report No. 123, "Screening Models for Releases of Radionclides to Atmosphere, Surface Water, and Ground," dated January 22, 1996 (Ref. 12), 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 cubic meters per second. Licensees should use site-specific values for these parameters when available. Licensees should also address multiple radionuclides or release points or both using the "sum-of-fractions" technique as discussed previously in Section 2.a.

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 Section 2.b. The licensee could use several different types of meteorological models to determine atmospheric $\overline{\chi}/Q'$ at a receptor location. 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. 13), describes methods that the NRC staff consider acceptable for calculation models and assumptions used to estimate atmospheric transport and dispersion of airborne emissions from power reactors. The NRC would consider these methods acceptable for use by nonreactor facilities that use this guide.

More complex models, such as Lagrangian puff dispersion models, can also be used, but, unless the facility already has a model in place, the additional effort and expense of implementing the model would not likely provide significant benefit.

Concentrations determined in this manner should be compared with 10 percent of the applicable effluent concentrations in Column 1 of Table 2 in Appendix B to 10 CFR Part 20 similar to the method presented in Section 2.a.

d. The NRC staff also considers acceptable for demonstrating compliance with 10 CFR 20.1101(d) the methods that appear in the worksheets contained in either NCRP Commentary No. 3, "Screening Techniques for Determining Compliance with Environmental Standards," issued January 1989 (with an addendum issued in October 1989) (Ref. 14); 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 [Department of Energy] Federal Facilities," Revision 2, issued October 1989 (Ref. 15); or the worksheets in NCRP Report 123 (Ref. 12).

e. Another method that the NRC staff considers acceptable for demonstrating compliance with 10 CFR 20.1101(d) is the use of appropriate 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 that the licensee possesses during the monitoring period is entered. The calculations are based on generic parameters. Level 4 produces a more accurate dose estimate; it provides a more complete treatment of air dispersion by requiring the greatest amount of site-specific information. A licensee that does not pass at the lowest level in COMPLY should move to the next higher level until it can demonstrate compliance, or by failing to show compliance at Level 4, the licensee should consider the possibility that its air emissions do not meet the constraint. The basis for the methods in COMPLY appear in EPA 520/1-89-003, "Users Guide for the COMPLY Code," Revision 2, issued October 1989 (Ref. 16), and in EPA 520/1-89-002.

If the NRC has granted a licensee an exemption to use the dosimetry guidance in ICRP Publication 68, "Dose Coefficients for Intake of Radionuclides by Workers" (Ref. 17), the licensee may use the computer code CAP88 PC. The version of CAP88 PC the licensee uses 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 via download from the EPA Web site at http://www.epa.gov/radiation/assessment/software.

If a 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 is appropriate for modeling airborne emissions and 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 U.S. Nuclear Regulatory Commission if a Constraint Has Been Exceeded**

If measurements or calculations determine that the constraint of 10 mrem (0.1 mSv) per year to the member of the public likely to receive the highest dose has been exceeded, licensees 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 they must describe the extent of exposure in accordance with 10 CFR 20.2203(b)(1). The report should include the following information:

(1) an estimate of the dose,
(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 draft regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

The NRC has issued this draft guide to encourage public participation in its development. The NRC will consider all public comments received in development of the final guidance document. In some cases, applicants or licensees may propose an alternative 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.

# REGULATORY ANALYSIS

## Statement of the Problem

This regulatory guide is being updated to reflect the applicability of references, to clarify the subject matter, and to be consistent in format with other regulatory guides.

## Objective

The objective of this regulatory action is to clarify the applicability of the constraint on air emissions of radioactive material to the environment and the acceptable methods that a licensee can use to demonstrate that it meets the constraint.

## Alternative Approaches

The NRC staff considered the following alternative approaches:

Do not revise Regulatory Guide 4.20.
Revise Regulatory Guide 4.20.

Alternative 1: Do Not Revise Regulatory Guide 4.20

Under this alternative, the NRC would not revise or issue additional guidance, and the current guidance would be retained. If the NRC does not take action, there would not be any changes in costs or benefit to the public, the licensees, or the NRC. However, the "no-action" alternative would not address concerns with the current version of the regulatory guide regarding suitable clarification of methods, applicability, and references. The NRC would continue to review each application on a case-by-case basis. This alternative provides a baseline condition from which any other alternatives will be assessed.

Alternative 2: Revise Regulatory Guide 4.20

Under this alternative, the NRC would revise Regulatory Guide 4.20, taking into consideration the applicability and availability of referenced documents and guidance. One benefit of this action is that it would further clarify the applicability of the guidance and its references and clarify methods that a licensee can use to demonstrate that it meets the constraint.

The impact to the NRC would be the costs associated with preparing and issuing the revised regulatory guide. The impact to the public would be the voluntary costs associated with reviewing and providing comments to the NRC during the public comment period. The value to the NRC staff and its applicants would be the benefits associated with enhanced efficiency and effectiveness in using a common guidance document as the technical basis for license applications and other interactions between the NRC and its regulated entities.

## Conclusion

Based on this regulatory analysis, the NRC staff recommends revision of Regulatory Guide 4.20. The staff concludes that the proposed action will clarify the methods acceptable for licensees to demonstrate that they have met the constraint on air emissions of radioactive material to the environment as well as update the methods and references applicable to performing this action as per this guidance.

# 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, Pub. L. No. 83-703, 68 Stat. 919 (August 30, 1954).[2]

3. *Clean Air Act*, as amended, Pub. L. No. 91-604, 84 Stat. 1676 (1970).

4. 40 CFR Part 61, "National Emission Standards for Hazardous Air Pollutants (NESHAPS)," 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.

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.

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

12. 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.


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[1] Publicly available NRC published documents such as Regulations, Regulatory Guides, NUREGs, and Generic Letters listed herein are available electronically through the Electronic Reading room on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. Copies are also available for inspection or copying for a fee from 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] Copies of the non-NRC documents included in these references may be obtained directly from the publishing organization.

13. 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.

14. 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).

15. 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.

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

17. ICRP Publication 68, "Dose Coefficients for Intakes of Radionuclides by Workers," *Annals of the ICRP*, Volume 24(4), International Commission on Radiological Protection, Ottawa, Ontario, Canada.