Department of Energy

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MEMORANDUM FOR DISTRIBUTION

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SUBJECT: Technical Position Regarding Appropriate Accountable Sealed Radioactive Source Values for Strontium-90

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

This technical position addresses an acceptable approach for evaluating Strontium-90 source activities for determining compliance with the Department's accountable sealed radioactive source requirements.

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

Please ensure further distribution of the attached document to the applicable radiation protection organizations at your facilities. The DOE Radiological Control Coordinating Committee has reviewed this technical position.

Attachment

Department of Energy
Office of Worker Safety and Health Policy
Radiological Control Technical Position
RCTP 2010-02

Appropriate Accountable, Sealed Radioactive Source Values for Strontium-90

Issue:

Accountable, sealed radioactive source controls are addressed in title 10, Code of Federal Regulations, part 835, *Occupational Radiation Protection* (10 C.F.R. 835). The 10 C.F.R. 835, Appendix E, *Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements*, lists values for certain sealed radioactive sources, above which specified 10 C.F.R. 835 requirements apply. Strontium-90, with a 29-year half- life, decays to Yttrium-90 which, with a 64-hour half-life, relatively quickly reaches radioactive decay equilibrium with Strontium-90. The issue is whether the value in appendix E includes both Strontium-90 and Yttrium-90 activity or should the Strontium-90 be accounted for separately.

Discussion:

Applicable Provisions

10 C.F.R. 835

§ 835.2 Definitions

(a) As used in this part:

> Accountable, sealed radioactive source means a sealed radioactive source having a half-life equal to, or greater than, 30 days and an isotopic activity equal to, or greater than, the corresponding value provided in appendix E of this part.
>
> Sealed radioactive source means a radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators.

Subpart M—Sealed Radioactive Source Control

§ 835.1201 Sealed radioactive source control.

Sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with operations involving the sources.

§ 835.1202 Accountable, sealed radioactive sources.

(a) Each accountable, sealed radioactive source shall be inventoried at intervals not to exceed 6 months. This inventory shall:

(1) Establish the physical location of each accountable, sealed radioactive source;
(2) Verify the presence and adequacy of associated postings and labels; and
(3) Establish the adequacy of storage locations, containers, and devices.

(b) Except for sealed radioactive sources consisting solely of gaseous radioactive material or tritium, each accountable, sealed radioactive source shall be subject to a source leak test upon receipt, when damage is suspected, and at intervals not to exceed 6 months. Source leak tests shall be capable of detecting radioactive material leakage equal to or exceeding 0.005 μCi.

(c) Notwithstanding the requirements of paragraph (b) of this section, an accountable, sealed radioactive source is not subject to periodic source leak testing if that source has been removed from service. Such sources shall be stored in a controlled location, subject to periodic inventory as required by paragraph (a) of this section, and subject to source leak testing prior to being returned to service.

(d) Notwithstanding the requirements of paragraphs (a) and (b) of this section, an accountable, sealed radioactive source is not subject to periodic inventory and source leak testing if that source is located in an area that is unsafe for human entry, or otherwise inaccessible.

(e) An accountable, sealed radioactive source found to be leaking radioactive material shall be controlled in a manner that minimizes the spread of radioactive contamination.

Appendix E to Part 835--VALUES FOR ESTABLISHING SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND RADIOACTIVE MATERIAL POSTING AND LABELING REQUIREMENTS

The data presented in appendix E are to be used for identifying accountable, sealed radioactive sources and radioactive material areas as those terms are defined at § 835.2(a), establishing the need for radioactive material area posting in accordance with § 835.603(g), and establishing the need for radioactive material labeling in accordance with § 835.605.

Nuclide	Activity (μCi)
...	...
Sr-90	3.5E+04
...	...

11.5.0 Contamination Control Values

Footnote 5 to appendix D of 10 C.F.R. 835 discusses application of the listed surface contamination values for Sr-90. The Department of Energy (DOE) recognizes that Sr-90 is typically present in equilibrium with its daughter, Y-90. Therefore, the values given for Sr-90 in appendix D should be applied to the total activity from the Sr-90/Y-90 contamination.

Calculation of Appendix E Values

The preamble to the June 8, 2007, amendment to 10 C.F.R. 835, Federal Register Final Rule Vol. 72, No. 110, discusses DOE's use of International Commission on Radiological Protection (ICRP) Publication 60, *1990 Recommendations of the International Commission on Radiological Protection,* in revising 10 C.F.R. 835, appendix E, values:

> R. Text and Footnote in appendix E in 10 C.F.R. 835
>
> "As discussed earlier, DOE proposed to adopt the system of dosimetry for intake of radioactive materials set forth in more recent ICRP publications. DOE proposed to revise the appendix E to part 835 values using the ICRP Publication 60 methodology and the same exposure scenarios discussed in the 1998 amendment to 10 C.F.R. 835. In summary, the values were based on the more limiting of the quantity of radioactive material which results in either an external or internal whole body dose, from either inhalation or ingestion, of 100 millirems. The external exposure scenario assumed a photon exposure for 12 hours a day for 365 days with the source distance being at 1 meter. The internal exposure scenario assumed an instantaneous intake of 0.001% of the material by an individual. Consistent with the other proposed changes, the values in appendix E to part 835 were recalculated to reflect the previously mentioned ICRP publications."

This approach is consistent with the approach described in the November 4, 1998, Technical Basis for the 1998 Amendment for 10 C.F.R. 835, *Sealed Radioactive Source Accountability Values,* with the exception that the 1998 amendment used the Federal Guidance Report Number 11 dose coefficients.

The internal exposure is more limiting for Strontium-90. The appendix E value was accordingly determined as follows:

$$\mu Ci = \frac{0.001 Sv}{DCF\ (IF)\ (CF)} \quad \text{where}$$

0.001Sv is the annual dose limit (Sv)
DCF is the dose conversion factor (Sv/Bq) from ICRP 60 methodology
IF is the intake fraction (10E-5, dimensionless)

µCi is the appendix E activity, and
CF is conversion factor of 3.7E4 Bq/ µCi.

For example, for Sr-90

$$\mu Ci = \frac{0.001 Sv}{(7.7E\text{-}08\ Sv/Bq)\ (1E\text{-}05)\ (3.7E4\ Bq/\mu Ci)} = 3.5E4\ \mu Ci.$$

Discussion

Strontium-90 decays with a 29-year half-life to Yttrium-90. Yttrium-90 decays with a 64-hour half- life. Accordingly, within a month of manufacturing a Strontium-90 sealed source with a given quantity of radioactivity, there will be an equivalent amount of Yttrium-90 present in equilibrium with the Strontium-90. If a source is manufactured with 3.0E4 µCi of Strontium-90, which is below the 10 C.F.R. 835, appendix E, value of 3.5E4 µCi, and later is determined to have 6.0E4 µCi of total activity (Strontium-90 and Yttrium-90) does the source exceed the 10 C.F.R. 835, appendix E, value?

Depending on the sealed source manufacturer, the source activity may indicate just the original Strontium-90 activity, or the Strontium-90 and Yttrium-90 total activity, or a two pi emission rate, which would include a backscatter correction factor.

As shown above, in developing DOE G 441.1-1C, DOE did recognize that Strontium-90 is typically present in equilibrium with its daughter, Yttrium-90 when applying the limits in 10 C.F.R. 835, Appendix D, *Surface Contamination Values*. The Guide offers that the values given for Strontium-90 in 10 C.F.R. 835, appendix D, should be applied to the total activity from the Strontium-90/Yttrium-90 contamination. The Guide does not have comparable discussion referring to compliance with 10 C.F.R. 835, appendix E, values.

The Office of Worker Safety and Health Policy reviewed the technical basis for derivation of the 10 C.F.R. 835, appendix E, values. The dose conversion factor used for Strontium-90 (7.7E-8 Sv/Bq) does not include the dose from any Yttrium-90 present when the inhalation exposure took place. The dose conversion factor does include the dose from subsequent Yttrium-90 produced from decay of the Strontium-90 while in the body. The dose conversion factor for Yttrium-90 is significantly (i.e., a factor of 45) smaller than that of Strontium-90. Consequently, the effect of accounting for any Yttrium-90 present when the inhalation exposure took place would result in a change in the 10 C.F.R. 835, appendix E, value for Strontium-90 from 3.5E4 µCi to 3.4E4 µCi. This change is considered insignificant given the conservative exposure scenario utilized. Accordingly, it is acceptable to only consider the Strontium-90 activity in sealed radioactive sources when evaluating compliance with 10 C.F.R. 835, appendix E, values.

Typically, this would be done by counting a source in a fixed geometry and evaluating the net count with the Strontium-90 activity listed on the source certificate (adjusted for decay if

necessary) to determine the counting efficiency. It is not necessary to apply a factor to the source activity to account for the equilibrium of the Yttrium-90.

10 C.F.R. 835, appendix E, values are derived based on whole body exposure scenarios. DOE recognizes that Strontium-90/Yttrium-90 sources below the 10 C.F.R. 835, appendix E, criteria can pose exposure hazards to the extremities and to the skin. The ALARA provisions of 10 C.F.R. 835.1003 are applicable for using these sources.

Technical Position:

It is acceptable to only consider the Strontium-90 activity in sealed radioactive sources when evaluating compliance with 10 C.F.R. 835, appendix E, values.

References:

10 C.F.R. 835, *Occupational Radiation Protection*, U.S. Department of Energy, June 8, 2007

DOE G 441.1-1C, *Radiation Protection Programs Guide for Use with Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection*, 05-19-08

Federal Guidance Report Number 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, U. S. Environmental Protection Agency, September 1988.

ICRP Publication 60, 1990 Recommendations of the International Commission on Radiological Protection, International Commission on Radiological Protection, 1990

Technical Basis for the 1998 Amendment for 10 C.F.R. 835, Sealed Radioactive Source Accountability Values, November 4, 1998