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AIR SAMPLING IN THE WORKPLACE

A. INTRODUCTION

Air sampling in the workplace is an acceptable method for meeting certain of the survey and dose assessment requirements of 10 CFR Part 20, "Standards for Protection Against Radiation. " For example, 10 CFR 20.1204 allows estimates of worker intakes of radioactive materials based on air sampling and allows adjustments of derived air concentrations (DACs) and annual limits on intake (ALIs) based on the particle size distribution; 10 CFR 20.1501 requires radiation surveys necessary to comply with the regulations and to evaluate potential radiological hazards; 10 CFR 20.1703 requires assessment of airborne radioactive material concentrations when respirators are used; 10 CFR 20.1902 requires posting of airborne radioactivity areas; 10 CFR 20.2103 requires records of radiation surveys; and 10 CFR 20.2202 and 10 CFR 20.2203 require reporting of excessive concentrations of or exposure to airborne radioactive materials.

This guide provides guidance on air sampling in restricted areas (as defined in 10 CFR Part 20) of the workplace. In this guide, the term "air sampling" includes the collection of samples for later analysis as well as real-time monitoring in which samples are analyzed as they are collected, The guide does not cover environmental or effluent sampling or the analysis of samples.

In addition, this guide does not apply to activities conducted under 10 CFR Part 50 at reactor facilities. Although the provisions of 10 CFR Part 20 apply equally to nuclear reactors and to other facilities, the air sampling programs of reactor licensees are well established, and the NRC is satisfied that the quality of air sampling at nuclear reactors is adequate. Therefore, no further guidance on air sampling is needed at this time for reactor licensees.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Part 20, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 20 have been cleared under OMB Clearance No. 3150-0014.

B. DISCUSSION

Air sampling can be used to determine whether the confinement of radioactive materials is effective, to measure airborne radioactive material concentrations in the workplace, to estimate worker intakes, to determine posting requirements, to determine what protective equipment and measures are appropriate, and to warn of significantly elevated levels of airborne radioactive materials, If bioassay measurements are used to determine worker doses of record, air sampling may be used to determine time of intake and to

determine which workers should have bioassay measurements.

General guidance on air sampling for specific types of facilities is also discussed in several other regulatory guides, including:

- Regulatory Guide 8.21, "Health Physics Surveys for Byproduct Material at NRC-
- Licensed Processing and Manufacturing Plants"
- Regulatory Guide 8.23, "Radiation Safety Surveys at Medical Institutions"
- Regulatory Guide 8.24, "Health Physics Surveys During Enriched Uranium-235 Processing and Fuel Fabrication"
- Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills"

These facility-specific guides cover air sampling in general terms, while this guide discusses air sampling in more depth. Thus, the guides are complementary.

This guide provides recommendation on air sampling to meet the requirements of 10 CFR Part 20. Draft NUREG-1400, "Air Sampling in the Workplace,"[1] provides examples, methods, and techniques that the licensee may find useful for implementing the recommendations in this guide. However, NUREG-1400 does not establish regulatory positions or recommendations and should not be used as a compliance document to establish the adequacy of licensee programs.

C. REGULATORY POSITION

1. EVALUATING THE NEED FOR AIR SAMPLING

The implementation of some sections in 10 CFR Part 20 may require air sampling. This section of the guide provides recommendations on when and what type of air sampling is acceptable to meet the Part 20 requirements.

1.1 When To Evaluate the Need for Air Sampling

As a general rule, any licensee who handles or processes unsealed or loose radioactive materials in quantities that during a year will total more than 10,000 times the ALI for inhalation should evaluate the need for air sampling. (If the same material is used repeatedly, multiply the quantity used by the number of times used.) If more than one radioactive material is used, the need for air sampling should be determined by whether the sum of the quantities of each divided by each respective ALI exceeds 10,000. When quantities handled in a year are less than 10,000 times the ALI, air sampling generally is not needed. (The basis for this value is that experience has shown that worker intakes are unlikely to exceed one one-millionth of the material being handled or processed, as discussed in NUREG-1400.)

1.2 Air Sampling Based on Potential Intakes and Concentrations

The extent of air sampling may be based on estimates of worker intakes and on estimated airborne concentrations of radioactive materials as shown in Table 1. Estimates of potential intakes and concentrations should be based on historical air sampling or bioassay data if these data are available. If the data are not available, potential intakes and concentrations should be estimated. Estimates of intakes and concentrations should be based on a consideration of (1) the quantity of radioactive material being handled, (2) the ALI of the material, (3) the release fraction for the radioactive material based on its physical form and use, (4) the type of confinement for the material, and (5) other factors appropriate for the specific facility. The estimated prospective intake provides only a guide to the appropriate types of air sampling. The radiation safety officer should use professional judgment and experience to perform air sampling appropriate for the specific situation.

1.3 Grab vs. Continuous Air Sampling

Air sampling may be continuous during work hours or intermittent (grab samples taken during part of the work). When continuous sampling during the work day is performed for continuous processes, a weekly sample exchange period is generally acceptable (except for very short-lived radionuclides). Longer sample exchange periods may be appropriate if airborne radioactive material concentrations and nuisance dust concentrations are both relatively low. When grab sampling is performed for continuous processes, a weekly sampling frequency is generally acceptable; however, monthly or quarterly sampling may be acceptable for areas in which concentrations of airborne radioactive material are expected to average below a few percent of the DAC. Grab sampling would also be appropriate when operations are conducted on an intermittent basis.

1.4 Air Sampling When Respiratory Protective Equipment Is Used

Air sampling is required by 10 CFR 20.1703 (a) (3) (i) to evaluate airborne hazards whenever respiratory protective equipment is used to limit intakes pursuant to 10 CFR 20.1702. Air samplers that are located to determine worker intake are

[1] Single copies of draft NUREG- 1400 are available free, to the extent of the supply. Submit a written request to the Office of Administration, Distribution and Mail Services Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555. A final version of NUREG-1400 is being developed and should be published in 1993.

Table 1
Air Sampling Recommendations Based on Estimated Intakes and Airborne Concentrations

Worker's estimated annual intake as a fraction of ALI	Estimated airborne concentrations as a fraction of DAC	Air sampling recommendations
< 0.1	< 0.01	Air sampling is generally not necessary. However, monthly or quarterly grab samples or some other measurement may be appropriate to confirm that airborne levels are indeed low.
	> 0.01	Some air sampling is appropriate. Intermittent or grab samples are appropriate near the lower end of the range. Continuous sampling is appropriate if concentrations are likely to exceed 0.1 DAC averaged over 40 hours or longer.
> 0.1	< 0.3	Monitoring of intake by air sampling or bioassay is required by 10 CFR 20.1502(b).
	> 0.3	A demonstration that the air samples are representative of the breathing zone air is appropriate if (1) intakes of record will be based on air sampling and (2) concentrations are likely to exceed 0.3 DAC averaged over 40 hours (i.e., intake more than 12 DAC-hours in a week).
Any annual intake	> 1	Air samples should be analyzed before work resumes the next day when potential intakes may exceed 40 DAC-hours in 1 week. When work is done in shifts, results should be available before the next shift ends. (Credit may be taken for protection factors if a respiratory protection program is in place.)
	> 5	Continuous air monitoring should be provided if there is a potential for intakes to exceed 40 DAC-hours in 1 day. (Credit may be taken for protection factors if a respiratory protection program is in place.)

acceptable for this purpose, if the worker's job activity will be the main source of airborne radioactive material, the sampling should be done during the activity, not prior to the activity.

1.5 Prompt Analysis of Certain Samples

In situations in which there is a potential for intakes to exceed 40 DAC-hours in a week, air samples should be analyzed promptly on a daily basis. (In evaluating the need for prompt analysis, credit may be taken for respirator protection factors if a respiratory protection program is in place.) Sample results should be available before work resumes the following day. When work is done in shifts, results should be available before the next shift ends, preferably during the first half of the next shift, For special or Nonroutine operations, an attempt should be made to have analysis results available within one hour. ,

1.6 Continuous Air Monitoring

In situations in which there is a potential for accidents to cause intakes exceeding 40 DAC-hours in a day, continuous air monitoring should be done. When continuous air monitors with automatic alarms are used, the alarm set points should be set as low as practical for the work being conducted without causing excessive false alarms (e.g., more than once per quarter). If continuous air monitors with automatic alarms are used, check sources should be used weekly to check that the monitor responds and causes an alarm. Continuous check sources may also be used, provided there is no interference with the radionuclides of interest. If the response is not within

±20 percent of the normal response, the monitor should be repaired or recalibrated.

1.7 Establishing Airborne Radioactivity Areas

Air sampling with samplers located to determine worker intake may be used to determine whether an area is an airborne radioactivity area. Any room, enclosure, or area must be posted as an airborne radioactivity area if (1) concentrations of airborne radioactive materials are in excess of the DAC or (2) a worker in the area would be exposed to more than 12 DAC-hours in a week (10 CFR 20.1902 and 20.1003). To determine whether the concentration exceeds the DAC over the short term, the sample collection time should not exceed 1 hour. Shorter sample collection times may be used if desired, but they are not required.

Areas should not be posted as airborne radioactivity areas on the basis of unlikely accidents that might cause the DAC to be exceeded. An airborne radioactivity area should be established based on the radioactivity levels normally encountered or on levels that can reasonably be expected to occur when work is being performed.

1.8 Air Sampling vs. Bioassay for Determining Intakes

If sufficient data to determine a worker's intake are available from both air sampling and bioassay measurements and the results are significantly different, the licensee should base the worker's intake estimate on the data considered by the radiation protection staff to be the most accurate.

1.9 Substitutes for Air Sampling

If experience indicates that worker intakes are generally low, it may be acceptable to substitute other techniques in place of air sampling. For example, when working with tritium, iodine, or other materials that are easily and effectively detected by bioassay, it could be appropriate to eliminate all air sampling and rely completely on bioassays to measure intakes and verify confinement.

2. LOCATION OF AIR SAMPLERS

Concentrations of airborne radioactive materials in a room are generally not uniform. Concentrations usually vary greatly from one location to another, sometimes by orders of magnitude even for locations that are relatively close. Therefore, the location of air samplers is important because inappropriately placed samplers can give misleading results.

This section applies only to fixed-location and portable samplers. It does not apply to personal (lapel) samplers.

2.1 Purpose of the Measurement

Before selecting a sampling location, the licensee should decide on the purpose of the measurement. Examples of purposes are (1) estimating worker intakes, (2) verifying that the confinement of radioactive materials is effective, (3) providing warning of abnormally high concentrations, (4) determining whether there is any leakage of radioactive materials from a sealed confinement system, and (5) determining whether an airborne radioactivity area exists.

2.2 Determination of Airflow Patterns

Airflow patterns should be determined in order to locate air samplers appropriately. The locations of ventilation air inlets and exhausts and of sources of airborne radioactive materials should be noted in order to determine the predominant airflow patterns and likely radioactive material transport routes. When sampling air in rooms with complex airflow patterns, it may be useful to use smoke tubes or neutrally buoyant markers to determine airflow patterns.

When sampling air in an airborne radioactivity area to determine the intakes of workers whose intake must be monitored under 10 CFR 20. 1502(b), smoke tubes or neutrally buoyant markers should be used to determine airflow patterns from the source to the worker's breathing zone. In some instances, the use of larger smoke sources or neutrally buoyant marker sources to observe airflow patterns is desirable. However, observations of airflow patterns should be omitted in areas of high external radiation exposure if making the observations would result in total worker doses (internal plus external) that are not as low as is reasonably achievable.

The airflow pattern determinations should be repeated if there are changes at the facility, including changes in locations of the individual work locations and seasonal variations that might change airflow patterns, or if there is a reason to suspect problems. The radiation protection staff should be aware of facility characteristics, operations, and changes that might change airflow patterns. In addition, the location of at least 10 percent of the fixed-location samplers should be evaluated annually to confirm that their locations are still appropriate.

2.3 Selecting Sampler Locations

Air samples should be collected in airflow pathways downstream of sources of airborne radioactive material.

When the purpose of the sample is to verify the effectiveness of confinement or to provide warning of elevated concentrations, the sampling point should be located in the airflow pathway near the release point. These samplers do not have to be placed near the worker's breathing zone, and thus concentrations

might be considerably different from the concentrations in the breathing zone. If the room has several widely spaced sources of airborne radioactive material, more than one sampling point may be needed.

When the purpose of sampling is to determine worker intakes, each frequently occupied work location should have its own sampler. The air samplers should be placed as close to the breathing zone of the worker as practical without interfering with the work or the worker. In addition, air flow patterns in the area should be considered in placing samplers so that the sampler is likely to be in the airflow downstream of the source and prior to or coincident with the location of the worker. An estimate should be made of the time the worker spends at the work location (unless personal air samplers are being used).

For hoods, glove boxes, and other similar enclosures used to contain radioactive material, air samplers may be installed slightly above head height and in front of the worker or they may be installed on the front face of the enclosure,

Normally, air samplers intended to measure workplace concentrations should not be located in or near exhaust ducts, because concentrations there will usually be diluted compared to concentrations in work areas. However, samplers may be located in ducts if their purpose is to detect leakage from systems that do not leak during normal operation and if quantitative measurements of workplace airborne concentrations are not needed.

3. DEMONSTRATION THAT AIR SAMPLING IS REPRESENTATIVE OF INHALED AIR

Section 20. 1502(b) of 10 CFR Part 20 requires monitoring of the intake of any worker whose intake is likely to exceed 0.1 ALI. Section 20.1204 allows the use of air sampling, bioassay, or a combination of both to determine a worker's intake.

3.1 Need To Demonstrate that Air Sampling Is Representative of Breathing Zone Air

It should be demonstrated that the air sampled is representative of breathing zone air if all four of the following conditions are met: (1) monitoring of intake is required by 10 CFR 20. 1502(b) because annual intake is likely to exceed 0.1 ALI, (2) the intake of record will be based on air sampling rather than bioassay, and (3) the exposure will occur in an airborne radioactivity area where airborne concentrations are likely to exceed 12 DAC-hours in a week, and (4) lapel samplers or samplers located within about 1 foot of the worker's head are not used. (The results from lapel samplers or samplers that are located within about 1 foot of the worker's head may be accepted as representative without further demonstration that the results are representative.)

3.2 Demonstration that Air Sampling Is Representative

Four methods may be used to demonstrate representativeness of the results from samplers that are not located within about 1 foot of the worker's head: (1) comparison with lapel sampler results (for this comparison, lapel samplers may be equipped with cyclones with an efficiency of at least 50 percent for particles with an aerodynamic equivalent diameter of 4 micrometers if the particles sampled are volubility class W or Y),[2] (2) comparison with bioassay results, (3) comparison using multiple measurements near the breathing zone, and (4) comparison with quantitative airflow tests.

Table 2 describes the application of each of the methods and includes acceptance criteria for determining whether sampling results may be considered representative.

3.3 Corrective Actions if Sampling Results Are Not Representative

If the method used to demonstrate representativeness does not show that the sampling results are representative, the licensee should analyze the situation, determine the likely cause of the problem, and fix the problem. The licensee should also correct intake estimates made within the last year and subsequent to the previous demonstration of representativeness. To fix the problem, it may be appropriate to relocate samplers to be more representative, apply correction factors to correct sampling results, switch to lapel sampling, or use bioassay measurements to determine intakes.

4. ADJUSTMENTS TO DERIVED AIR CONCENTRATIONS

NRC regulations in 10 CFR 20. 1204(c) permit, upon prior approval of the NRC, the adjustment of DACs to reflect the actual physical and chemical characteristics of airborne radioactive materials.

4.1 Adjusting DACs Based on Measurements of Particle Size

If the licensee elects to request approval to adjust DACs based on measured activity median aerodynamic diameters of airborne particles, the following information should be submitted:

1. The need for the adjustment.
2. The radioactive materials involved and either their chemical form (if the chemical

[2] American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, Notice of Intended Changes: Appendix D—Particle Size Selective Sampling Criteria for Airborne Particulate Matter, 1991. The 4-micrometer criterion is also in the process of being adopted by the International Standards Organization (IS0) and the European Standardization Committee (CEN).

Table 2
Methods To Demonstrate the Representativeness of Air Sampling

Method	Description
1. Comparison with lapel samplers	*Include:* Workers whose annual intakes must be monitored under 10 CFR 20.1502(b) because intakes are likely to exceed 10% of an ALI and whose dose of record will be based primarily on air sampling. *Comparison:* Compare intakes measured by air sampling with intakes measured by lapel samplers for at least 1 week for continuous operations or for several operations for repeated short-duration operations. *Acceptance criteria: The* ratio of the intakes calculated from air sampling divided by the intakes calculated from lapel samplers should exceed 0.7 when averaged for all workers included in the comparison. The ratio for each individual worker should exceed 0.5. (The values of 0.7 and 0.5 were selected so that the accuracy of intakes based on air sampling would be compatible with the accuracy expected of external radiation Dosimeters.)
2. Comparison with bioassay results	*Include:* Workers whose annual intakes must be monitored under 10 CFR 20.1502 (b) because intakes are likely to exceed 10% of an ALI and whose dose of record will be based primarily on air sampling. *Comparison:* Compare the sum of the intakes determined from air sampling with the sum of the intakes calculated from those bioassay measurements. *Acceptance criteria: The* ratio of the sum of the intakes calculated from air sampling divided by the sum of the intakes calculated from bioassay measurements should exceed 0.7 when averaged for all workers included in the comparison. The ratio for each individual worker should exceed 0.5 for each individual worker.
3. Comparison with multiple samplers	*Include:* Work locations at which airborne concentrations are likely to exceed 0.3 DAC and that are generally occupied by workers whose intakes must be monitored and whose dose of record will be based on air sampling. *Comparison:* Use multiple samplers to take measurements at four or more locations around the worker's head. *Acceptance criteria: The* concentration determined by the fixed-location sampler divided by the concentration averaged for all the multiple samplers should exceed 0.7 for the work location.
4. Comparison with quantitative airflow measurements	*Include:* Work locations at which airborne concentrations are likely to exceed 0.3 DAC that are generally occupied by workers whose intakes must be monitored and whose dose of record will be based on air sampling. *Comparison:* Release a tracer material near the source release point. Measure its concentration with the fixed-location sampler and with another sampler placed closed to the worker's head. *Acceptance criteria:* The concentration measured by fixed-location sampler divided by the concentration of the sampler placed close to the worker's head should exceed 0.7.

compounds are listed in Appendix B of Part 20) or their volubility classes (D, W, or Y). Describe how the chemical forms or solubility classes were determined.

3. A graph of the adjusted DAC vs. activity median aerodynamic diameter.

4. The method by which the activity median aerodynamic diameter will be measured.

5. The locations at which the measurements will be made.

6. The frequency of measurements.

7. Methods or techniques that will be used to average results by location or time.

The following locations and frequency of measurements are acceptable to the NRC. For an initial determination of the adjustment, the licensee should take the average of three measurements of the activity median aerodynamic diameter at or near each work location or process. The licensee should then determine whether the entire area or room can be represented by a single activity median aerodynamic diameter or whether the area or room should be divided into areas with different particle sizes, After the initial determination of median diameter in each area of the workplace has been made, the licensee should reassess the median diameters by making another measurement at approximately one-quarter of the work locations at 6-month intervals, selecting different locations each time. However, if two consecutive reassessments do not show a substantial change in the median diameter, reassessments may be annual. Reassessments should also be done after there have been process changes likely to affect the size distribution of particles. If the activity median aerodynamic diameter has changed, the median diameter for the area should either be reassessed or replaced with a default value of 1 micrometer.

If the licensee elects to adjust the DAC based on the size distribution for short-duration operations, such as special maintenance jobs, at least one measurement should be made each time the job is done. In the event of abnormal or accident conditions, the median diameter for normal operating conditions may be assumed for intake assessments.

4.2 Using Cyclones To Adjust Measured Airborne Concentrations

If the licensee elects to request approval to use cyclones or other particle size discrimination samplers to adjust the measured airborne concentrations, the following information should be submitted:

1. The need for the adjustment.

2. The radioactive materials involved and their chemical form (relative to the chemical forms listed in Appendix B to Part 20) or volubility class (D, W, or Y),

3. A description of how the chemical form or volubility class was determined.

4. The type of cyclone, the type of sampler, the air flow rate, and the collection efficiency of 4 micrometer particles at the flow rate that will be used.

5. A list of locations or worker areas that will be sampled using cyclones.

In general, this method is suitable for volubility class W and Y compounds but not volubility class D compounds. Cyclones should have an efficiency of at least 50 percent for particles with an aerodynamic diameter of 4 micrometers.[2]

4.3 Adjusting DACs for Volubility

NRC regulations in 10 CFR 20.1204(c) permit, upon prior approval of the NRC, the adjustment of the DAC based on chemical characteristics. If the licensee elects to request approval to adjust DACs based on particle volubility in the human body, the following information should be submitted:

1. The need for adjustment.

2. A description of how the volubility of the material was determined.

3. A description of how the adjusted DAC was determined.

4. The number and frequency of measurements. (A frequency of at least annually is recommended.)

5. MEASURING THE VOLUME OF AIR SAMPLED

The accuracy of air sampling measurements and the calibration of air sampling instruments is not explicitly dealt with in Part 20. However, it is implied that measurements required by Part 20 must be suitably accurate. This section of the guide describes acceptable methods to determine the volume of air to be sampled to ensure suitable accuracy.

5.1 Means To Determine Volume of Air Sampled

All air samplers to be used for quantitative measurements should have a means to determine the volume of air sampled. This recommendation applies to fixed-location samplers, portable samplers, and lapel samplers.

5.2 Calibration Frequency and Methods

The licensee should calibrate airflow meters at least annually. Additional calibrations should be

performed after repairs or modifications to the meter or if the meter. is believed to have been damaged. The methods described in Section F of "Air Sampling Instruments"[3] to calibrate airflow meters are acceptable to the NRC staff.

5.3 Uncertainty

The uncertainty in the volume of air sampled should be less than 20 percent. The uncertainty, U_v, in percent may be calculated from the equation:

$$U_v = [U_3^2 + U_C^2 + U_t^2]^{1/2}$$

where: U_v = the percent uncertainty in reading the meter scale

U_C = the percent uncertainty in determining the calibration factor

U_t = the percent uncertainty in the measurement of the sampling time.

5.4 Inleakage

Air samplers and associated sampling lines should be checked for 'leakage of air into the sampling line upstream of the flow measurement device when they are calibrated for volume of air sampled.

5.5 Change in Flow Rate

If the flow rate changes by more than ± 10 percent during collection of a sample, a correction should be made by averaging the initial and the final flow rates.

6. EVALUATION OF SAMPLING RESULTS

6.1 Detecting Changes in Air Concentrations Over Time

For fixed-location sampling whose purpose is to confirm confinement of radioactive materials for routine or repeated operations, the results should either (1) be analyzed for trends (for example, by control charts) to determine whether airborne concentrations are within the normal range and administrative and engineering controls are thus operating properly to maintain occupational doses as low as is reasonably achievable or (2) be compared with administrative action levels that serve as a basis for determining when confinement is satisfactory.

6.2 Efficiency of Collection Media

If the efficiency of the collection media (such as filters) for an air sample is less than 95 percent for . the material being collected, the sample result should be corrected to account for radioactive material not collected by the collection media. If penetration of radioactive material into the collection media or self-absorption of radiation by the material collected would reduce the count rate by more than 5 percent, a correction factor should be used.

6.3 Detection Sensitivity

The 10 CFR Part 20 monitoring criteria (i.e., 10 percent of the limit) do not establish required levels of detection sensitivity (lower level of detection, minimum detectable activity, minimum detectable concentration, etc.). For example, lapel samplers may not be able to detect uranium concentrations of 10 percent of the DAC, but lapel samplers are still acceptable for measuring the uranium intake of workers. The monitoring criteria should not be considered requirements on the sensitivity of a particular measurement because when the results of multiple measurements are summed, the sum will have a greater statistical power than the individual measurements. However, to achieve the greater statistical power, the licensee should record all numerical values measured, even values below . "minimum detectable amounts" and values that are negative because the measured count rate is below the background. Results should not be recorded as "below MDA" or similar statements.

If the licensee desires to calculate the minimum detectable activity of a single sample (MDA), it may be calculated by use of the following equation:

$$MDA = \frac{2.71 + 3.29[R_b T_s (1 + T_s/T_b)]^{1/2}}{EKT_s}$$

where: R_b = the background count rate

T_s = the sample counting time

T_b = the background (or blank) counting time

E = the filter efficiency

K = a calibration factor to convert counts per minute into activity (e.g., counts per minute per microcurie)

(The derivation of this equation is described in NUREG-1400.)

If the proportion of the total activity of a sample that is due to a specific radionuclides in a mixture is known, the MDA for that radionuclides should be reduced proportionally:

$$MDAi = Ai/A \times MDA$$

where:

Ai/A = the proportion of the total sample activity from radionuclides i.

[3] 7th Edition, American Conference of Governmental Industrial Hygienists, 1989. Copies are available for purchase from the ACGIH, 6500 Glenway Avenue, Building D-7, Cincinnati, Ohio 45211.

6.4 Deposition of Particulate in Sampling Lines

If sampling lines are used for collecting airborne particulate, the lines should be as short as possible and should be made of a material not subject to significant static charge effects (e.g., grounded me@., However, up to several feet of flexible plastic tubing, such as tygon, may be used to connect the sampling line to the sample collector. The penetration of particles with an aerodynamic equivalent diameter of 10 micrometers should be at least 50 percent. DEPOSITION [4] software is an acceptable means of calculating penetration.

6.5 Annual Review of Air Sampling Measurements

Section 20.110 1(c) of Part 20 requires that the licensee periodically (at least annually) review the radiation protection program content and implementation. The review of the air sampling component of the program should determine (1) whether the measurements are accurate and reliable and (2) whether changes should be made to improve the measurements. The review should be done annually and should cover the prior year's activities. The annual review of air sampling measurements may be combined with reviews of other aspects of the radiation protection program.

The annual review should include but not necessarily be limited to:

1. *Purposes and amount of air sampling:* Was the air sampling appropriate for the intended purposes? Was there too much or too little air sampling done?

2. *Location of Sampling:* Were fixed-location air samplers located properly? Were grab samples taken with proper regard to airflow patterns?

3. *Trends:* Do trends in air sampling results and worker intakes indicate that confinement of radioactive materials remains adequate? Were prospective estimates of intake reasonably accurate?

4. *Posting:* Is the posting of airborne radioactivity areas appropriate?

5. *Procedures:* Are written procedures still suitable and up to date?

6. *Adjustment of DACs* Were DACs adjusted for particle size or volubility? If so, are the original adjustment factors still valid?

7. *Correction factors:* Were correction factors applied to air samples to determine worker intakes? If so, are the correction factors still valid?

8. *False alarms:* Was continuous air monitoring done? If so, did excessive false alarms occur?

9. *Representativeness:* For air sampling done to determine significant intakes, was the representativeness demonstrated to be adequate?

10. *Changes:* Have changes in air sampling procedures or equipment occurred that could affect the quality of the measurements? Have changes in the facility operation or equipment occurred that could affect the quality of air sampling measurements?

D. IMPLEMENTATION

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

Except in those cases in which an applicant proposes acceptable alternative methods for complying with specified portions of the Commission's regulations, the methods described in this guide will be used in the evaluation of applications for new licenses, license renewals, and license amendments and for evaluating compliance with 10 CFR 20.1001-20.2401.

[4] N. K. Anand and A, R. McFarland, "DEPOSITION: Software for Characterizing Aerosol Particle Deposition in Sampling Lines, " Draft NUREG/CR-0006, October 1991. Single copies are available free, to the extent of supply, upon written request to the Office of Information Resources Management, Distribution Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555. A final version of NUREG/CR-0006 is being developed. For information on DEPOSITION software contact: Aerosol Technology Laboratory, Department of Mechanical Engineering, Texas A&M University, College Station, TX 77843, Attention: Dr. Andrew R. McFarland. Telephone (409) 845-2204.

REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. The regulatory analysis prepared for 10 CFR Part 20, "Standards for Protection Against Radiation" (56 FR 23360), provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the "Regulatory Analysis for the Revision of 10 CFR Part 20" (PNL-6712, November 1988), is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street, NW. — (Lower Level), Washington, DC, as an enclosure to Part 20.