# TECHNICAL BASIS AND EVALUATION CRITERIA FOR AN AIR SAMPLING MONITORING PROGRAM

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# Technical Basis and Evaluation Criteria for an Air Sampling/Monitoring Program

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## ABSTRACT

Air sampling and monitoring programs at DOE facilities need to be reviewed in light of revised requirements and guidance found in, for example, DOE Order 5480.6 (RadCon Manual). Accordingly, the Oak Ridge National Laboratory (ORNL) air monitoring program is being revised and placed on a sound technical basis. A draft technical basis document has been written to establish placement criteria for instruments and to guide the "retrospective sampling or real-time monitoring" decision. Facility evaluations are being used to document air sampling/monitoring needs, and instruments are being evaluated in light of these needs. The steps used to develop this program and the technical basis for instrument placement are described.

## INTRODUCTION

The workplace air sampling/monitoring program is intended to: (1) prevent or minimize inhalation of radioactivity by personnel; and (2) assess and confirm control of radioactive materials in the workplace. The primary intent of an air quality program is, of course, personnel protection. Unexpected releases of airborne radioactivity (or releases at higher than expected levels) should be recognized as early as possible in order to minimize the total committed dose to personnel. At the same time, even minor releases which do not constitute a significant exposure threat to personnel should be detected quickly in order to regain control of the workplace and minimize cleanup costs.

The two justifications given above for an air quality program are not intended to include dose assessment. In some sense, of course, the measurement of airborne radioactivity is closely related to worker safety. The program is designed to measure airborne radioactivity in occupied areas, emphasizes the worker breathing zone, and is partly intended to minimize worker intakes. The primary concern of an air monitoring/sampling program, however, is control of the workplace. Determination of worker intake of radioactive materials through bioassay is almost always more accurate than the estimate which can be made based on air samples and worker movements. Control and knowledge of airborne radioactivity levels in the workplace allows job planning and assessment which prevents unnecessary or unexpected intakes under normal work conditions.

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In the past, some air samplers and monitors have been located in convenient or temporarily useful locations, and often have been placed without a firm technical basis. Workers tend to assume that they are safe as long as monitoring instruments are not alarming. In fact, the instruments may simply be incorrectly located or too insensitive to detect significant releases. In addition, most facilities have in the past tended to exclusively utilize either air samplers or air monitors. The critical decision was whether any instrumentation was needed, a simple yes or no choice. Recent DOE regulations and current practice recognize the usefulness of both retrospective air samplers and real-time air monitors, so a modern air quality program is three-tiered: no instrumentation, air sampler, or air monitor. The decision to use an air sampler rather than an air monitor, for example, should be technically justified and documented.

## ESTABLISHING AN AIR QUALITY PROGRAM

The first, and perhaps most important, step in establishing a technical basis for an air sampling/monitoring program is the definition of administrative requirements and limits. These limits may come from internal administrative guidelines, DOE requirements, or simply technical feasibility. Unrealistic or poorly defined limits make an accurate assessment of need difficult, and make a technical basis for instrument type and placement impossible.

The second step in the initiation of an air quality program should be the development of a technical basis for unit placement. Included should be an outline of the method to be used to determine unit type and location, as well as minimum technical specifications for instrumentation. The technical basis document is a statement of intent, informing the reader of the applicable regulations and how the program complies - in short, how you intend to do business. In the absence of such guidance, users and auditors alike have no firm basis for the design and assessment of operations.

The third step in establishing a technically sound air quality program is assessment of instrument needs. In an organization such as Oak Ridge National Laboratory, with diverse operations and numerous facilities, workplace air monitoring needs can only be accurately determined through facility surveys. One efficient method of conducting such a survey is through a series of interviews. The range and variety of information needed to determine air monitoring needs over the entire Laboratory makes a written survey form inefficient, difficult to design, even more difficult to convince managers to return, and potentially incomplete or misleading. In a one- to two-hour interview and tour with the facility manager and local Health Physics technician, a two- or three-man technical assessment team can gather all of the information needed to recommend an air quality program for the facility. A written report summarizing facility operations which involve radioactive materials and the resulting instrument needs must then be developed by the technical assessment team based on the survey meeting. It is vital to an effective program that recommended actions be consistent with the hazards.

Finally, samplers and monitors that meet the needs of the facility must be obtained and installed. ORNL is considered a multiple-threat facility, with a wide variety of radioactive materials, a diverse set of missions, and a long history. In most facilities, transuranic materials cannot be ruled out, so worst-case isotopes must normally be considered for material clearance or contamination control purposes. A material survey is most important in setting up the air sampling/monitoring program, since all isotopes which constitute a real threat must be considered when obtaining, programming, and interpreting results from air quality instruments. Complete and accurate technical specifications for air monitors can only be set after the threats are well-documented and understood.

## DETERMINATION OF RISK

The air monitoring program must be designed for a particular workplace and set of operations. A number of factors should be taken into account in evaluating the appropriate level of air monitoring. Among these are historical data concerning past release levels, bioassay results of area workers, the specific physical and chemical characteristics of the materials being used, confinement of materials, frequency of operations or occupancy, and release limits of the radioactive materials.

In the absence of changes in the radioactive materials inventory or handling, a decision to decrease or increase the air monitoring level in a given facility should be based on two factors: historical air sampling results and bioassay results. A consistent record of facility air monitoring station samples indicating no unpredicted airborne contamination and a history of worker bioassay results indicating no unusual inhalation of radioactive materials may be used to support the downgrade of air monitoring levels in a facility. These factors provide strong indications that the facility has good airborne contamination controls and that there are not frequent significant releases that need to be continuously monitored. Conversely, unexpected positive bioassay results or a routine retrospective air sample which detects the presence of unpredicted airborne contamination should trigger a re-evaluation of the facility air monitoring program.

## HAZARD INDEX

The NRC draft technical resource document NUREG-1400, "Air Sampling in the Workplace" suggests the use of a Hazard Index to determine an appropriate air monitoring program level. The hazard index method provides a documented, quantified, objective set of modifying factors which may be used to assess the fraction of an ALI (allowed limit on intake) a worker is likely to receive from a given operation or by working in a particular facility. Since there is a reasonable consensus on the appropriate actions to be taken once a likely intake has been determined and since ALIs are established for all isotopes of interest, the hazard index method provides a reasonable basis for the air monitoring program technical justification to be used for a given set of operations in a particular facility.

The basic and key assumption of the Hazard Index is that the fractional amount of radioactivity inhaled by a worker is generally less than one millionth ($10^{-6}$) of the amount of radioactivity processed. This figure is based on many years of practical experience and observation, and is not derived from first principles (see Brodsky 1980). If this "intake fraction" is accepted, additional modifying factors may be applied to the ALI in order to determine the risk and the appropriate air monitoring policy.

The basic Hazard Index (HI) equation is:

$$HI = \frac{Q \times R \times F}{10^4 \times ALI \times C} \quad (1)$$

where

*HI* = the % of ALI likely to be inhaled,
*Q (Ci)* = the radioactive material to be handled,
*R* = the release fraction (see Table 1),
*F* = includes other modifying factors (see below),
$10^4$ = converts the material present to % intake,
*ALI (Ci)* = the annual limit on intake, and
*C* = the confinement factor (see Table 2).

The hazard index is expressed here as a percentage of the ALI rather than a fraction. Tables 1-3 display release fractions and confinement factors for the most common situations. Annual limits on intake (ALIs) for isotopes of interest may be obtained from the Derived Air Concentrations (DACs) found in Table 1 of DOE Order 5480.11, Attachment 1. The ALI (in Ci) is 2400 times the DAC (in μCi/mL), assuming that a typical worker breathes 2400 $m^3$ of air in a working year (2000 hours). The factor F can be used to take any other pertinent modifying factors into account. For example, administrative limits on the exposure allowed in a given operation may be accounted for in F (e.g., if workers are restricted from receiving more than 10% of an ALI, a modifying factor F=10 would result).

The suggested action that follows from the hazard index should be based on the administrative requirements or limits which form the basis for the technical justification. The "typical" set of recommendations given below would be consistent with the DOE RadCon Manual.

**Table 1. Release Fractions (R) for Radioactive Materials**

| Physical Form | Release Fraction (R) |
|---|---|
| Gases or volatile material | 1.0 |
| Non-volatile powders, beta-gamma | $10^{-2}$ |
| Non-volatile powders, alpha | $10^{-3}$ |
| Solid (including pellets or metal) | $10^{-5}$ |
| Liquids | $10^{-4}$ |
| Surface contamination, beta-gamma | $10^{-3}$ |
| Surface contamination, alpha | $10^{-4}$ |
| Encapsulated material | 0.0 |

Table 2. Confinement Factor (C) for Workplace Conditions

| Type of Confinement | Confinement Factor (C) |
|---|---|
| Glovebox | 10 |
| Hood (well-ventilated) | 1.0 |
| Open bench - normal ventilation | 0.1 |
| Non-routine, violent, or special or unknown ventilation | 0.01 |

Table 3. Recommended Air Monitoring Actions based on Hazard Index.

| Hazard Index (% of ALI) | Action |
|---|---|
| <2 | Very low hazard. No action required. |
| 2 to 100 | Air sampling. |
| >100 | Real-time air monitoring. |

## SUMMARY

Air monitors and samplers should be used to confirm that no releases of airborne radioactive material have occurred, to monitor the levels of expected releases during operations, or to detect unexpected releases. The placement and use of such devices should have a documented and defendable technical basis, and one procedure which leads to such a basis has been described in this paper. Oak Ridge National Laboratory is continually improving its radiation protection instrumentation program, with the intent of reducing the occupational radiation dose for all workers to the lowest reasonable level.

## REFERENCES AND RELATED DOCUMENTS


1. DOE Order 5480.11, "Radiation Protection for Occupational Workers," (revision in progress).

2. Draft DOE Implementation Guide, "Internal Dosimetry," (Revision 4.1, October 1991).

3. Draft DOE Technical Manual, "Internal Dosimetry Programs," (Revision 11, October 1991).

4. NRC Technical Resource NUREG-1400, "Air Sampling in the Workplace," (Draft, October 1991).

5. Brodsky, A. 1980. "Resuspension Factors and Probabilities of Intake of Material in Process (Or 'Is $10^{-6}$ a Magic Number in Health Physics?')." Health Physics 39, 992 (1980).

6. DOE N 5480.6, "Radiological Control Manual," June 1992.