Department of Energy
Office of Worker Protection Policy and Programs
Radiological Control Technical Position
RCTP 2000 - 05

Use of Respiratory Protection Device Assigned Protection Factors for Radiological Protection Purposes

Issue:

Many Department of Energy (DOE) facilities are required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, to comply with the requirements of Title 29 Code of Federal Regulations (CFR), Part 1910, *Occupational Safety and Health Standards*, (in particular 29 CFR 1910.134, *Respiratory Protection)* and American National Standards Institute Standard Z88.2 (ANSI Z88.2), *Respiratory Protection*.

> **Note**: Since 29 CFR 1910.134 does not prescribe assigned protection factors for respiratory protection devices, this technical position will only discuss ANSI Z88.2 requirements.

Title 10 Code of Federal Regulations, Part 835 (10 CFR 835), *Occupational Radiation Protection*, establishes occupational radiation protection requirements for DOE activities and includes requirements for controlling individual exposures to ionizing radiation. 10 CFR 835 must also be adhered to for DOE activities involving personnel exposures to ionizing radiation.

A question concerning the implementation of ANSI Z88.2 requirements for radiological environments was submitted to the DOE.

Introduction:

The Office of Worker Protection Policy and Programs (EH-5.2) received a request for a response on whether, for radiological protection purposes, the assigned respirator protection factors found in ANSI Z88.2 can ever be exceeded, even for short durations.

Discussion:

Applicable Requirements

Nonregulatory Requirements

ANSI Z88.2 (1992), American National Standard for Respiratory Protection

Definitions

3.21 exposure limit: The maximum allowable concentration of a contaminant in the air to which an individual may be exposed. These may be time-weighted averages, short-term limits, or ceiling limits.

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3.29 hazard ratio: A number obtained by dividing the concentration of a contaminant by its exposure limit.

3.55 time weighted average: The average concentration of a contaminant in air during a specific time period.

7.2.2.2 Selection Steps
f) Divide the measured or estimated concentration of each contaminant by the exposure limit or guideline to obtain a hazard ratio.... Select a respirator with an assigned protection factor greater than the value of the hazard ratio.

Regulatory Requirements

10 CFR 835 Occupational Radiation Protection
(These requirements were published in the November 4, 1998, amendment to 10 CFR 835)

Definitions

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (International Commission on Radiological Protection Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue.

Derived air concentration (DAC) means, for the radionuclides listed in appendix A of this part, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m^3).

Total effective dose equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

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10 CFR 835.202 Occupational dose limits for general employees

(a) Except for planned special exposures conducted consistent with § 835.204 and emergency exposures authorized in accordance with § 835.1302, the occupational dose received by general employees shall be controlled such that the following limits are not exceeded in a year:

(1) A total effective dose equivalent of 5 rems (0.05 sievert); and

(2) The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rems (0.5 sievert);

10 CFR 835.209 Concentrations of radioactive material in air

(a) The DAC values given in appendices A and C of this part shall be used in the control of occupational exposures to airborne radioactive material.

Technical Position:

In response to the question, "For radiological protection purposes can the assigned respirator protection factors found in ANSI Z88.2 ever be exceeded, even for short durations?"--the term "exposure limit" as used in ANSI Z88.2 must first be put in radiological protection terms. ANSI Z88.2 states that the exposure limits may be time weighted averages (TWAs). TWAs are concentration values averaged over a specific time period. For radiation protection purposes, the exposure limits are defined in a time period of a work year (i.e., 2000 hours).

The DOE exposure limit for general employees exposed to ionizing radiation from DOE activities is 5 rem TEDE in a year. To control internal exposures the regulations specify DAC values. 10 CFR 835.209 requires that the DAC values provided in 10 CFR 835 be used in the control of occupational exposures to airborne radioactive material. Using standard biological models, a 2000 DAC-hours exposure would result in an individual inhaling the ALI, which would correspond to a TEDE of 5 rem. Accordingly, the protection factor of respiratory protection devices used by workers during a year must be such that the total exposure during a year is less than 2000 DAC-hours, assuming there is no dose from external sources.

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Note: There are other exposure limits, such as the 50 rem committed dose equivalent to any organ or tissue as well as separate limits for minors, declared pregnant workers, and members of the public in controlled areas. For brevity, this response will only address the TEDE limit to general employees. The same approach discussed in this response may be used in complying with the other limits.

As an initial approach one should consider selecting a respiratory protection device which has an assigned protection factor greater than the peak concentration value, in multiples of DAC, expected. DOE recognizes that there are situations where this may not be the optimal approach. There are situations where there are no respiratory protection devices with assigned protection factors greater than the peak concentration value expected. There are also situations where, for ALARA considerations, the total exposure may be lower using a respiratory protection device with a lower assigned protection factor (or, in some cases, no respiratory protection device), such as in areas with high external dose rates. Nonradiological hazards (e.g., heat stress, reduced visibility) may also influence selection of respiratory protection devices.

As an alternate approach, to ensure the radiological protection exposure limit of 5 rem TEDE in a year is not exceeded, one may use the conversion of 2.5 millirem per DAC-hour and account for the protection factor of the respiratory protection device and the time in the area.

For example, a 250 millirem administrative control level (ACL) for a job with no external exposures, estimated to take 20 hours to complete, and airborne radioactivity concentrations of 400 times the DAC would have a hazard ratio of 80. This job could be conducted using a respiratory protection device with a protection factor greater than 80 (e.g., a respirator with a protection factor of 100).

$$\frac{400 \text{ DAC} \times 20 \text{ hrs} \times 2.5 \text{ millirem/DAC-hr}}{250 \text{ millirem (ACL)}} = \frac{20{,}000 \text{ millirem (potential dose)}}{250 \text{ millirem (ACL)}} = 80 \text{ hazard ratio}$$

There are several precautions to consider in using this approach:

- In practice, the 5 rem TEDE exposure limit typically also includes exposure from external sources. Accordingly, those exposures must also be considered.
- The 5 rem TEDE exposure limit is applicable to all occupational exposures during the year. Accordingly, exposures already received during that year must be considered.
- There is great variability in estimating potential air concentration values. Accordingly, conservative assumptions regarding potential peak concentration values should be made.

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- There is great biological variability associated with intakes of radioactive material, i.e., air monitoring results could indicate an intake of less than one ALI and subsequent bioassay analysis could result in an assigned dose in excess of the annual limit.

Accordingly, DOE recommends that use of this alternate approach be based on a job specific ACL for that activity that is much lower than the 5 rem TEDE limit.

For any approach taken, the ALARA provisions of 10 CFR 835 would need to be appropriately considered in making these determinations.

The U.S. Nuclear Regulatory Commission (NRC) has issued requirements and guidance for respiratory protection programs for its licensees (i.e., 10 CFR 20, *Standards for Protection Against Radiation*, and Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection, Rev. 1*). This technical position is consistent with the NRC requirements and guidance for using respiratory protection devices and their assigned protection factors to maintain occupational exposures ALARA.

Summary

When using respiratory protection devices for radiological protection, as an initial approach one should consider selecting a respiratory protection device which has an assigned protection factor greater than the peak concentration value, in multiples of DAC, expected. As an alternate approach, to ensure the radiological protection occupational exposure limit of 5 rem TEDE is not exceeded, one may establish an administrative control level for that activity that is much lower than the 5 rem TEDE limit and use the conversion of 2.5 millirem per DAC-hour and account for the protection factor of the respiratory protection device and the time in the area. However, there are some considerations before using this approach.

Regardless of the approach taken, the ALARA provisions of 10 CFR 835 would need to be appropriately considered.

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References:

10 CFR 20, *Standards for Protection Against Radiation*, U.S. Nuclear Regulatory Commission, November 24, 1992

10 CFR 835, *Occupational Radiation Protection*, U.S. Department of Energy, November 4, 1998

10 CFR 1910.134, *Occupational Safety and Health Standards -Respiratory Protection*, U.S. Occupational Safety and Health Administration, May 2, 1996

ANSI Z88.2, *Respiratory Protection*, American National Standards Institute, 1992

DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, U.S. Department of Energy, March 27, 1998

U. S. Nuclear Regulatory Commission Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection, Rev. 1*, October 1999