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PROGRAMS FOR MONITORING RADIOACTIVITY IN THE ENVIRONS OF NUCLEAR POWER PLANTS

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 licensees provide means for monitoring the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.

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 during a specified period of time to ensure 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 not exceed specified quantities. Section 20.201 of 10 CFR Part 20 further requires that a licensee conduct surveys of levels of radiation or concentrations of radioactive material as necessary to show compliance with Commission regulations.

This guide describes a basis acceptable to the NRC staff for the design of programs for monitoring levels of radiation and radioactivity in the plant environs.

B. DISCUSSION

Present requirements to keep levels of radioactive material in effluents as low as practicable (as specified in 10 CFR §50.34a) should ensure that radiation doses to the public resulting from effluent releases will continue to remain minimal. The principles presented in this guide are considered an acceptable basis for establishing preoperational and operational monitoring programs to provide information needed to determine whether exposures in the environment are within established limits and to ensure that long-term buildup of specific radionuclides in the environment will not become significant.

A preoperational program should be conducted in the environs of each proposed nuclear power plant site to (1) measure background levels and their variations in environmental media in the area surrounding the plant, (2) evaluate procedures, equipment, and techniques, and (3) provide experience to personnel.

Years of experience at various Atomic Energy Commission facilities have demonstrated that specific radionuclides behave in known ways under given environmental conditions. Therefore, analyses of "indicator media" can be used to define radionuclide levels in the environment. The "indicator medium" (or organism) concept of environmental surveillance involves the sampling of organisms and media which are sensitive and reliable measures of the quantities of individual radionuclides cycling through pathways. For example, where the plant-cow-milk-man food chain is determined to be an important pathway, it may not be necessary to extensively sample and measure grazing plants and fodder to keep track of iodine-131 cycling in the food chain, since sampling and measuring the milk produced by dairy cows in surrounding areas may be adequate.

After the plant is in operation, a program for measuring radiation levels and radioactivity in the plant environs must be maintained on a continuing basis to assist in verifying anticipated radioactivity concentrations and related public exposures. The initial preoperational and operational monitoring programs should be designed in accordance with the following criteria:

1. They should be based on the analysis of important pathways for the anticipated types and quantities of radionuclides released from the plant into the surrounding environment;

2. They should consider the possibility of buildup of long-lived radionuclides in the environment and identify physical and biological sites of accumulation that may contribute to human exposures;

3. They should consider the potential radiation exposure to important plants and animals;[1]

4. They should be designed to establish correlations between levels of radiation and radioactivity in the environment and radioactive releases from plant operation. (A variety of techniques, including measurements at control locations, preoperational surveys, and comparisons of operating versus shutdown levels of radioactivity in the environs may all be useful for this purpose.) Information of this nature will be of considerable help in modifying the initial environmental measurements program.

Data obtained from this program should be used by the licensee to show that environmental levels are consistent with those determined from the effluent radiation monitoring and sampling program. The latter program is used together with dispersion estimates to ensure that plant releases to the environment and radiation doses to the public are maintained within the numerical design objectives determined to be as low as practicable.

The Commission's staff has evaluated the types of information needed to provide supporting evidence for assessing the performance of the plant with respect to keeping population exposures as low as practicable and to verify predictions of concentrations of specific radionuclides in the environment based on effluent measurements at the plant. Based on this evaluation and on a review and assessment of existing licensees' monitoring and reporting programs, the staff has developed the regulatory position set forth below.

C. REGULATORY POSITION

The program for monitoring radioactivity in the environs of nuclear power plants should provide suitable information from which levels of radiation and radioactivity in the environs of each plant can be estimated. This information also may provide supporting evidence in evaluating the performance of systems and equipment installed to control releases of radioactive material to the environment.

The basic principles set forth in this guide constitute an acceptable basis for use in establishing an environmental monitoring program. These same principles will also be used as bases in developing the licensee's corresponding technical specifications. Guidance on the format, content, and preparation of Appendix B environmental technical specifications for operating licenses is presented in Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants."

1. Preoperational Program

A preoperational monitoring program should be initiated two years prior to operation to provide a sufficient data base for comparison with operational data and to provide experience that will improve the efficiency of the operational program. It may not be necessary for all media in the preoperational program to be sampled for the entire two-year period; i.e., for those media sampled frequently, a six-month or one-year period is usually sufficient. However, if the sampling period is not representative, because of abnormal conditions, the period may require extension until representative samples are obtained.

2. Operational Program

Generally, the operational program should be an extension of the preoperational program to ensure that data from the two programs are compatible and that a smooth transition between programs is achieved.

a. Sample Media

Where practical, a suitable indicator medium or organism in each important pathway should be sampled and analyzed for the plant-contributed radionuclides released to the environment. When sampling organisms, an abundant, readily available species with known habits should be selected.

Careful attention should be given to sampling programs to avoid inducing serious stress on populations of important species. Sampling of large numbers of organisms could result in a temporary decline or permanent loss of desirable populations. In such cases, other indigenous but abundant species should be substituted as indicator organisms to provide an estimate of the radionuclides available to man through natural food chains. In some instances, properly selected and sampled vegetation may also provide a good measure of the radionuclides in a pathway.

[1] A species, whether animal or plant, is "important" if a specific causal link can be identified or hypothesized between the nuclear power plant and the species and if one or more of the following criteria applies: (1) the species is commercially or recreationally valuable, (2) the species is threatened or endangered, (3) the species affects the well-being of some important species within criteria (1) or (2), or (4) the species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment. A threatened or endangered species is any species officially designated as such by the Secretary of the Interior or the Secretary of Commerce.

Where use of a single indicator medium is impractical, samples of several media from each pathway should be collected and analyzed. The Commission recognizes that some pathways do not have more than one environmental medium; e.g., external radiation exposures from clouds of gamma-ray-emitting radionuclides involve only one pathway – the atmosphere. The actual number of media to be sampled in each pathway should be determined on a case-by-case basis for each site. In some cases, field measurements may be preferable to collecting samples for laboratory analysis.

The program should include sampling of environmental media to estimate radionuclide concentrations in important biota (see B.3 above). Radiation exposures (external) and internal doses from short-lived nuclides may be estimated by calculations (using effluent measurements and appropriate dispersion and bioaccumulation factors) rather than by routine collection of samples of environmental media. In some cases, field measurements at certain locations to establish concentrations of specific radionuclides may be necessary, initially, to confirm predictions.

b. Sampling Frequency

When a radionuclide has a short half-life (minutes to days), it may be necessary to evaluate concentrations or radiation exposure by making measurements in the field (e.g., by use of thermoluminescent dosimeters, pressurized ion chambers, or in situ gamma spectrometers).

When a radionuclide with an intermediate half-life (weeks to months) is released continuously or frequently, sampling and analysis of environmental media in the associated pathway should generally be carried out at intervals no greater than two or three half-lives of the nuclide. For long-half-life radionuclides (years), measurements should generally be made at least once per year. Where seasonal or other temporal variations may be evident, the frequency of sampling should be planned to allow resolution of any important effects.

In some cases, sampling on a continuous basis may be necessary (e.g., air sampling and continuous measurement of cumulative external radiation exposure). Composites of some selected sample types such as air filters may be appropriate for measurement of long-lived radionuclides.

c. Program Scope

During the initial three years of commercial power operation (or other period corresponding to maximum fuel burnup in the initial core cycle), the measurement program should be relatively comprehensive in an attempt to verify any projected correlations between radioactive effluents and levels in environmental media. The extent of measurement of environmental media should be based on the type, quantity, and concentration of radionuclides expected from the plant as well as the results obtained from previous measurements.

If, after this period, the licensee is able to demonstrate from levels in environmental media or calculations (using measured effluents and appropriate dispersion and bioaccumulation factors) that the doses and concentrations associated with a particular pathway are sufficiently small, the number of media sampled in the pathway and the frequency of sampling may be reduced. An adequate program with emphasis on indicator organisms and selected media should still be continued in order to confirm that the levels of radioactivity in environmental media remain small.

Results from all individual measurements should be retained by the licensee along with information on sampling location and date, sample size (e.g., wet/dry weight), sampling and analytical procedures, units of data presentation, and precision and accuracy associated with individual measurements. Explanations of anomalous measurements should be provided.

d. Analyses

Samples should be analyzed for plant-contributed radionuclides released to the environment. Gross radioactivity measurements alone are generally not adequate for radiological monitoring. However, gross radioactivity measurements may be useful to indicate the concentration of a specific radionuclide when such measurements are shown to be truly indicative of the actual quantity or concentration of that radionuclide.

e. Quality Control

Control checks and tests should be applied to the analytical process by the use of blind duplicate analyses of selected samples and by cross-check analysis of selected samples with an independent laboratory. Quality controls should also be applied to the entire sample-collection procedure to ensure that representative samples are obtained and that samples are not changed, cross-contaminated, or otherwise affected prior to their analysis because of handling or because of their storage environment.

3. Detection Capabilities

The detection capabilities associated with measuring and analyzing radioactivity levels should be established primarily on the basis of potential human dose. These detection capabilities will vary depending on the instrumentation and analytical techniques used. Because of the need for a preoperational monitoring program,

detection capabilities for a particular program should be determined during an early stage of licensing. Every reasonable effort should be made to achieve detection capabilities that will detect radiation levels or radioactivity concentrations in pathways that could result in radiation doses corresponding to a few percent of the Federal Radiation Council's radiation protection guides (i.e., a few percent of 170 mrem/yr for whole body dose to a suitable sample of the exposed population).[2] Similarly, the detection capability of environmental measurements should be the most sensitive that is practicably achievable for measuring plant-contributed radionuclides in the environment.

[2] Federal Radiation Council Report No. 1, *Background Material for the Development of Radiation Protection Standards*, May 13, 1960.

D. IMPLEMENTATION

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

This guide reflects current regulatory practice. Therefore, except in those cases in which the applicant proposes an alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of submittals for operating license or construction permit applications docketed after the date of issue of this guide.

If an applicant wishes to use this regulatory guide in developing submittals for applications docketed on or prior to the date of issue of this guide, the pertinent portions of the application will be evaluated on the basis of this guide.