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SAFETY GUIDE 21 - MEASURING AND REPORTING OF EFFLUENTS FROM NUCLEAR POWER PLANTS

A. Introduction

10 CFR Part 50 §50.36a(a)(2) requires that each licensee's technical specifications 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 specifies the quantity of each of the principal radionuclides released to unrestricted areas in liquid and airborne effluents during the last six months of operation. The report must include other information as may be required to estimate annual potential radiation doses to the public resulting from effluent releases.

This safety guide describes effluent measuring and reporting programs which are acceptable to the regulatory staff. In some cases, the programs will need to be supplemented because of individual plant design features or other factors. The need for supplemental or modified programs will be determined on an individual case basis.

B. Discussion

To obtain quantitative information on the identity and quantity of

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radionuclides released to the environment and to provide a uniform basis for evaluating potential environmental consequences of these releases, carefully planned programs for the measurement of radioactive effluents from nuclear power plants and for periodically summarizing and reporting the results of these programs are needed.

The specific composition of radioactive material in nuclear power plant effluents may vary depending on operating conditions, changes in hold-up time, treatment process performance, power level or other operating factors. Because radiation dose depends on the radionuclides released, specific radionuclides in effluents should be identified and measured.

As nuclear power stations increase in number and size, it is essential to develop uniform methods of measuring, recording, and reporting data on effluent releases. This will permit the comparison of data from different sources and the preparation of meaningful summary compilations of data, as well as supplying the Commission with the necessary information to estimate maximum potential annual radiation doses to the public resulting from effluents from nuclear power plants.

The measuring method suggested generally includes gross radioactivity measurements of each sample and the pooling or compositing of samples for subsequent isotopic analyses.

C. Regulatory Position

All normal and potential paths for release of radioactive material during normal reactor operation, including anticipated operational occurrences, should be monitored. The sensitivity and calibration of each monitor should be determined periodically. Measurement and reporting of releases of radioactive material should be conducted in accordance with the following provisions. The frequencies of sampling and analysis given are considered to be minimum. In the event effluent levels approach technical specification limits the frequencies of sampling and analysis should be increased.

1. Noble Gas and Tritium Releases to the Atmosphere

a. Measurements should be made continuously and station records retained[1/] of the quantity of radioactive gases released. The isotopic composition of the gases released should be determined as in Secion 1.b. below. For the period of release, the station records should also indicate the existing meteorological conditions on an hourly basis (i.e., wind speed, wind direction, and atmospheric stability, which are representative of conditions at principal points of release). For some nuclear power plants releasing continuously at low effluent levels, hourly meteorological measurements may only be necessary until meaningful average meteorological parameters are established. Additional measurements should be made during the plant lifetime to confirm these meteorological parameters.

1/ All record retention should be in accordance with the requirements of the facility technical specifications. Records of all isotopic analysis performed should be retained.

b. For reactors which release gases continuously, within one month after the date of initial criticality of the reactor, at least monthly thereafter, and following each refueling, process change or other occurrence which could alter the mixture of radionuclides, an isotopic analysis should be made of a sample of the gaseous activity being released.[2/] This analysis should provide the identity and quantity of the principal radionuclides, except tritium, released each month. The sensitivity[3/] of the analysis should be such

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2/ For those processes or other conditions which are changed frequently an isotopic analysis should be done following each change until a pattern has been established which can be used to predict the isotopic composition of the reactor effluent.

3/ The sensitivity limits given for radioactivity analyses in this guide are based on technical feasibility and on the potential significance in the environment of the quantities released. For some nuclides, lower detection limits may be readily achievable and when nuclides are measured below the stated sensitivity limits they should also be reported. For certain mixtures of nuclides of gamma emitters, it may not be possible to measure nuclides in concentrations near their sensitivity limits when other nuclides are present in the sample in much greater concentrations. Under these circumstances, it may be more appropriate to calculate releases of such radionuclides using observed ratios with those nuclides which are readily measurable. In any event, if a sodium iodide detector is used, gamma emitting nuclides should be identified and measured to the extent that no significant peaks are left after spectrum stripping and that the total residual counts after stripping are less than 5% of the total counts in the original spectrum. If a germanium detector is used, all significant peaks should be identified and measured.

that at least 10 μCi/sec of each nuclide released continuously to the atmosphere is measurable. (See Appendix A, Section II, for a list of suggested nuclides.)

c. For reactors which release gases intermittently, a representative sample of each release should be analyzed isotopically. The sensitivity[3/] of the analysis should be such that a concentration of at least 10^{-4} μCi/cc is measurable in waste tanks or containment vessels which are discharged intermittently. (See Appendix A, Section II, for a list of suggested nuclides.)

d. For reactors releasing gases intermittently, tritium in a representative sample of each release should be determined. For reactors releasing gases continuously, the release rate of tritium to the atmosphere should be determined at least quarterly. The sensitivities[3/] of the analyses should be such that at least 10^{-2} μCi/sec released continuously to the atmosphere and a concentration of 10^{-6} μCi/cc in waste tanks or containment vessels which are discharged intermittently to the atmosphere are measurable.

2. Iodine Releases to the Atmosphere

For releases which contain or potentially contain iodines, a sample should be drawn continuously through an iodine sampling device. A determination should be made of the quantity of

radioiodine released. The device should be analyzed at least weekly for iodine-131. An analysis should also be performed of a weekly sample at least quarterly for the radionuclides I-133 and I-135. The sensitivity[3/] of the analysis for radioiodines should be such that at least 10^{-4} μCi/sec released continuously to the atmosphere is measurable and at least a concentration of 10^{-10} μCi/cc is measurable in waste tanks or containment vessels which are discharged to the atmosphere intermittently.

3. Particulate Releases to the Atmosphere

   a. For releases of radioactive material in particulate form, a sample should be drawn continuously through a particulate filter. Measurements should be made on these filters to determine the quantities of nuclides with half-lives greater than 8 days in particulate form that are released to the environment. The sensitivities[3/] of the analyses should be such that at least 10^{-4} μCi/sec of each gamma emitting nuclide (10^{-5} μCi/sec each for gross alpha radioactivity, gross radioactivity (β,γ), Sr-89 and Sr-90) released continuously to the atmosphere is measurable and at least a concentration of 10^{-10} μCi/cc of each gamma emitting nuclide (10^{-11} μCi/cc each for gross alpha radioactivity, gross radioactivity (β,γ), Sr-89 and Sr-90) is measurable in waste tanks or the containment vessel which are discharged to the environment intermittently.

b. The particulate filters should be changed and analyzed at least weekly for gross radioactivity (β,γ)[4/] and an analysis for at least the radionuclides Ba-140, La-140, and I-131 should be made.

c. A monthly composite of the weekly samples should be analyzed for the principal gamma emitting nuclides.

d. Analyses for Sr-89 and Sr-90 should be made on a composite of a month's duration of filters at least quarterly.

e. An analysis for gross alpha radioactivity on a sample of a week's duration should be made at least quarterly.

4. Liquid Releases

a. Measurements should be made on a representative sample of each batch[5/] released and station records retained of the quantity and concentration of radioactive materials and volume of each batch of liquid effluent released and estimates made of the average water flow used to dilute the liquid effluent prior to release from the restricted area.

4/ Gross radioactivity (β,γ) measurements (i.e., gross beta or gross beta in conjunction with gross gamma measurements) should approximate the total activity in the sample. This comment applies to all gross radioactivity (β,γ) measurements suggested in this guide. The details of such approximations should be explained in each report.

5/ For plants also releasing radionuclides continuously (for example, steam generator blowdown and secondary leakage in PWRs), a batch should be considered as that volume of liquid released over a period of not more than one week. Data on quantities of gross radioactivity (β,γ), iodine-131 and tritium should be collected and reported separately.

b. Each batch of liquid effluent released should be analyzed for gross radioactivity (β,γ).[4/] At least one batch per month should be analyzed for dissolved fission and activation gases. The batch(s) should be typical of average releases of radioactivity. The sensitivities[3/] of analyses for gross radioactivity (β,γ) and dissolved gas radioactivity should be such that at least concentrations of 10^{-7} μCi/ml, and 10^{-5} μCi/ml are measurable respectively.

c. A weekly proportional composite sample[6/], including an aliquot of each batch released during a week, should be analyzed for Ba-La-140 and I-131.

d. A monthly proportional composite sample[6/], including an aliquot of each batch released during a month, should be analyzed for the principal gamma emitting fission and activation products. In addition, the sample should be analyzed for tritium, Sr-89, and gross alpha radioactivity. The sensitivities[3/] of analyses of waste tank liquids should be such that there is a capability of measuring concentrations of 10^{-5} μCi/ml of tritium, 10^{-8} μCi/ml each of Sr-89 and Sr-90, 10^{-7} of gross alpha radioactivity and 5×10^{-7} μCi/ml of gamma emitting

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6/ A proportional composite sample is one in which the quantity of liquid added to the composite is proportional to the quantity of liquid in each batch that was released. The composite should represent the average concentration prior to release and by multiplying by the total volume released should represent the quantity of radioactivity released during the compositing period.

radionuclides. (See Appendix A, Section I, for a list of suggested radionuclides for analyses.)

e. A composite proportional sample, including an aliquot of each batch released during a quarter, should be analyzed for Sr-90.

5. Reporting of Effluent Releases

Data should be reported to the Commission in the form given in Appendix A of this Guide.[7/] Except as noted, effluent data should be summarized on a monthly basis, although in some instances more detailed data may be needed. The need for these additional data to be reported to the Commission will be determined on an individual case basis. Where the majority of the activity is released as batches and where there are less than 3 batches per month, each batch should be reported.

a. Gaseous Releases

(1) total radioactivity (in curies) releases of noble and activation gases.

(2) maximum noble gas release rate during any one-hour period.

(3) total radioactivity (in curies) released, by nuclide, based on representative isotopic analyses performed.

(4) percent of technical specification limit.

7/ Estimates of the error associated with each six month total should be reported.

b. Iodine Releases

(1) total (I-131, I-133, I-135) radioactivity (in curies) released.

(2) total radioactivity (in curies) released, by nuclide, based on representative isotopic analyses performed.

(3) percent of technical specification limit.

c. Particulate Releases

(1) gross radioactivity (β,γ) released (in curies) excluding background radioactivity.

(2) gross alpha radioactivity released (in curies) excluding background radioactivity.

(3) total radioactivity released (in curies) of nuclides with half-lives greater than eight days.

(4) percent of technical specification limit.

d. Liquid Releases

(1) gross radioactivity (β,γ) released (in curies) and average concentration released to the unrestricted area.

(2) total tritium and alpha radioactivity (in curies) released and average concentration released to the unrestricted area.

(3) total dissolved gas radioactivity (in curies) and average concentration released to the unrestricted area.

(4) total volume (in liters) of liquid waste released.

(5) total volume (in liters) of dilution water used prior to release from the restricted area.

(6) the maximum concentration of gross radioactivity (β,γ) released to the unrestricted area (averaged over the period of release).

(7) total radioactivity (in curies) released, by nuclide, based on representative isotopic analyses performed.

(8) percent of technical specification limit for total activity released.

APPENDIX A

REPORT OF RADIOACTIVE EFFLUENTS

Facility _____ Docket _____ Year _____

I. LIQUID RELEASES

	Units	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1. Gross Radioactivity (β,γ)														
a) Total release	Curies													
b) Average concentration released	μCi/ml													
c) Maximum concentration released	μCi/ml													
2. Tritium														
a) Total release	Curies													
b) Average concentration released	μCi/ml													
3. Dissolved noble gases														
a) Total release	Curies													
b) Average concentration released	μCi/ml													
4. Gross Alpha Radioactivity														
a) Total release	Curies													
b) Average concentration released	μCi/ml													
5. Volume of liquid waste to discharge canal	liters													
6. Volume of dilution water	liters													
7. Isotopes Released	Curies													
Ba+La-140														
Sr-89														
I-131														
Xe-133														
Xe-135														
Cs-137														
Cs-134														
Co-60														
Co-58														
Cr-51														
Mn-54														
Zn-65														
Sr-90														
Others (specify)														
8. Percent of technical specification limit for total activity released	%													

II. AIRBORNE RELEASES

	Units	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1. Total noble gases	Curies													
2. Total halogens	Curies													
3. Total particulate gross radioactivity (β,γ)	Curies													
4. Total tritium	Curies													
5. Total particulate gross alpha radioactivity	Curies													
6. Maximum noble gas release rate	µCi/sec													
7. Percent of applicable limit for:														
a. noble gases	%													
b. halogens	%													
c. particulates	%													
8. Isotope released:	Curies													
Particulates														
Cs-137														
Ba-La-140														
Sr-90														
Cs-134														
Sr-89														
Halogens														
I-131														
I-133														
I-135														
Gases														
Kr-85														
Xe-133														
Kr-88														
Kr-87														
Kr-85m														
Xe-138														
Xe-135m														
Xe-135														
Ar-41														
Others as appropriate (specify)														