
**Surveillance of the activity
concentrations of airborne radioactive
substances in the workplace of
nuclear facilities**

*Surveillance de l'activité volumique des substances radioactives dans
l'air des lieux de travail des installations nucléaires*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

Introduction

Sampling of airborne radionuclides and monitoring of activity concentration in workplaces are critically important for maintaining worker safety at facilities where dispersible radioactive substances are used. Specifically, air sampling and monitoring are critical for evaluation of containment integrity, evaluation of effectiveness of contamination control programs and work practices, providing measurements for qualitative dose assessment, providing a general assessment of the level of the airborne hazard in a room, and for providing workers an immediate warning when the activity concentration exceeds safe levels.

This document sets forth guidelines and performance criteria for sampling airborne radioactive substances and monitoring activity concentration in the workplace of nuclear facilities. Emphasis is on health protection for workers in indoor environments. This document provides best practices and performance-based criteria for the use of sampling devices and systems, including delayed radioactivity measurement samplers and continuous air monitors. Specifically, this document covers air sampling program objectives, design of sampling and monitoring programs to meet program objectives, methods for air sampling and monitoring in the workplace, and quality assurance to ensure system performance toward protecting workers against unnecessary inhalation exposures. Taken together, these activities constitute the sampling or surveillance program.

The primary purpose of the surveillance of airborne activity concentrations in the workplace is to evaluate and mitigate inhalation hazards to workers in facilities where these may become airborne. Results often provide the basis for development and evaluation of control procedures and may indicate if engineering controls or operational changes are necessary.

The surveillance can consist of two general techniques. The first is retrospective sampling, in which constituents of the air are sampled, the collection medium is removed and taken to a radiation detector system and analysed for radioactive substances, and the activity concentration results made available at a later time. In this context, the measured activity concentrations are evaluated retrospectively. The second approach is real-time monitoring, in which activity concentrations are continuously monitored so that workers can be warned that a significant release of airborne activity may have occurred. In implementing an effective sampling program, it is important to achieve a proper balance between the two general approaches of the program. The specific balance depends on the hazard level of the work and the characteristics of each facility.

When designing a surveillance program, the optimization of worker protection minimizes internal and external exposures while balancing social, technical, economic, practical, and public policy considerations that are associated with the use of the radioactive substance.

A comprehensive surveillance program should also consider that the monitoring program is only one element of a comprehensive radiation protection program. Therefore, individuals involved with the monitoring program should interact with personnel working in the other elements of the radiation protection program, such as contamination control and internal dosimetry.

Surveillance of the activity concentrations of airborne radioactive substances in the workplace of nuclear facilities

1 Scope

This document provides guidelines and performance criteria for sampling airborne radioactive substances in the workplace. Emphasis is on health protection of workers in the indoor environment.

This document provides best practices and performance-based criteria for the use of air sampling devices and systems, including retrospective samplers and continuous air monitors. Specifically, this document covers air sampling program objectives, design of air sampling and monitoring programs to meet program objectives, methods for air sampling and monitoring in the workplace, and quality assurance to ensure system performance toward protecting workers against unnecessary inhalation exposures.

The primary purpose of the surveillance of airborne activity concentrations in the workplace is to evaluate and mitigate inhalation hazards to workers in facilities where these can become airborne. A comprehensive surveillance program can be used to

- determine the effectiveness of administrative and engineering controls for confinement,
- measure activity concentrations of radioactive substances,
- alert workers to high activity concentrations in the air,
- aid in estimating worker intakes when bioassay methods are unavailable,
- determine signage or posting requirements for radiation protection, and
- determine appropriate protective equipment and measures.

Air sampling techniques consist of two general approaches. The first approach is retrospective sampling, in which the air is sampled, the collection medium is removed and taken to a radiation detector system and analysed for radioactive substance, and the concentration results made available at a later time. In this context, the measured air concentrations are evaluated retrospectively. The second approach is continuous real-time air monitoring so that workers can be warned that a significant release of airborne radioactivity may have just occurred. In implementing an effective air sampling program, it is important to achieve a balance between the two general approaches. The specific balance depends on hazard level of the work and the characteristics of each facility.

A special component of the second approach which can apply, if properly implemented, is the preparation of continuous air monitoring instrumentation and protocols. This enables radiation protection monitoring of personnel that have been trained and fitted with personal protective equipment (PPE) that permit pre-planned, defined, extended stay time in elevated concentrations of airborne radioactive substances. Such approaches can occur either as part of a planned re-entry of a contaminated area following an accidental loss of containment for accident assessment and recovery, or part of a project which involves systematic or routine access to radioactive substances (e.g. preparing process material containing easily aerosolized components), or handling objects such as poorly characterized waste materials that may contain radioactive contaminants that could be aerosolized when handled during repackaging. In this special case, the role of continuous air monitoring is to provide an alert to health physics personnel that the air concentrations of concern have exceeded a threshold such that the planned level of protection afforded by PPE has been or could be exceeded. This level would typically be many 10's or 100's of times higher than the derived air concentration (DAC) established for unprotected workers. The monitoring alarm or alert would therefore be designed not to be confused with the normal

monitoring alarm, and the action taken in response would be similarly targeted at the specific site and personnel involved.

The air sampling strategy should be designed to minimize internal exposures and balanced with social, technical, economic, practical, and public policy considerations that are associated with the use of the radioactive substance.

A comprehensive air sampling strategy should also consider that the air sampling program is only one element of a broader radiation protection program. Therefore, individuals involved with the air sampling program should interact with personnel working in other elements of the radiation protection program, such as contamination control and internal dosimetry.

This document does not address outdoor air sampling, effluent monitoring, or radon measurements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11929, *Determination of the characteristic limits (decision threshold, detection limit and limits of the confidence interval) for measurements of ionizing radiation — Fundamentals and application*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

accuracy

closeness of agreement between a measured value and a true value

3.2

aerodynamic diameter

D_a

diameter of a sphere with density 1 000 kg·m⁻³ that has the same sedimentation velocity in quiescent air as the actual particle of arbitrary shape and density

3.3

aerosol

dispersion of solid or liquid particles in air or other gas

Note 1 to entry: An aerosol is not only the aerosol particles.

3.4

airborne radioactive substance

radioactive substance dispersed in the air in the form of dusts, fumes, particulates, mists, vapours, or gases

3.5

air contamination area

area accessible to individuals where the measured activity concentrations of an airborne radioactive substance exceeds or is likely to exceed the applicable national criteria