Preface

A-VORBEMERK-LUFT

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Procedures manual for monitoring of radioactive substances in the environment and of external radiation
(Messanleitungen für die „Überwachung radioaktiver Stoffe in der Umwelt und externer Strahlung")

Preface

In Germany, the monitoring of radioactivity contained in the atmosphere is based on the following legislation:

- The law regulating the Deutscher Wetterdienst (DWD),
- the Precautionary Radiation Protection Act (Strahlenschutzvorsorgegesetz, StrVG),
- the Radiation Protection Ordinance (Strahlenschutzverordnung, StrlSchV) and the guidelines for the monitoring of emissions and immissions of nuclear installations (REI) that are based on it.

According to the General Administrative Regulation on the Integrated Measuring and Information System for the Monitoring of Radioactivity in the Environment (AVV-IMIS) (1), gamma spectrometric measurements, measurements of alpha emitters, measurements of Sr-89/Sr-90, and measurements of gaseous iodine radionuclides are to be taken in normal operations.

According to REI, gamma spectrometric measurements of airborne particulate radionuclides and of alpha emitters and Sr-90 are mandatory as well (2).

The aim of the measurements is to determine activity concentrations of airborne particulate and gaseous radionuclides in the atmosphere. In order to be able to measure these very small activities, airborne particulate is captured on a filter or gaseous radionuclides are accumulated through adsorption on a suitable adsorbent. Here, two methods can be distinguished:

a) Airborne particulate matter or gaseous radionuclides, as may be the case, are separated on a stationary filter or adsorbent, respectively, and their activity is then measured.
b) Activity is continuously determined by extracting airborne particulate matter on a uniformly moving filter band that is constantly measured, or through monitoring a stationary filter for changes in activity.

The mean activity concentration is determined from the separated activity relative to the air throughflow volume and the collection period.

The degree of representation of a sample is determined by the configuration of the sampling installation, i. e., its location, the inflow speed of the air, the type of filter used, and the type of pump employed (3). In order to comply with prescribed detection limits, air throughflow, collection interval, measuring period, and the detector used need to be optimised.

Gamma spectrometry is the most important technique for determining the nuclide-specific composition of individual gamma emitting radionuclides, as this technique permits to directly measure the filter or measure ashed filter residue.

In order to identify radionuclides that are present only in traces, a high volume of air throughflow, long collection intervals, and extended measuring periods are inevitable. Nuclide-specific measuring results then facilitate the evaluation of even minute changes in the activity concentration at trace level in the range of 0,1 $\mu Bq \cdot m^{-3}$.

Analyses and interpretations of results need to take into consideration the different behaviour of natural and artificial radionuclides in the atmosphere (4).

Being constituents of natural decay chains, the noble gases Rn-220 and Rn-222 emanate from the ground and so reach the atmosphere. They give rise to decay products – short-lived lead, bismuth and polonium isotopes – that attach themselves to airborne particulate matter. Depending on weather conditions, these are horizontally and vertically displaced and eventually return to the ground through dry deposition or the rinsing effect of precipitation. As a result, natural radioactivity reaches its highest concentrations near the ground.

The concentration of natural radioactivity in the atmosphere is subject to weather-influenced fluctuations. Precipitation, frost and snow cover cause a reduction, as they obstruct the emanation of the above-mentioned noble gases from the ground. Wind and sunny conditions with the ground being dry, as well as inversion situations in lower strata increase the concentration of natural radioactivity. The activity concentration above oceans is only about 1 % of that above land, with the emanation of radon being negligible. Air above the sea therefore has a significantly lower degree of activity than air above land.

A different behaviour is noted in artificial radionuclides that have entered the atmosphere as a result of atmospheric nuclear tests or emissions from nuclear installations. Gravity will here ensure that part of the airborne particulate radionuclides are returned to the ground near the site of original emission as a "local deposition". The remaining part, whose sedimentation plays practically no role due to the small size of the aerosol particles, is left suspended in the air and will be displaced both horizontally and vertically with the respective atmospheric currents. Taking long translocation routes, sometimes as much as several circumglobal orbits, this airborne particulate matter may not only be globally distributed, but also end up in the collector of a sampling installation where their activity concentration is determined with suitable measuring instrumentation.

In specified normal operation, activity is mainly attached to airborne particulate matter with an aerodynamic diameter of between 0,1 µm and 20 µm (see procedure J-γ-SPEKT-ALUFT-03). Experiments have demonstrated that the activity distribution as a function of aerosol particle diameter experiences only a minor shift towards larger aerosol particles even in the case of an accident (5).

Depending on their size, radioactive particles have a residence time of about 10 days to 20 days in the troposphere. The residence time of aerosol particles in the stratosphere varies from 1 year to 10 years. The transport of airborne particulate matter from the stratosphere to the troposphere usually takes years. The transport rate increases in spring, however, when it is favoured by tropopause gaps. In the 1950s and 1960s, this led to regularly observed spring maxima in the activity concentrations of those artificial radionuclides in the atmosphere near the ground that had been released through nuclear tests. Depositions from the troposphere are facilitated mainly by precipitation (rain, snow etc.).

References

(1) German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (ed.): Allgemeine Verwaltungsvorschrift zum Integrierten Mess- und Informationssystem nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) (Common Administrative Procedure on the Integrated Measuring and Information System according to the Precautionary Radiation Protection Act), Federal Gazette 47, Number 200a dated 24. October 1995

(2) German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (ed.): Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen (Guideline concerning Emission and Immission Monitoring of Nuclear Installations) GMBl. 44, dated 19. August 1993

(3) Klockow, D.: Zum gegenwärtigen Stand der Probenahme von Spurenstoffen in der freien Atmosphäre, Fresenius Z. Anal. Chem. 326: 5-24, 1987

(4) Hinzpeter, M., Meyer, H. K.: Meteorologische Einflüsse auf radioaktive Beimengungen in der Atmosphäre, Schriftenreihe des Bundesministers für Atomkernenergie und Wasserwirtschaft, Strahlenschutz, Heft 16, 1961

(5) Langhans, J.: Two-dimensional analysis of the thermohydraulic and aerosol behavior in the phebus-FPTO-containment vessel. J. Aerosol Sci., Vol. 25, Suppl. 1, S 89-90, 1994