

Self Assessment as Internal Control Tool for Occupational Exposure

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Abstract

In Germany regional authorities regulate practices using radio-nuclides by means of conditions as elements of licenses in order to control and minimise the exposure of workers involved in these activities and the public.

Users of unsealed sources, e.g. radio-chemical, biotechnological, pharmaceutical, neutron activation laboratories are classified in terms of the amount of radioactivity and its way of handling thus setting the laboratory-layout and technical equipment required and defining designated areas prior to licensing. The use of sealed sources is categorized according to source types, activities and external exposure conditions.

In Bavaria the user's radiation safety officer has to assess and report to the authority the amount of potential activity intake and the dose resulting thereof as well as any external dose. Depending on these estimates the strategy for monitoring and minimising radioactive intake and external exposure to levels established by legislation has to be outlined and measures taken accordingly. NORM users are regulated correspondingly.

Not strictly related to "occupational" exposure the conditions for licensees' control of releases of radioactive materials to the atmosphere, sewer or as waste are briefly reviewed as yet another practical self assessment tool.

Enforcement regime

Dosimetry

The German Radiation Protection Ordinance, in July 2001 implementing the Council Directive 96/29/Euratom, sets out to limit doses to workers and the public to annually

- 1 mSv effective dose
 - 15 mSv organ dose eye lense
 - 50 mSv organ dose skin
- for individuals of the public
- 6 mSv effective dose
 - 45/150 mSv organ doses eye lense/skin, hands, feet
- for category B workers
- 20 mSv effective dose
 - 50 mSv organ dose gonads, uterus, marrow
 - 150 mSv organ dose eye lense and organs
 - 300 mSv organ dose thyroid and bone surface
 - 500 mSv organ dose hands and feet
- for category A workers
- 400 mSv effective life dose workers
 - 100/250 mSv annual/life dose on particular occasions.

Monitoring of occupational exposures is required for workers in designated controlled areas, unless keeping within 1mSv effective dose or one tenth of category A workers' organ doses is ensured:

Controlled areas are surveyed determining the

- dose rate
- concentration of airborne radioactive matter
- workplace contamination.

Individual doses to workers are determined by these measurements and additionally by monitoring the

- body or excretion activity
- assessing further properties of the radiation source or field.

Radioactive discharges and waste disposal

The basic restriction for the exposure of the public via atmospheric or liquid discharges of radioactive material is an effective individual dose limit of 0.3 mSv/a. The equivalent limit for the release of radioactive waste via the usual disposal pathways is 10 μ Sv/a.

Based on the relevant assumptions of potential exposures for the critical population groups via ingestion and inhalation concentration limits have been calculated and implemented for all media concerned and more or less all radionuclides in use.

Self assessment of dosimetry requirements

Applicants for licensed practices using sealed sources must specify the dose rates of sources and storage facilities submitting source manufacturer's data and shielding calculations.

Applying for practices with unsealed radioactive materials involves the accurate listing of nuclides used, their chemical and physical properties i.e. species and volatility, the activities stored and handled daily as well as the probabilities of releases of radioactive matter into the workplace atmosphere. The practice is classified within four safety categories and conditions established accordingly in the licence.

An adequate period after commencement of operations the responsible person has to assess the radiological exposure of his workers and report to the authority. The external dose is readily estimated by means of dose rate surveys, manufacturer's source specifications and accountancy of exposition hours, enabling the RSO to categorise workers and determine further dosimetry requirements.

The potential doses from internal radiations caused by inhalation of unsealed radioactive materials are assessed as follows:

$$A_U \cdot D_K = D_i$$

where

$$A_U = a \cdot N \cdot A$$

with

A_U	maximum potential annual intake
a	relative fraction of workplace activity which can be incorporated unnoticed $a = 5 \cdot 10^{-5}$ under normal conditions
N	exposition days per annum $N = 200$ unless other indications
A	annual mean value of workplace activity
D_K	effective (or organ) dose coefficient for internal occupational exposure (Sv/Bq)

Dose coefficients were adopted in 2001 from the "ICRP Database of Dose Coefficients : Workers and Members of the Public".

Typical occupational inhalation dose coefficients for frequently used nuclides (Sv/Bq):

	water & gas effective	organic critical organ		effective	critical organ
H-3	1.8E-11	4.1E-11	I-125	7.3E-09 1.4E-08 vapour	1.5E-07 thyroid 2.7E-07 thyroid
	effective	critical organ	I-131	1.1E-08 2.0E-08 vapour	2.1E-07 thyroid 3.9E-07 thyroid
P-32	2.9E-09	1.6E-08 lung	Th-228	2.5E-05	2.1E-04 resp. tract
P-33	1.3E-09	9.6E-09 lung	Th-232	2.9E-05	1.5E-03 bone surface

C-14 5.8E-10 vapour

1.5E-05 resp. tract

Cr-51 3.6E-11 2.5E-10 respiratory tract

Where regular monitoring of air concentrations of radionuclides takes place, these can be used for the estimation of inhalation exposure instead.

Ingestion doses are usually neglectable due to less intake or lower dose coefficients.

If the above estimate for D_i exceeds 1 mSv/a the licensee induces appropriate individual dosimetry measures and reports them to the authority for approval.

Acknowledged dosimetry methods are defined in the "Guideline for Physical Radiation Protection Surveillance", implemented 1994, "Guideline for Assessment of Exposure by Incorporated Radiation Emitters", 1997.

The implementation of the BSS (96/29/Euratom) now covers work activities in non-nuclear industries involving NORM, too. Use of uranium or thorium not on behalf of their radioactive properties does not require licences. Certain work activities, however, which might lead to significant exposure of the workers or the public have been identified and are listed in the Radiation Protection Ordinance. The facility's management has to assess the exposure to radon-222 or the potential intake of uranium, thorium and their associated decay products. If the effective dose can exceed 6 mSv/a the persons concerned and the type of work must be reported to the regulatory authority. Assessment is usually carried out by means of determination of the airborne dust concentration followed by the analysis of the dust for the relevant nuclides and dose calculations corresponding to working hours.

Self assessment of atmospheric and sewer discharges and release as waste

Compliance with the discharge concentration limits established by legislation or license conditions is in the first instance placed in the facility's responsibility. Since annual inventories on the total input and output activities are to be submitted the inspecting authority will decide on how to verify compliance by means of control measures either by themselves or by acknowledged experts. In larger communities radionuclide concentrations in sewers are surveyed by the operating organisation of the sewer system.

On account of the sophisticated regulations and clearance levels for radioactive waste and the analytical difficulties encountered when measuring activity concentrations at these low levels and inhomogeneous batches, the self assessment tools conceded to disposers are consequently more severe. Thus the release of laboratory, medical or industrial radioactive waste as non-active waste requires well-defined procedures, written instructions, appropriate equipment and skilled personnel to safeguard compliance with the waste management regulations.

If the licensee cannot prove these qualifications at his disposal, the clearance of each batch of waste has to be applied for and approved by the authority.

Experience and Conclusion

No internal doses exceeding 1 mSv/a were found for laboratory and medical uses of H-3, P-32, P-33, S-35, Cr-51, Tc-99.

Incorporation causing higher doses was experienced for I-131 nursing staff and I-125 laboratory staff. Regular monitoring has been implemented consequently by means of thyroid monitors for I-131 and urine analyses for I-125.

Regulations for workplace applications involving ionising radiations require the control of exposures to workers and the public due to their activities. In Bavaria the regulator makes the user carry out dose assessments and develop control strategies laid out by guidelines. Experience shows that these self assessment tools, controlled by reports and inspection help to improve radiological knowledge and strengthen safety consciousness and sense of responsibility of radiation safety personnel and workers.

