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Zentrale Verwaltung
Abteilung V-5
Arbeitsbereich Isotopenanwendung

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Radiation protection instructions for the work area Isotope Application at Ulm University

Radiolabelled substances play an important role in modern biomedical research. Their handling is regulated in the German radiation protection ordinance, which again gives rise to various general precautionary measures and rules of conduct. Furthermore, each laboratory has specific operational and organisational rules. Compliance with the resulting radiation protection instructions is important to ensure safe handling of radioactive isotopes but also to safeguard the environment.

The handling of radioactive substances poses to two potential hazards:

a) Radiation exposure during experimentation with radioactive substances

b) Accidental incorporation of radioactive material leading to more or less long-term radiation exposure of body organs.

Moreover, any contamination that is not removed –even if it is far below all health-risk thresholds—can invalidate any experiment.

Therefore, even very small amounts of radioactive substances must be handled with utmost care to prevent not only health risks but also workplace contamination.

The bodily harm resulting from radiation exposure through the two hazard mentioned above varies greatly. Radioactive isotopes emitting soft beta radiation pose less external radiation hazard than gamma radiation-emitting nuclides. Isotopes with a long half-life and specific affinity to body tissues are more dangerous after incorporation than isotopes with a short half-life and a homogenous distribution in the body.

The radiation protection ordinance defines so called exposure limits for the individual radionuclides in line with their radiotoxicity. These are the activity amounts that a non-specialised laboratory may handle. The table below lists the exposure limits of the radionuclides most frequently used at Ulm University.

Isotope	Exp. limit in Bq	Exp. limit in µCi
^{90}Sr, ^{137}Cs, ^{204}Tl	1 x 10^4 Bq	0,27 µCi
^{32}P, ^{90}Y, ^{60}Co, ^{86}Rb	1 x 10^5 Bq	2,7 µCi
^{22}Na, ^{36}Cl, ^{54}Mn, ^{55}Fe, ^{57}Co, ^{59}Fe, ^{75}Se, ^{85}Sr ^{95}Nb, ^{103}Ru, ^{109}Cd, ^{125}I, ^{131}I, ^{133}Ba, ^{152}Eu, ^{186}Re	1 x 10^6 Bq	27 µCi
^{14}C, ^{45}Ca, ^{51}Cr, ^{99m}Tc, ^{141}Ce, ^{145}Pm	1 x 10^7 Bq	270 µCi
^{33}P, ^{35}S, ^{63}Ni	1 x 10^8 Bq	2700 µCi
^{3}H	1 x 10^9 Bq	27000 µCi

To assess the risks inherent in any experiment the characteristics of the used isotopes and of the respective experiment must be taken into account. Irrespective thereof, there are some rules that need to be observed in **any handling** of radioactive isotopes.

GENERAL RULES

All persons wishing to work in the controlled area must register **before starting their work**.
Please ask employees in the work area Isotope Application for registration forms.

All persons working in the controlled area must undergo **personal dose controls**. Persons working with gamma and hard beta emitters must wear a film badge while persons handling soft beta emitters must regularly submit urine samples. Employees of the individual units are responsible for dispensing, collecting and the monthly submission of the badges and dosimeters. For further details please contact the work area Isotope Application.

Any **withdrawal of radioactive substances** from the storage cabinets or the stock solution containers must be entered in the provided forms. Radioactive substances may only be taken from the work area Isotope Applications in consultation with the radiation safety officer. Type and amount must be entered in a register of withdrawals and countersigned by the user.

All persons in the controlled area working with activities **exceeding exposure limits more than 100-fold** must previously inform the radiation safety officer. Such experiments require the presence of **two** or more persons. Moreover, protective clothing must be worn, which is blue in contrast to ordinary laboratory coats. Before leaving the controlled areas, this clothing must be checked for radioactive contamination with the monitor provided for this purpose and then taken off.
The blue protective clothing must never be worn outside the controlled area!

Nobody is allowed to enter the controlled area unless required to do so for specific tasks. Each access must be entered in writing in the register of clearance measurement and dose control provided at the entrance.

All experiments using radioactive isotopes require **special cleanliness and care**. Precautions for handling radioactive substances are, in many respects, similar to those required for bacteriological work. This work requires a high degree of orderliness.

Before **introducing any new method** using radioactive isotopes, blank tests using non-radioactive substances must be carried out in order to minimize radiation exposure and risk of accidents as much as possible while developing the new method.

All laboratory benches and other surfaces in the isotope laboratory where radioactive contamination cannot by excluded **must be covered** before work by absorbent paper sealed with an impermeable plastic film at the underside. This paper is provided by the work area Isotope Application.
Radioactive solutions are handled over a tray large enough to hold all the liquid in case of breakage of the containers. If possible, radioactive solutions must be held not only in their own container (glass bottle) but also in a second container made of polyethylene or any other break-proof material.

The **stock solutions of the radioactive substances** or any other solutions containing high levels of radioactivity must be kept under lock and key and, if required, in a lead-lined safe. They are dispensed by the staff of the work area at the beginning of the experiment **(no self-service!)**.

Radioactive material may only be kept **at the workplace in such quantities** and for as long as is required by the process step. The vessels holding the radioactive material may not be left open or outside the protective containers longer than necessary for the process step.

All radioactive experiments in the controlled area should be conducted during normal office hours. Should an experiment urgently require that **work is done outside normal office hours**, a special arrangement must be made with the radiation safety officer.
Office hours of the radiation safety officers:
Mon. – Thu. : 8.30 am to 3.30 pm,
Fri.: 8.30 am to 2.00 pm

PRECAUTIONS AGAINST EXTERNAL RADIATION

As radiation intensity decreases with the square of the distance to the source of radiation (inverse square law), instruments for indirect handling of the source of radiation can already provide a high degree of radiation protection.

Where higher-activity radiation sources are used, additional lead-lined protective screen must be available. If only beta radiation is used, a 0.5 cm glass screen or a 1 cm Plexiglas screen are sufficient protection. Where radioisotopes emitting hard gamma radiation are handled, it is necessary to use a gap-free protective shield of lead bricks with a thickness of 5 cm to warrant sufficient protection against the gamma rays.
The isotope application work area provides workplaces offering such protection.

PRECAUTIONS AGAINST CONTAMINATION, INHALATION OR INCORPORATION

To avoid contamination of the hands any handling of open sources of radiation requires the use of disposable gloves, which are then disposed of with the radioactive waste.
Should the hands have become contaminated despite the gloves, they must be intensively washed with soap and a nail brush until no more contamination can be detected. In exceptional cases it may be necessary to cut the finger nails very short to eliminate any contamination under them. If any radioactive liquid splashes into your face, it may be necessary to wash your hair in the hand wash basin. Extensive skin contamination should be washed off under a shower.

Radioactive substances must not be handled by persons with open wounds or a rash on their hands or wrists, even if such injuries are bandaged.

The pipetting of solutions using the mouth is not permitted in the isotope laboratory.
For labelling bottles or materials, only self-adhesive labels may be used.

In areas where open radioactive substances are kept or used the following items must not be introduced or used:

a) Food or beverages
b) Tobacco products
c) Lip sticks or any other cosmetics or tools to apply them
d) Personal tissues (cloth handkerchiefs that are put back)
e) Dishes and drinking vessels

The isotope laboratories provide paper tissues and paper towels.

Whenever radioactive gas, dust or vapour may form during the work with radioactive isotopes, such work must be done using adequate exhaust ventilation. If necessary, respiratory masks must be worn for extra protection.

PREVENTION OF CONTAMINATION OF LABORATORIES

In labs with workplaces for both radioactive and non-radioactive work, the use of radioactive materials should, if possible, be restricted to one area in the lab. The area where radioactive substances are handled should, if possible, be very limited, i.e. try not to “spread all over the table”. To minimize experimental errors through radioactive contamination, work involving large amounts of radioactivity should be kept separate from work using low activity.

> **Any incidence of contamination must immediately be reported to the radiation safety officer.**

To do this, the lab may only be exited if the contamination can clearly and without any doubt be localised. Otherwise, the telephones available in all labs must be used.

In particular, any accidental contamination of the floors must be avoided as the radioactivity spreads very quickly to cover a large area.
However, if floors have become radioactively contaminated, such areas must be marked immediately. Such areas of the laboratory may not be accessed until measurements show that such areas are no longer contaminated.
Special care must be taken when working with isotopes such as ^{3}H, ^{14}C and ^{35}S.

These radionuclides are very difficult or impossible to detect using standard laboratory equipment.
For this reason the following general rule applies:

> **Checks MUST be carried out by the personnel in the work area in case of ANY suspected contamination. If any “cover up” can be demonstrated, the person responsible may be banned from working in the controlled area.**

Everybody is responsible for keeping their workplace clean (free of contamination). To do this, after finishing the experiment the workbench, the floor, the sinks and all glassware as well as all equipment must be checked for contamination **using the appropriate radiation measuring instrument!**
For isotopes ^{14}C and ^{35}S, an argon methane flowmeter is used; for all other isotopes, xenon monitors are available. (For any work involving ^{3}H, a wipe test is required to ensure absence of contamination.)

If external users introduce equipment into the controlled area, this must undergo thorough checks for contamination before exiting the controlled area.

When leaving the controlled area, all users must undergo clearance measurements using the hand, foot and clothes monitor by the exit and entering this in the register.
Any contamination of hands or feet MUST be reported to the radiation safety officer.

DISPOSAL OF RADIOACTIVE WASTE

The following rules apply to any work done in the controlled area of the isotope application work area:

1. **Liquid radioactive waste** is, as a rule, collected
   (avoid large volumes!) and poured into the receptacles provided.
   In the waste room, there are receptacles for the following categories:

   A) liquid, inorganic (watery)
   1) > 100 days half-life
   2) < 100 days half-life
   3) ^{32}P (biologically contaminated) waste water

   B) liquid, organic (flammable)
   All nuclides

2. **Solid radioactive waste** must be separated into:

   A) flammable (e.g.: cellulose, gloves, pipette tips)
   1) > 100 days half-life loose in 120 l - containers
   2) < 100 days half-life shrink-wrapped in plastic bags.

   B) non-flammable (e.g.: glass, metal, aluminium foil)
   all nuclides in Plexiglas containers

The activity amount, isotope etc. must be entered in the respective forms.

3. **Scintillation vials are <u>separated</u>** according to their threshold values:

Isotope <		**Isotope >**	
H3	600000 cpm	H3	600000 cpm
C14	48000 cpm	C14	48000 cpm
S35	36000 cpm	S35	36000 cpm
P32	12000 cpm	P32	12000 cpm
⇩		⇩	
Shrink-wrapped in plastic bags, number of samples (max. 100 vials resp. 150 mini-vials per bag)		loose in 25 l – containers, (Bq x 10^4)	

and entered in the lists provided.

4. **<u>Animal carcasses and other biological materials</u>**
   are placed in opaque plastic bags and labelled with a water-insoluble pen.
   Data to be indicated are: Type and quantity of the isotope and date.
   These data, together with the name, must be transferred to the list provided and the bags must frozen in the freezer provided for this purpose.

The staff in the isotope application work area are happy to answer any question related to the handling of radioactive isotopes you may have.

<u>PLEASE CONTACT</u>

Head of radiation protection:	Ms E. Brax	22131
Radiation safety officers:	Ms Y. Bozyk	22551
	Ms B. Wolfgang	22551
	Ms J. Kupfer	22551
	Ms E. Bauer	22551
	Mr R. Dick	22137
Waste disposal	Mr F. Schwender	22136
Company doctor:	Dr. Kren-Lotspeich	66190