August 1980

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 8.25
(Task OH 905-4)

CALIBRATION AND ERROR LIMITS OF AIR SAMPLING INSTRUMENTS FOR TOTAL VOLUME OF AIR SAMPLED

A. INTRODUCTION

Paragraph (a)(3) of §20.103, "Exposure of Individuals to Concentrations of Radioactive Materials in Air in Restricted Areas," of 10 CFR Part 20, "Standards for Protection Against Radiation," requires that licensees use suitable measurements of concentrations of radioactive materials in air for detecting and evaluating airborne radioactivity in restricted areas. In addition, paragraph (c)(4) of §20.106, "Radioactivity in Effluents to Unrestricted Areas," requires that licensees provide information as to the highest concentration of each radionuclide in an unrestricted area, a procedure that in many cases requires air monitoring beyond the restricted area. This guide identifies methods acceptable to the NRC staff for calibrating air sampling instruments for total volume of air sampled and provides guidance for ensuring that volumes of air sampled are known within certain limits.

B. DISCUSSION

In order to accurately assess the air concentration of radioactive materials in a given location, the volume of air sampled as well as the quantity of contaminant in the sample must be determined. Accurate determination of the volume of air sampled requires standard, reproducible, and frequent calibration of the air metering devices that are used with air sampling instruments.

The American Conference of Governmental Industrial Hygienists has published a manual entitled "Air Sampling Instruments for Evaluation of Atmospheric Contaminants,"[1] 5th Edition, 1978. Part II, Section I, "Calibration of Air Sampling Instruments," of this manual provides instructions for acceptable methods of calibrating air volume and flow rate metering devices. In particular, Tables II, III, and IV of this manual provide sources of published, recommended, or standard methods; a summary of recommended standard methods; and a listing of calibration instruments and their suppliers.

This guide supplements the instructions in this manual by adding guidance for frequency of calibration, for acceptable error limits in volume measurement, and for documentation.

C. REGULATORY POSITION

The publication entitled "Air Sampling Instruments for Evaluation of Atmospheric Contaminants,"[1] 5th Edition, 1978, provides guidance on total air sample volume calibration methods acceptable to the NRC staff, as supplemented below:

1. FREQUENCY OF CALIBRATION

A licensee committed to a routine or emergency air sampling program should perform an acceptable calibration of all airflow or volume metering devices at least once every 6 months, with the exception of permanently installed effluent monitors.[2] Special calibrations should be performed at any time there is reason to believe that the operating characteristics of a metering device have been changed, by repair or alteration, or whenever system performance is observed to have changed significantly. Routine instrument maintenance should be performed as recommended by the manufacturer. Primary or secondary standard instruments used to calibrate air sampling instruments should be inspected frequently for consistency of performance.

[1] Copies are available from the American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, Ohio 45201.

[2] See NUREG-0472, "Radiological Effluent Technical Specifications for PWRs," July 1979, and NUREG-0473, "Radiological Effluent Technical Specifications for BWRs," July 1979, which specify calibration at least once every 18 months.

2. ERROR LIMIT FOR MEASUREMENT OF AIR SAMPLE VOLUME

Most methods of calibrating airflow or air volume metering devices require direct comparison to a primary or secondary standard instrument to determine a calibration curve or a correction factor. An example of a primary standard is a spirometer that measures total air volume directly with high precision by liquid displacement. An example of a secondary standard is a wet-test meter that has been calibrated against a primary standard. Primary standards are usually accurate to within 1 percent and secondary standards to within 2 percent.

The significant errors associated with determining the total air volume sampled are:

E_c: The error in determining the calibration factor. (An acceptable estimate is the percent error associated with the standard instrument used in the calibration.)[3]

E_s: Intrinsic error in reading the meter scale. (An acceptable estimate is the percent equivalent of one-half of the smallest scale division compared to the scale reading.)

E_t: The percent error in measurement of sampling time that should be kept within 1 percent.

E_v: The most probable value of the cumulative percent error in the determination of the total air volume sampled.

E_v can be calculated from the following equation provided there are no additional significant sources of errors:

$$E_v = [E_s^2 + E_c^2 + E_t^2]^{1/2}$$

Air sampling instruments, including those personal (lapel) samplers that have flow rate meters, should have flow rate or total volume metering devices calibrated so that the most probable value of the cumulative error E_v, in the determination of total volume, is less than 20 percent. This analysis assumes a linear change in the flow rate across the sample collector during the sampling period when flow rate meters are used. In turn, this assumption allows simple averaging of the initial and final flow rates for a single sample.

If there are significant differences in pressure and temperature between the calibration site and the sampling site, appropriate corrections should be made using the ideal gas laws as discussed in the previously described manual.

A sample calculation of the most probable value of the cumulative error in total volume measured is as follows: If accuracies of the scale reading, the calibration factor, and sample time are ± 4, 2, and 1 percent, respectively, and there are no other significant sources of error, the cumulative error would be:

$$E_v = [4^2 + 2^2 + 1^2]^{1/2} = 4.58\% \text{ or } \sim 5\%$$

3. DOCUMENTATION OF CALIBRATION OF AIR METERING DEVICES

The licensee should maintain records of all routine and special calibrations of airflow or volume metering devices, including the primary or secondary standard used, method employed, and estimates of accuracy of the calibrated metering devices. All instruments should be clearly labeled as to the date and results of the most recent calibration and should include the appropriate correction factors to be used.

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 or licensee proposes an acceptable alternative method for complying with §§20.103 and 20.106 of the Commission's regulations, the staff will use the method described herein in the evaluation of ongoing and proposed air monitoring programs after November 15, 1980.

If an applicant or licensee wishes to use the method described in this regulatory guide on or before November 15, 1980, the pertinent portions of the application or the licensee's performance will be evaluated on the basis of this guide.

[3]The calibration factor should be based on two kinds of determinations. First, correction factors should be determined at several flow rates distributed over the full-scale range. Each flow rate correction factor should be determined while adjusting flow rates upscale and again while adjusting flow rates downscale, and the two sets of data should be compared. Second, subsequent calibrations should compare the new correction factors to those determined during the previous calibration. If observed differences are significant compared to the overall volume error limit of 20 percent, an additional error term should be included in the calculation above.

VALUE/IMPACT STATEMENT

1. PROPOSED ACTION

1.1 Description

Many NRC licensees are required to maintain radiation and contamination survey programs, including air sampling, to assess concentrations of airborne radionuclides. Regulatory concentration values are specified in Appendix B to 10 CFR Part 20. The proposed action is to provide guidance for improving air sampling procedures in the form of acceptable methods of calibrating air sampling instruments for determining total volume of air sampled, frequency of calibration, and documentation procedures. Measurement of the total volume is required in the calculation of the concentration.

1.2 Need for Proposed Action

In order to accurately characterize the air quality of a working environment, the volume of air sampled as well as the quantity of contaminant must be determined. Accurate assessment of the quantity of air sampled requires frequent calibration of air metering devices by standard, reproducible methods. To assess internal exposure resulting from airborne radioactive material and to evaluate working conditions, acceptable standard calibration and measurement methods must be developed. The Office of Nuclear Materials Safety and Safeguards requested the Office of Standards Development to accelerate the schedule for issuing guidance to NRC licensees on acceptable methods for total volume calibration and measurement.

1.3 Value/Impact of Proposed Action

1.3.1 NRC Operations

Acceptable methods for calibrating air sampling instruments provide additional criteria for inspection and enforcement of NRC radiation protection regulations. Increased accuracy in assessing airborne radioactive material concentrations would provide a more reliable data base for developing additional regulatory action to control and reduce internal radiation exposure. Impacts of the development of guidance as described include task completion manpower cost, estimated to be 0.3 man-year, and printing costs of approximately $300.

1.3.2 Other Government Agencies

Coordination with several governmental agencies (e.g., NBS, OSHA, EPA) has been necessary to ensure consistency in cases where respective regulatory and monitoring functions interface. Agreement States whose licensing regulations include air sampling requirements may benefit by the availability of acceptable calibration methods suitable for adoption in their programs.

1.3.3 Industry

The value to industry in providing guidance on air volume calibration procedures consists of the probable improvement in worker protection from more accurate assessment of airborne radioactive material hazards. The impacts include equipment and manpower costs that do not appear to be excessive in view of the proposed acceptable methods and frequency of calibration requirements. The staff estimates the initial cost of an acceptable calibration system to be less than $300 and approximate man-power requirements to be 1 to 2 man-hours per year per instrument.

1.3.4 Workers

For the workers, the values of improved air monitoring include more accurate assessments of the quality of the working environment and a probable reduction in internal radiation exposure. Recent staff discussion with union representatives indicates that there is an increasing concern about exposure to airborne radioactive material on the part of workers in the industry. Continued NRC efforts to increase our understanding of this aspect of radiation hazard and to improve monitoring and control of airborne radioactivity is essential.

1.3.5 Public

Environmental monitoring to assess the release of radioactive materials in the vicinity of NRC-licensed facilities includes air sampling. Calibration procedures for low-flow-rate, continuous air sampling instruments will be included. The public will benefit from increased reliability of environmental measurements.

1.4 Decision

The NRC should develop and provide guidance on acceptable total air volume calibration methods for those types of radiological air sampling instruments used by licensees.

2. TECHNICAL APPROACH

The action proposed here is to provide guidance on acceptable methods of calibrating airflow and air volume metering devices on radiological air samplers. Survey programs and, where appropriate, air monitoring programs are required of many NRC licensees. It is our intent that acceptable methods of air volume calibration be a required

component of licensee monitoring procedures. There are no technical alternatives to providing this guidance.

3. PROCEDURAL APPROACH

3.1 Procedural Alternatives

The proposed action, to publish guidance on calibration procedures for radiological air sampling instruments, could be accomplished by several methods: publishing an NRC regulation requiring that specific calibration procedures be used by all licensees; preparing or revising a regulatory guide (based on the existing paragraph 20.201(b) of 10 CFR Part 20) that would provide an acceptable method for calibration; developing an ANSI standard on calibration procedures that could be endorsed by a new regulatory guide; or publishing a NUREG report or a branch position paper.

3.2 Value/Impact of Procedural Alternatives

An *NRC regulation* establishes general legal requirements, is more costly and time consuming to prepare, and is not an appropriate vehicle for the specific and narrow objective proposed here. One advantage is that a regulation legally requires compliance. In general, this approach is not considered cost effective in view of the objective of the proposed action.

ANSI standards are generally intended as technical treatments of broad areas of concern to industry. An ANSI standard concerning all aspects of an acceptable monitoring program would be appropriate but beyond the narrower objective proposed here. Developing an ANSI standard and an endorsing regulatory guide might require several years and would be costly. This approach is not considered cost effective in view of the proposed objective.

A *NUREG report* would be an appropriate vehicle for reporting on technical studies of various methods of calibrating air samplers. Regulatory guidance, however, is not established through publication of a NUREG report. Since this proposal includes establishing an acceptable method for compliance with required surveying programs, a NUREG report is not considered suitable.

Branch position statements are intended as interim measures to be used when an immediate response is required. They are usually superseded when a more permanent mode of guidance is developed.

A *regulatory guide* can be prepared at reasonable cost within a reasonable time period. A regulatory guide can establish acceptable criteria for compliance with a regulatory requirement and, if incorporation into a license is requested, is subject to inspection and enforcement.

Development of a regulatory guide allows extensive input from all segments of the nuclear industry and the public. A regulatory guide could reference existing and acceptable standard calibration methods or adequately describe calibration procedures acceptable to the NRC staff. The staff does not consider that revision of any existing regulatory guides could provide the objectives proposed here.

3.3 Decision on Procedural Approach

The staff concludes that a regulatory guide adopting acceptable methods for total air volume calibration for radiological air sampling instruments should be published.

4. STATUTORY CONSIDERATIONS

4.1 NRC Regulatory Authority

Paragraph 20.201(b) of 10 CFR Part 20 establishes a legal requirement that each licensee make or cause to be made such surveys as may be necessary for him to comply with the regulations. The NRC is thus authorized to provide criteria for acceptable survey methodology, including calibration of instrumentation.

4.2 Need for NEPA Statement

The action proposed here is not considered to constitute a major addition or change and would entail no effect on the environment. The staff does not believe that an environmental impact statement is necessary.

5. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS OR POLICIES

Several regulatory guides concerning health physics surveys at various types of NRC-licensed facilities such as Regulatory Guide 8.21, "Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants," are in preparation. These guides would appropriately reference the guide proposed here. In addition, guides such as Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," will include a commitment to acceptable air sampler calibration procedures. When next revised, these guides should include cross-references to this guide as an acceptable element of a licensee's monitoring program.

The proposed guide is consistent with Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable." When next revised, Regulatory Guide 8.8 should include a cross-reference to this guide.

6. SUMMARY AND CONCLUSIONS

In summary, it is proposed that a regulatory guide be published for the purpose of providing guidance on acceptable methods of calibrating radiological air sampling instruments for total volume of air sampled.

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