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REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 4.6

MEASUREMENTS OF RADIONUCLIDES IN THE ENVIRONMENT STRONTIUM-89 AND STRONTIUM-90 ANALYSES

A. INTRODUCTION

General Design Criterion 64, "Monitoring Radioactivity Releases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that means be provided for monitoring the plant environs of light-water-cooled nuclear power plants for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.

Paragraph 50.36a (a)(2) of 10 CFR Part 50 provides that technical specifications for each operating license for a nuclear power reactor will include a requirement that the licensee submit a report to the Commission within 60 days after January 1 and July 1 of each year which, in addition to specifying the quantity of each of the principal radionuclides released to unrestricted areas in liquid and airborne effluents during the previous six months of operation, provides sufficient information to estimate annual radiation doses to the public resulting from effluent releases.

Paragraph 20.106(e) of 10 CFR Part 20, "Standards for Protection Against Radiation," provides that the Commission may limit the quantities of radioactive materials released in air or water by licensees during a specified period of time if it appears that the daily intake of radioactive materials from air, water, or food by a suitable sample of an exposed population group, averaged over a time period not exceeding one year, would otherwise exceed specified quantities. Section 20.201, "Surveys," of 10 CFR Part 20 requires that a licensee conduct surveys of levels of radiation or concentrations of radioactive material as necessary for compliance with AEC regulations in 10 CFR Part 20. Paragraph 20.1(c) of 10 CFR Part 20 states that every reasonable effort should be made by AEC licensees to

maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in Part 20 as practicable, i.e., as low as is practicably achievable, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest.

This guide describes radioanalytical procedures acceptable to the Regulatory staff for implementing these requirements with respect to the determination of Sr-89 and Sr-90 in the environment.

B. DISCUSSION

Radioisotopes of strontium, principally Sr-90 and Sr-89, are fission products of concern because they are chemically similar to calcium and deposit in bone. The literature lists a large number of procedures for conducting Sr-90 and Sr-89 analyses, and a wide range of analytical sensitivities may be obtained depending on the procedure used; no single procedure, however, is applicable to all situations. This guide is intended to provide a selection of radioanalytical procedures which have the required performance standards of sensitivity and accuracy for the determination of Sr-89 and Sr-90 in various media.

The levels of Sr-90 and Sr-89 in environmental media are normally quite low, Sr-89 being measurable only for relatively short periods after its release to the environment. Large sample sizes and low-background beta counters are usually required in analyzing for Sr-90 and Sr-89. Although procedures have been developed for analyzing a medium such as milk without prior ashing or concentration of the sample, most methods for analyzing biological and environmental samples require some degree of sample preparation prior to analysis. This

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usually implies wet or dry ashing of the sample. If Sr-90 alone is to be determined, the use of Sr-85 tracer for radiochemical yield determination is recommended, but if both Sr-90 and Sr-89 analyses are required, Sr-85 tracer should not be used because it interferes with the Sr-89 measurement. It is necessary in the latter case to do the yield determination by a gravimetric technique.

One of the most important steps in the analysis is the early exchange of strontium carrier and/or tracer with the Sr-89 and Sr-90 in the sample. Equilibration can be considered to have been attained when the radiostrontium in the sample has been completely solubilized in the presence of strontium carrier and/or tracer. Once this equilibrium has been established, any subsequent loss of radiostrontium can be accurately assessed through yield determination of carrier or tracer. It is important, therefore, that all steps leading to equilibration be performed with extra care to avoid losses in these steps.

If a significant amount (several milligrams) of stable strontium is present in the sample, as is the case for sea water, some shellfish, and certain soils, the gravimetric yield determination will be in error if a correction is not made for the additional strontium. Most other bioenvironmental media of concern have small concentrations of stable strontium which are not expected to cause a problem and in general can be ignored.

Calcium, however, is present in significant amounts in most bioenvironmental media, and its separation from small amounts of added strontium carrier can be tedious; if this separation is not performed properly, however, the gravimetric yield will be biased in proportion to the amount of calcium remaining in the strontium fraction.

Since Sr-90 and Sr-89 concentrations in normal bioenvironmental media are expected to be low, appropriate low-level techniques should be used in making these measurements. Some of the better high precision radiochemical procedures for low-level Sr-90 assay depend on counting the Y-90 daughter activity, rather than Sr-90 itself or the combined Sr-90 - Y-90 activities. There are several advantages of the former technique. The 64-hour half-life of Y-90 makes it convenient for following radioactive decay as a check on isotopic purity, and the single-component activity minimizes ambiguities in its measurement. Strontium-89 determinations are made by difference, i.e., by taking the difference between total strontium counts and the counts due to Sr-90 alone.

The Sr-89 and Sr-90 radioanalytical procedures described in HASL 300¹ and SWRHL-11² have been in routine use for many years at their respective laboratories and have been shown to provide consistently good results in terms of both sensitivity and accuracy.

C. REGULATORY POSITION

The analytical procedures for Sr-89 and Sr-90 described in HASL 300¹ and in SWRHL-11² are acceptable to the Regulatory staff as bases for meeting the analytical performance standards needed to assess accurately the Sr-89 and Sr-90 levels in biological and environmental media.

¹ "HASL Procedures Manual." Copies may be obtained from Health and Safety Laboratory, U.S. Atomic Energy Commission, 376 Hudson St., New York, N.Y. 10014.

² "Southwestern Radiological Health Laboratory—Handbook of Radiochemical Analytical Methods," March 1973. Copies may be obtained from EPA National Environmental Research Center, Las Vegas, P.O. Box 15027, Las Vegas, Nevada 89114.