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MEMORANDUM FOR DISTRIBUTION

FROM: PATRICIA R. WORTHINGTON, PhD
DIRECTOR
OFFICE OF HEALTH AND SAFETY
OFFICE OF HEALTH, SAFETY AND SECURITY

SUBJECT: Radiological Control Technical Position Regarding Surface Contamination Values for Alpha-Emitting Radionuclides not Listed in Title 10, Code of Federal Regulations, Part 835, Appendix D

The Office of Worker Safety and Health Policy issues Radiological Control Technical Positions in response to questions or issues associated with Department of Energy (DOE) occupational radiation protection programs.

The attached technical position addresses provisions regarding values of removable and total contamination for certain radioisotopes not listed in title 10, Code of Federal Regulations, part 835, appendix D. The technical position provides an acceptable approach to determine which value to use based on comparison with dose coefficients from International Commission on Radiological Protection Publication 68.

The technical position does not represent new policy or direction to the field.

This technical position will also be posted on the radiation protection Web site at **http://www.hss.doe.gov/HealthSafety/WSHP/radiation/tpp.html** and electronically distributed to the DOE Radiological Control Coordinating Committee.

Attachment

cc w/attachment:
See attached list.

Department of Energy
Office of Worker Safety and Health Policy
Radiological Control Technical Position
RCTP 2012-01

Values for Alpha-Emitting Radionuclides not Listed in Title 10, Code of Federal Regulations, Part 835, Appendix D

Issue:

Values for surface contamination are addressed in title 10, Code of Federal Regulations, part 835, *Occupational Radiation Protection* (10 C.F.R. 835). The table in 10 C.F.R. 835, Appendix D, *Surface Contamination Values in DPM/100 cm^2*, lists values for both total and removable surface contamination for certain radionuclides and types of radionuclides. The values are used in establishing requirements for radiological control for material, equipment, and areas. Although appendix D provides values for the radionuclides typically encountered at DOE facilities, 10 C.F.R. 835, appendix D, does not include values for all radionuclides. This position paper addresses the issue regarding the appropriate values to use for radionuclides not listed in 10 C.F.R. 835, appendix D.

Applicable Provisions

10 C.F.R. 835

§ 835.2 Definitions.

Contamination area means any area, accessible to individuals, where removable surface contamination levels exceed, or are likely to exceed, the removable surface contamination values specified in appendix D of this part, but do not exceed 100 times those values.

High contamination area means any area, accessible to individuals, where removable surface contamination levels exceed, or are likely to exceed, 100 times the removable surface contamination values specified in appendix D of this part.

Subpart C--Standards for Internal and External Exposure

§ 835.603 Radiological areas and radioactive material areas.

Each access point to radiological areas and radioactive material areas (as defined at § 835.2) shall be posted with conspicuous signs bearing the wording provided in this section.

(e) Contamination Area. The words, "Caution, Contamination Area," shall be posted at each contamination area.
(f) High Contamination Area. The words, "Caution, High Contamination Area," or "Danger, High Contamination Area," shall be posted at each high contamination area.

§ 835.1101 Control of material and equipment.

(a) Except as provided in paragraphs (b) and (c) of this section, material and equipment in contamination areas, high contamination areas, and airborne radioactivity areas shall not be released to a controlled area if:

(1) Removable surface contamination levels on accessible surfaces exceed the removable surface contamination values specified in appendix D of this part; or

(2) Prior use suggests that the removable surface contamination levels on inaccessible surfaces are likely to exceed the removable surface contamination values specified in appendix D of this part.

(b) Material and equipment exceeding the removable surface contamination values specified in appendix D of this part may be conditionally released for movement onsite from one radiological area for immediate placement in another radiological area only if appropriate monitoring is performed and appropriate controls for the movement are established and exercised.

(c) Material and equipment with fixed contamination levels that exceed the total surface contamination values specified in appendix D of this part may be released for use in controlled areas outside radiological areas only under the following conditions:

(1) Removable surface contamination levels are below the removable surface contamination values specified in appendix D of this part; and

(2) The material or equipment is routinely monitored and clearly marked or labeled to alert personnel of the contaminated status.

§ 835.1102 Control of areas.

(a) Appropriate controls shall be maintained and verified that prevent the inadvertent transfer of removable contamination to locations outside radiological areas under normal operating conditions.

(b) Any area in which contamination levels exceed the values specified in appendix D of this part shall be controlled in a manner commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable surface contamination levels.

(c) Areas accessible to individuals where the measured total surface contamination levels exceed, but the removable surface contamination levels are less than, corresponding surface contamination values specified in appendix D of this part, shall be controlled as follows when located outside of radiological areas:

(1) The area shall be routinely monitored to ensure the removable surface contamination level remains below the removable surface contamination values specified in appendix D of this part; and

(2) The area shall be conspicuously marked to warn individuals of the contaminated status.

(d) Individuals exiting contamination, high contamination, or airborne radioactivity areas shall be monitored, as appropriate, for the presence of surface contamination.

(e) Protective clothing shall be required for entry to areas in which removable contamination exists at levels exceeding the removable surface contamination values specified in appendix D of this part.

Appendix D to Part 835-- SURFACE CONTAMINATION VALUES

The data presented in appendix D are to be used in identifying the need for posting of contamination and high contamination areas in accordance with § 835.603(e) and (f) and identifying the need for surface contamination monitoring and control in accordance with §§ 835.1101 and 835.1102.

SURFACE CONTAMINATION VALUES[1] IN DPM/100 CM[2]

Radionuclide	Removable [2,4]	Total (Fixed + Removable)[2,3]
U-nat, U-235, U-238, and associated decay products	[7] 1,000	[7] 5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5]	1,000	5,000
Tritium and STCs [6]	10,000	See footnote 6.

[Footnotes omitted.]

Discussion:

The values in 10 C.F.R. 835, appendix D, are used as criteria for many radiation protection purposes[1], including:

- Limiting exposures;
- Identifying and posting contamination and high contamination areas;
- Controlling material and equipment;
- Controlling areas; and
- Specifying protective clothing.

Examination of 10 C.F.R. 835, appendix D, shows that most radionuclides encountered at DOE sites are either specifically listed in the appendix (e.g., U-235 and Sr-90) or are listed by being part of a family of nuclides (i.e., transuranics and beta-gamma emitters). Although the most commonly encountered alpha-emitting radionuclides at DOE sites are listed in the appendix, some are not listed.

In the appendices to10 C.F.R. 835, DOE typically includes default values for radionuclides not listed. For example:

Excerpt from second paragraph of appendix A to part 835--DERIVED AIR CONCENTRATIONS (DAC) FOR CONTROLLING RADIATION EXPOSURE TO WORKERS AT DOE FACILITIES:

"For any single radionuclide not listed in appendix A with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours, the DAC value shall be 4 E−11 μCi/mL (1 Bq/m^3). For any single radionuclide not listed in appendix A that decays by alpha emission or spontaneous fission the DAC value shall be 2 E−13 μCi/mL (8 E−03 Bq/m^3)."

Excerpt from paragraph c. of appendix C to part 835--DERIVED AIR CONCENTRATION (DAC) FOR WORKERS FROM EXTERNAL EXPOSURE DURING IMMERSION IN A CLOUD OF AIRBORNE RADIOACTIVE MATERIAL

"For unknown radionuclides, the most restrictive DAC (lowest value) for those isotopes not known to be absent shall be used."

[1] 10 C.F.R. 835, appendix D, values are not intended for clearance of property for public use. Release from DOE control is addressed by requirements in DOE Order (O) 458.1. To the extent that 10 C.F.R. 835, appendix D, values differ from preapproved authorized limits or dose-based authorized limits under DOE O 458.1, the DOE O 458.1 values and requirements apply for clearance for either restricted or unrestricted release to the public.

Excerpt from second and third paragraphs of appendix E to part 835--VALUES FOR ESTABLISHING SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND RADIOACTIVE MATERIAL POSTING AND LABELING REQUIREMENTS:

"Any alpha-emitting radionuclide not listed in appendix E and mixtures of alpha emitters of unknown composition have a value of 10 μCi.

With the exception that any type of [special tritium compound] has a value of 10 Ci, any radionuclide other than alpha-emitting radionuclides not listed in appendix E and mixtures of beta emitters of unknown composition have a value of 100 μCi."

As illustrated by the above, the appendices are intended to include appropriate radiological control values for all radionuclides. Since 10 C.F.R. 835, appendix D, does not specify values for all alpha-emitting radionuclides, it would be beneficial for DOE to provide an acceptable method to assign surface contamination values for radioisotopes not listed, or otherwise included, in 10 C.F.R. 835.

The American National Standards Institute (ANSI) provides a methodology for addressing this issue in ANSI N13.12 (1999), *Surface and Volume Radioactivity Standards for Clearance*. To determine the proper group for radionuclides not listed in the standard, a comparison of the effective dose factors by exposure pathway is made and a determination of the proper group made based on similarity of the factors. However, there is no guidance provided on how to compare the effective dose factors in making a determination of the proper group in which to place the unlisted radionuclide.

Acceptable Method to Develop Values to use for Radionuclides not Listed in 10 C.F.R. 835, appendix D.

In 2007, DOE adopted use of the radiation dose assessment methodology from International Commission on Radiological Protection Publication 60 (ICRP 60), *1990 Recommendations of the International Commission on Radiological Protection*, in establishing much of the 10 C.F.R. 835 requirements. This includes use of tissue weighting factors, radiation weighting factors, dose terminology and units, airborne radioactivity concentration controls; i.e., derived air concentration values in 10 C.F.R. 835, appendix A, to10 C.F.R. 835 and sealed radioactive source controls; i.e., 10 C.F.R. 835, appendix E, to 10 C.F.R. 835. This also includes use of the committed effective dose coefficients found in ICRP Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers,* and the ICRP Database of Dose Coefficients: *Workers and Members of the Public* (ICRP 68). For consistency, an acceptable approach for developing appropriate values to use for radionuclides not listed in 10 C.F.R. 835, appendix D, should be based on ICRP 60 and 68 methodologies. This would include use of the committed effective dose coefficients found in ICRP Publication 68 based on a 5-micron Activity Median Aerodynamic Diameter (AMAD) particle.

An evaluation for both inhalation and ingestion of radioactive material should also be included in developing the values. An acceptable method for such evaluation follows.

Committed Effective Dose Coefficients (Sv/Bq) for Radionuclides in Appendix D to 10 C.F.R. Inhalation (in order from highest appendix D values to lowest)

Nuclide	Appendix D Values dpm/100 cm^2 Removable/Total	Committed Effective Dose Coefficients (Sv/Bq) Inhalation	Committed Effective Dose Coefficients (Sv/Bq) Ingestion
Group1	*1000/5000*		
U-235		6.1E-06	4.6E-08
U-238		5.7E-06	4.4E-08
Group 2	*200/1000*		
Th-232		2.9E-05	2.2E-07
U-232		2.6E-05	3.3E-07
Ra-223		5.7E-06	1.0E-07
Ra-224		2.4E-06	6.5E-08
Group 3	*20/500*		
Pu-239		3.2E-05	2.3E-07
Pu-238		3.0E-05	2.5E-07
Am-241		2.7E-05	2.0E-07
Pa-231		8.9E-05	7.1E-07
Th-230		2.8E-05	2.1E-07
Th-228		2.5E-05	7.2E-08
Ra-226		2.2E-06	2.8E-07

Inhalation

The preceding table shows the ICRP 68 5-micron inhalation and ingestion committed effective dose coefficients (for adult workers) for selected alpha emitters in 10 C.F.R. 835, appendix D.

Note: Not all of the transuranic alpha emitters from 10 C.F.R. 835, appendix D, are included in group 3 of the table. The table includes representative radionuclides of most interest to DOE.

As can be seen from the table, there is overlap between the values in the table. For example:

- The values in group 1 range from 5.7E-06 to 6.1E-06.
- The values in group 2 range from 2.4E-06 to 2.9E-05.
- The values in group 3 range from 2.2E-06 to 8.9E-05.

One acceptable approach for assessing appropriate values to use for any radionuclide not listed in 10 C.F.R. 835, appendix D, would be to use, as a default, group 3 values; i.e., 20 and 500 dpm/100 cm^2, removable and total, respectively.

Another acceptable approach would be to use the committed effective dose coefficients found in ICRP 68 and assign them to groups 1, 2, or 3 as described in the following bullets:

- The majority of group 3 dose coefficients are greater than 1 E-5. Applying group 3 values for radionuclides with dose coefficients at or greater than 1 E-5 would establish an acceptable rational grouping for those radionuclides.
- For group 2, applying group 2 values for radionuclides with dose coefficients at, or greater than, 2 E-6 and less than 1 E-5 would establish a rational grouping for those radionuclides.
- The remaining radionuclides would be in group 1.

This is based on the assumptions that:

- Committed effective dose coefficients are based on adult workers inhaling 5-micron AMAD particles.
- The absorption type that corresponds to the committed effective dose coefficient having the highest value is selected.

Ingestion

The preceding table also shows the ingestion committed effective dose coefficients for selected alpha emitters in 10 C.F.R. 835, appendix D.

As with the inhalation dose coefficient table, there is overlap between the values. For example:

- The values in group 1 range from 4.4E-08 to 4.6E-08.
- The values in group 2 range from 6.5E-08 to 3.3E-07.
- The values in group 3 range from 7.2E-08 to 7.1E-07.

Again, one acceptable approach for assessing values to use for any radionuclide not listed in 10 C.F.R. 835, appendix D, would be to use, as a default, group 3 values; i.e., 20 and 500 dpm/100 cm^2, removable and total, respectively.

Another acceptable approach would be:

- The majority of group 3 dose coefficients are greater than 2 E-7. Applying group 3 values for radionuclides with ingestion dose coefficients at, or greater than, 2 E-7 would establish an acceptable rational grouping for those radionuclides.
- For group 2, applying group 2 values for radionuclides with dose coefficients at, or greater than, 5 E-8 and less than 2 E-7 would establish a rational grouping for those radionuclides.
- The remaining radionuclides would be in group 1.

This is based on the assumptions that:

- Committed effective dose coefficients for adult workers are selected.
- The fractional absorption in the gastrointestinal tract (f_1) value that corresponds to the committed effective dose coefficient having the highest value is selected.

Conclusion

The method for addressing alpha-emitting radionuclides not already included in 10 C.F.R. 835, appendix D, should be based on dose coefficients from ICRP 68. The below table shows an acceptable approach to using the ICRP 68 dose coefficients to establish values to use for radionuclides not listed in 10 C.F.R. 835, appendix D. The more restrictive of either the inhalation or the ingestion dose coefficients should be used in establishing the values; e.g., whichever dose coefficients result in the radionuclide being grouped with radionuclides having lower appendix D values.

Committed Effective Dose Coefficients (Sv/Bq) Inhalation	Committed Effective Dose Coefficients (Sv/Bq) Ingestion	10 C.F.R. Part 835, Appendix D, Values dpm/100 cm^2 Removable/Total
less than 2 E-6	less than 5 E-8	1000/5000
2 E-6 up to 1 E-5	5 E-8 up to 2 E-7	200/1000
1 E-5 or greater	2 E-7 or greater	20/500

Example

Polonium-210 (Po-210) as a distinct radionuclide; i.e., not as a component in the Uranium-238 decay series, is an example of an alpha emitter not listed in 10 C.F.R. 835, appendix D. The following examples illustrate an evaluation of the grouping of this isotope.

From ICRP 68, Po-210 has an inhalation committed effective dose coefficient of 2.2E-6 Sv/Bq for absorption type M material (which is the more restrictive value) and an ingestion committed effective dose coefficient of 2.4E-7 Sv/Bq. The inhalation committed effective dose coefficient would fall within group 2 (200/1000 dpm/100 cm^2), and the ingestion committed effective dose coefficient would fall within group 3 (20/500 dpm/100 cm^2). Accordingly, it would be acceptable to use group 3 values for Po-210 as a distinct radionuclide.

Summary

- 10 C.F.R. 835, appendix D, does not include values for all alpha-emitting radionuclides.
- One acceptable approach for establishing appropriate values for radionuclides not listed in 10 C.F.R. 835, appendix D, would be to use the most protective; i.e., 20 and 500 dpm/100 cm^2, removable and total surface contamination values, respectively.

- Alternately, this position paper provides guidance on an acceptable approach using the ICRP 68 dose coefficients to establish values to use for radionuclides not listed in 10 C.F.R. 835, appendix D.
- This method is not acceptable for clearance of property for release to the public – see DOE O 458.1.