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REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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ALARA LEVELS FOR EFFLUENTS FROM MATERIALS FACILITIES

A. INTRODUCTION

In 10 CFR Part 20, "Standards for Protection Against Radiation," § 20.1302(b) requires that:

"A licensee shall show compliance with the annual dose limit in § 20.1301 by (1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; or (2) Demonstrating that (i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to §§ 20.1001-20.2401; and (ii) If an individual were continually present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year."

In addition, 10 CFR 20.1101(b) requires that:

"The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses

to members of the public that are as low as is reasonably achievable (ALARA)."

This regulatory guide provides guidance on designing an acceptable program for establishing and maintaining ALARA levels for gaseous and liquid effluents at materials facilities. Materials facilities are those facilities at which the possession or use of source, byproduct, or special nuclear material is licensed under 10 CFR Parts 30, 40, 60, 61, and 70.

Additional guidance on ALARA programs can be found in other regulatory guides. While these guides deal primarily with occupational exposure and may be specific to one type of licensee, they contain programmatic information that may be useful to all licensees. They are as follows:

- Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable." This guide delineates the components of an ALARA program.
- Regulatory Guide 8.18, "Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable."
- Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable."

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Regulatory Guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in its review of applications for permits and licenses. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.

Written comments may be submitted to the Regulatory Publications Branch, DFIPS, ADM, U. S. Nuclear Regulatory Commission, Washington, DC 20555.

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- Regulatory Guide 10.8, "Guide for the Preparation of Applications for Medical Use Programs." Section 1.3 and Appendix G deal specifically with ALARA programs for medical facilities.

In addition, further information can be found in Revision 1 to NUREG-0267,¹ "Principles and Practices for Keeping Occupational Radiation Exposures at Medical Institutions As Low As Reasonably Achievable" (October 1982).

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 20, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 20 have been approved by the Office of Management and Budget, Approval No. 3150-0014.

B. DISCUSSION

At the relatively low levels of radiation exposure in the United States, it is difficult to demonstrate a relation between exposure and any health effects. The dose limits in 10 CFR Part 20 are based on limiting dose to what is considered to be an acceptable level of risk to the exposed individual. Still, any radiation exposure may carry some risk. Thus, the NRC requires licensees to take actions, to the extent practicable, utilizing procedures and engineering controls to further reduce risk below the levels implicit in the dose limits in keeping with the principle that exposures should be as low as is reasonably achievable. This is the goal and purpose for radiation protection programs. In order to achieve this goal, licensees must control the way radioactive material is handled from receipt through disposal.

NRC licensees have traditionally reduced exposures and effluents to small fractions of the dose limits using the ALARA process. Recently, the Environmental Protection Agency (EPA) conducted 2 studies of materials facilities. The first was a survey of 367 randomly selected nuclear materials licensees. The highest estimated dose to a member of the public from effluents was 8 mrem/yr, based on very conservative modeling. In addition, 98% of the facilities examined had doses to members of the public resulting from effluents less than 1 mrem/yr. The second study evaluated effluents from 43 additional facilities that were selected because of their potential for effluent releases resulting in significant public exposures. Of these, none exceeded 10 mrem/yr to a member of the public, and 75% of them were less than 1 mrem/yr to a member of the public. Based upon this information, and the ongoing NRC program of licensing and inspection, the NRC expects that the goals suggested in

this guide will be easily achievable by all NRC materials licensees.

The NRC staff will be examining licensee programs to determine compliance with the requirements of 10 CFR Part 20. In the event that a particular materials facility licensee establishes ALARA goals that are less stringent than the goals identified in this guide, or consistently fails to achieve ALARA goals it has established pursuant to this guide, the NRC staff will conduct a more detailed review of that licensee's program to determine the rationale for the greater levels. In such circumstances, the NRC will evaluate the rationale provided by the licensee, as well as the licensee's operations, to determine whether the licensee has established an adequate ALARA program and is operating that program in compliance with 10 CFR 20.1101(b).

This guide deals with only a part of a licensee's overall radiation protection program. Specifically, it deals with the application of ALARA in controlling gaseous and liquid effluents. In addition to controlling doses resulting from the release of effluents, licensees must implement a radiation protection program that controls dose rates in unrestricted areas to maintain overall doses to workers and members of the public ALARA and below the limits in 10 CFR Part 20. Licensees may choose to focus their evaluation of public dose to members of a critical group as suggested by the International Commission on Radiological Protection (ICRP) as a means of identifying and controlling the exposure to the individual member of the public likely to receive the highest exposure.

NRC licensees have taken actions to maintain doses to both workers and members of the public ALARA under the admonition contained in 10 CFR 20.1(c),² which requires that licensees "make every reasonable effort" to maintain doses and effluents ALARA. NRC licensees have generally reduced doses to relatively small fractions of the dose limits. Therefore, the NRC staff does not expect that most licensees will need to make significant changes to procedures, operations, and equipment in order to be in compliance with the requirements of 10 CFR 20.1101(b).² However, for those licensees who have not previously developed a radiation protection program that includes written procedures and policies as well as a commitment to ALARA, additional steps may be necessary to demonstrate compliance with requirements now explicit in 10 CFR Part 20 to maintain doses ALARA.

Components of an effective radiation protection program, as required by 10 CFR 20.1101(b), include radiation exposure control, written procedures and

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²In June 1991, 10 CFR Part 20 §§ 20.1001 through 20.2401 became effective, and compliance with these sections becomes mandatory on January 1, 1994. However, 10 CFR Part 20 §§ 20.1 through 20.601 became effective in 1957 and remains in effect until January 1, 1994, or when licensees voluntarily implement the requirements of 10 CFR Part 20 §§ 20.1001 through 20.2401, whichever is earlier.

policies, control of radioactive materials, radioactive contamination control, radioactive waste management, training, program reviews, and audits. Guidance on other facets of a radiation protection program for materials facilities is currently under development.

C. REGULATORY POSITION

An ALARA program for effluent control to control doses to members of the public should contain the following program elements:

1. Management commitment to ALARA, including goals,
2. Procedures, engineering controls, and process controls,
3. Surveys and effluent monitoring,
4. ALARA reviews,
5. Worker training.

These program elements, while given specifically for effluents in this guide, are also applicable to the control of direct exposure.

1. MANAGEMENT COMMITMENT TO ALARA, INCLUDING GOALS

The single most critical aspect of successfully achieving ALARA in the radiation safety program is the commitment of management to maintain doses ALARA, both occupational and to the public. The licensee's radiation protection program (including ALARA elements) should be commensurate with the potential hazards associated with the licensed activity.

1.1 ALARA Policy

The licensee should establish an ALARA policy that is issued and supported by the highest level of management. All employees should be made aware of the ALARA policy through training. This policy should make clear that all personnel will be responsible for ensuring that work they perform is in accordance with ALARA procedures.

1.2 ALARA Goals

To assist in demonstrating compliance with the requirements of 10 CFR Part 20, the licensee should set ALARA goals for effluents at a modest fraction of the values in Appendix B, Table 2, Columns 1 and 2, to §§ 20.1001–20.2401. These goals may be set independently for gaseous and liquid effluents. Past experience and effluent information reported to the NRC staff indicate that goals within a range of 10 to 20% of Appendix B values or less can be achieved by almost all materials facility licensees. However, establishing a goal is not intended as setting a precedent or a de facto limit. Goals may need to be adjusted up or

down on the basis of the annual review of what may be ALARA for the particular circumstance.

If the licensee chooses to demonstrate compliance with 10 CFR 20.1301 through a calculation of the total effective dose equivalent (TEDE) to the individual likely to receive the highest dose, the licensee should set the ALARA goal at a modest fraction of the dose limit for members of the public. Experience indicates that values of about 0.1 mSv/yr (10 mrems/yr) or less should be practicable for almost all materials facility licensees. Licensees need not assume worst case models when calculating dose but rather should make assumptions that will result in realistic estimates of actual dose received by the member of the public likely to receive the highest dose.

If the circumstances of a particular case are such that the licensee cannot achieve effluent concentrations less than 20% of the Appendix B values or demonstrate by calculation that the TEDE to the individual likely to receive the highest dose is less than 0.1 mSv/year (10 mrems/year), the ALARA philosophy continues to apply, and the licensee should demonstrate compliance with the requirements of 10 CFR 20.1101(b) by evaluating procedures, engineering controls, and process controls as described in Regulatory Position 2 below.

1.3 Investigation Levels

In addition to ALARA goals, the licensee should establish investigation levels at effluent values that are close to normal or anticipated release levels. If exceeded, an investigation should be initiated and corrective actions should be taken, as appropriate.

1.4 Radiation Safety Committee

For licensees that have a radiation safety committee, one responsibility of that committee should be to establish ALARA goals. The committee must meet at least annually to review the radiation protection program content. The committee should also review ALARA goals and discuss ways to further reduce doses if necessary. Goals may need to be adjusted on the basis of the committee's review. The committee should assess short-term and long-term performance in terms of achieving the ALARA goals. ALARA goals and the results of reviews should be reported at least annually to senior management with recommendations for changes in procedures or equipment needed to accomplish the requirements of the ALARA policy as appropriate.

For licensees with no radiation safety committee, the radiation safety officer should be responsible for setting, adjusting, and periodically reviewing the radiation protection program and the ALARA goals.

2. PROCEDURES, ENGINEERING CONTROLS, AND PROCESS CONTROLS

Licensees should consider available engineering options to control the release of effluents to the

environment. Examples of the available options include filtration, encapsulation, adsorption, containment, and the storage of liquids for decay. If further reductions in effluents are needed to achieve ALARA goals, the recycling of process fluids, leakage reduction, and modifications to facilities, operations, or procedures should be considered. These modifications should be implemented unless an analysis indicates that a substantial reduction in collective dose would not result or costs are considered unreasonable. A determination of reasonableness may be based on a qualitative analysis requiring the exercise of judgment and consideration of factors that may be difficult to quantify. These factors could include nonradiological social or environmental impacts, the availability and practicality of alternative technologies, and the potential for unnecessarily increasing occupational exposures.

Alternatively, reasonableness may be based on a quantitative cost/benefit analysis. Preparation of an ALARA cost/benefit analysis requires the use of a dollar value per unit dose averted. The NRC staff is conducting a review and analysis of various methodological approaches to setting dollar values, and the staff recognizes that varying degrees of justification exist for a wide range of dollar values. However, the value of \$1000 per person-cSv (man-rem) is acceptable to the NRC staff and may be used pending completion of that reassessment.

3. SURVEYS AND EFFLUENT MONITORING

Licensees must perform surveys and monitoring sufficient to demonstrate compliance with the requirements of 10 CFR 20.1302. This includes the monitoring and surveys that may be necessary to determine whether radiation levels and effluents meet the licensee's established ALARA goals. These surveys should include air and liquid effluent monitoring, as appropriate, as well as surveys of dose rates in unrestricted areas.

If the licensee chooses to demonstrate compliance with dose limits to the member of the public likely to receive the highest dose by calculating the TEDE, all significant environmental pathways should be evaluated. Some of the equations included in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," and Regulatory Guide 3.51, "Calculational Models For Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations," may be useful in performing dose assessments. However, pending the anticipated revision of these regulatory guides, the dose conversion factors should be based

on the methodology described in ICRP 30, "Limits for Intakes of Radionuclides by Workers."³

3.1 Airborne Radioactive Effluent Monitoring

When practicable, releases of airborne radioactive effluents should be from monitored release points (e.g., monitored stacks, discharges, vents) to ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure. Licensees should verify the performance of effluent monitoring systems by regular calibration (at least annually) to ensure that these monitors provide reliable indications of actual effluents. Further guidance can be found in Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)—Effluent Streams and the Environment."

Effluent monitoring systems should be designed in accordance with ANSI N13.1 (1969), "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities,"⁴ and ANSI N42.18, "Specification and Performance of On-site Instrumentation for Continuously Monitoring Radioactive Effluents."⁴

NCRP Commentary No. 3, "Screening Techniques for Determining Compliance with Environmental Standards,"⁵ published in January 1989 and the addendum published in October 1989 provide acceptable methods for calculating dose from airborne radioactive effluents. In addition, there are several computer codes available that perform these calculations. Licensees may use such computer codes as long as they can demonstrate that the code uses approved methods.

3.2 Liquid Effluent Monitoring

effluents should be monitored.⁶ Methods for calculating doses from liquid effluents similar to those described in NCRP Commentary No. 3 are currently under development by the NCRP. In the interim, guidance available in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," and 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

³Copies are available from Pergamon Press, Inc., 660 White Plains Road, Tarrytown, NY 10591-5153, phone (914) 594-9200.

⁴Copies of ANSI standards may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

⁵Copies may be purchased from the National Council on Radiation Protection and Measurements, NCRP Publications, 7910 Woodmont Avenue, Bethesda, MD 20814.

⁶Liquid effluents do not include releases into sanitary sewerage in accordance with 10 CFR 20.2003(a) or excreta from patients in accordance with 10 CFR 20.2003(b).

Uranium Hexafluoride Production Plants," may be useful to materials licensees in calculating doses from liquid effluents.

3.3 Unmonitored Effluents

If a licensee has release points for which monitoring is not practicable, the licensee should estimate the magnitude of the unmonitored effluents. For instance, a research hospital or university broad scope licensee might have dozens of locations where radioactive material could be released. The licensee should estimate the magnitude of unmonitored releases and include those estimated amounts when demonstrating compliance with dose limits and the licensee's ALARA goals. Unmonitored releases may be estimated based on the quantity of material used in these areas or the number of procedures performed or other appropriate methods. When practicable, unmonitored effluents should not exceed 30% of the total estimated effluent releases.

4. ALARA REVIEWS

According to 10 CFR 20.1101(c), the content and implementation of the radiation protection programs, which would include the ALARA effluent control program, must be reviewed at least annually. This review should include analysis of trends in release concentrations and radionuclide usage as well as other available monitoring data. The review should provide a documented basis for determining whether changes are needed in systems or practices to achieve

ALARA effluent goals. In addition, the licensee should review all designs for system installations or modifications to ensure compliance with 10 CFR 20.1101(b). The results of ALARA reviews should be reported to senior management along with recommendations for changes in facilities or procedures that are deemed necessary to achieve ALARA goals.

5. WORKER TRAINING

Specific training on ALARA should be provided as a part of the annual employee radiation protection training (see 10 CFR 19.12). For an ALARA program to be successful, employees must understand the ALARA program's goals and principles. The radiation protection staff should be available to help clarify the ALARA policy and its goals and to assist employees both during training and throughout the year.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this guide.

Except in those cases in which an applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described in this guide will be used in the evaluation of applications for new licenses, license renewals, or license amendments and for evaluating compliance with 10 CFR 20.1001–20.2401.

REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. The regulatory analysis prepared for 10 CFR Part 20, "Standards for Protection Against Radiation" (56 FR 23360), provides the regulatory basis for this guide. A copy

of the "Regulatory Analysis for the Revision of 10 CFR Part 20" (PNL-6712, November 1988) is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW., Washington, DC, as an enclosure to Part 20.



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