Local radiation protection rules when working with

RADIOACTIVE SUBSTANCES

at Karolinska University hospital Solna
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General information

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Local license requirements

The valid radiation protection legislation is adapted to the standards of the European Union. Consequently similar rules apply in most European countries.

Local license

Work with radioactive substances is only allowed if you have a local license to work with open radioactive sources issued by the Department of Nuclear Medicine, VO Sjukhusfysik (Hospital Physics). Laboratories are assigned a level (1-4) depending on the sort and range of work.

Radiation protection review

Nuclear Medicine performs annual radiation safety reviews at all laboratories working with radioactive substances. During the radiation safety review we ensure that the conditions for the holding of the license are met. The radiation safety review is a condition in order to get the license annually renewed.

Person in charge

For each laboratory with a local license a person in charge has been designated to ensure that the requirements have been met and in particular regarding that no radionuclides will be used except those stipulated in the licence

- the amount of activity permitted for disposal or storage is not exceeded
- records are kept of ordered and delivered radionuclides
- changes in purchases of radionuclides are reported to Nuclear Medicine
- the work with radioactive substances is carried out in approved premises
- all staff have adequate radiation protection training
- all staff have access to suitable radiation protection equipment
- personal dose and contamination measurements are conducted according to instructions
- radioactive waste is disposed of in accordance with local instructions
- all radiation related incidents and accidents are reported (page 17)
- a radiation protection supervisor is designated for the laboratory.

Radiation protection supervisor (contact)

Each licensed laboratory shall designate a radiation protection supervisor. The radiation protection supervisor’s duties are to

- give local instructions for work with radionuclides such as purchase, storage and waste procedures, where and how work should be conducted
- ensure that not only the laboratory staff but also students and visiting scientists have suitable training in radiation protection
- give local cleaning instructions for cleaning managers and cleaning staff
- monitor purchases of radio nuclides as well as keep a record of these to ensure that the maximum holding is not exceeded
- order and manage personal dosimeters and dose reports in the laboratories using dosimeters
- update Radiation safety file and/or be familiar with relevant radiation safety documentation in the document management system Centuri (se section I.7)
- ensure that all personnel working with unsealed sources partake of the radiation safety documentation and know where it is available
- ensure that all personnel reads the local radiation protective rules and sign it in the Radiation safety file.
Laboratory level

All laboratories at Karolinska University Hospital Solna working with unsealed radioactive sources are assigned a level. The department of Nuclear Medicine makes the decision.

- Level 1: Extensive work.
- Level 2: Laboratory work.
- Level 3: Low activity work.
- Level 4: Dormant license.

For more information, see the document “Nivåindelning av laboratorier” found in the document management system Centuri.

Categorisation

The Radiation Safety Authority (SSM) requires that both the staff who work with unsealed sources and the premises where the work is performed are categorised.

Categorisation of staff

The staffs are divided into categories according to their work. Staff may belong to category A, B or be uncategorized. Nuclear Medicine determines which category a worker is designated to. Most personell working with radioactive substances at the hospital belong to category B.

A worker will be categorised as category A

If it is deemed a risk that the staff could get an annual effective dose exceeding 6 mSv. For category A workers the following rules apply:

- Wearing personnel dosimeter with a measuring period of four weeks.
- Undergo periodical medical examinations every three years.
- Submit health declaration to your employer intervening years.

A worker will be classified as category B

If it is calculated that the annual effective dose could reach 1 mSv but not exceed 6 mSv workers are classified as category B workers if dose estimates and control procedures demonstrate that the placement is correct. This assessment is made by hospital physicists at Nuclear Medicine.

For more information, see the documents “Bedömningsgrunder för kategoriindelning av personal och arbetsställen inom verksamheter med joniserande stråning” Riktlinjer för persondosimetri inom verksamheter med joniserade strålning” and “Hälsoundersökning för arbetstagare i kategori A i arbete med öppna strålkällor” found in the document management system Centuri.

Categorisation of premises

All facilities where unsealed radioactive sources are used or stored are classified as controlled or supervised areas. Most areas within the premises of the Karolinska Hospital are defined as supervised areas. Nuclear Medicine conducts the classification.

A controlled area:

- There is either a considerable risk of contamination and/or category A workers work here.
- It is necessary to prevent, or closely supervise, access to the area by unauthorized employees or visitors.
- The controlled area must be clearly labelled and identified.
- The local radiation protection rules for the area must be written down and easily available for all staff members.

A supervised area:

- Workers belong to either category A or B.
- The protected area must be clearly labelled.
- The staff should have good knowledge of the areas written or oral rules.

For more information, see the documents “Bedömningsgrunder för kategoriindelning av personal och arbetsställen inom verksamheter med joniserande stråning” Riktlinjer för persondosimetri inom verksamheter med joniserade strålning” and “Hälsoundersökning för arbetstagare i kategori A i arbete med öppna strålkällor” found in the document management system Centuri.
**General radiation safety documentation**

Karolinska University Hospital uses the document managing system Centuri for radiation safety related documentation. All laboratories that can access the hospitals Intranet (Inuti) can also access Centuri, in order to receive instructions contact the department of Nuclear Medicine.

Laboratories that cannot access the web based radiation safety documentation must have current documentation in the radiation safety file. It is important that an annual audit of the documentation is performed if paper copies are used.
Training procedures for radiation safety

All personnel working with radionuclides in the form of unsealed radioactive sources shall in accordance with the Swedish Radiation Safety Authority’s (SSM) rules, have completed basic radiation safety training at their place of work (SSM FS 2008:35 §10).

At Karolinska University Hospital Solna, all personnel must, before work with radionuclides begins, read the “local radiation protective rules” and attend a lecture in basic radiation safety held by the department of Nuclear Medicine.

Both of these elements should be documented and signed by the employee. The local radiation protection supervisor must ensure that:

- the concerned staff read this document and sign for it
- all new personnel are briefed on how to work safely at the laboratory and how to use radiation safety equipment.

The person in charge at the laboratory is responsible for ensuring all staff attends the lecture in basic radiation safety before work with open radioactive sources begins.

Personnel from Nuclear Medicine offers lectures in basic radiation safety and ensures that this step is signed.

Other training requirements may occur and are described in more detail in the document “Rutiner för utbildning i strålsäkerhet av personal i verksamhet med joniserande strålning” found in the document management system Centuri.
**Guidelines for work with radionuclides**

When working with radioactive substances the risk of injury and contamination must be minimized, external and internal exposure should be avoided. A contamination easily leads to an internal exposure when the radioactive substance enters the body through the skin, mouth or nose. A contamination can also lead to inaccurate measurements and false results.

**Protection against external exposure**

**Radiation dose:** the magnitude of the radiation dose depends on several factors including:
- The time spent in the radiation field.
- The distance to the radiation source.
- The radiation shielding.

**Time:**

The external radiation is directly proportional to the time spent in the radiation field. A doubling of the time will mean a doubled radiation dose.
- Work quickly, safely and always systematically.
- Practise new and difficult situations with inert materiel.

**Distance:**

“The inverse square law” is a physical law stating that the intensity of the radiation is inversely proportional to the square of the distance. If the distance to the radiation source is doubled then the intensity will be reduced by a factor of 4, and by tripling the distance the intensity will be reduced by a factor of 9, and so on.

Remember to
- work on the largest possible distance from the source
- Use tongs, forceps or other distance tools for handling radioactive materials
- avoid handling unshielded containers with radioactive substances directly with your fingers.

**Shielding:**

Radiation intensity can be reduced by appropriate shielding. While the material selected depends on the type of emitted radiation the thickness of the shielding is governed mainly by the energy.

- **Beta-emitters**
  - <300 keV No shielding (e.g. $^1$H, $^{14}$C, $^{35}$S)
  - > 1MeV 10 mm Perspex (lucite) (e.g. $^{32}$P)
- **Gamma-emitters**
  - <200 keV 2 mm lead (e.g. $^{125}$I, $^{99m}$Tc)

For higher energies the design and dimension of the shielding depend on the amount of activity as well as the energy. The department of Nuclear Medicine will provide assistance if requested.
- When possible, work behind appropriate radiation shielding (it shields splashes as well).
- Use leaded shields for syringes when working with gamma-emitters.
- Always store your radioactive solutions shielded.

**Protection against internal exposure**

Spills and external contamination may easily lead to internal irradiation if the radioactive compound enters the body through the mouth, skin or respiratory tract. The magnitude of the radiation dose will depend on several factors:
- the activity and the type of emission
- the chemical form of the radioactive compound
- the metabolism of the radioactive compound
- the effective half-life of the radioactive compound.
The chemical compound that the radionuclide is part of is crucial to its exudation and distribution in the human body. This together with the physical nuclear decay properties is essential to the magnitude of the radiation dose to specific organs and whole body.

Working rules to minimise the risk of internal contamination is:

- both intake of and the storage of food and drink, snuffing and smoking is forbidden within the laboratories where radioactive substances are kept and/or used
- coasters with absorbent backing should be used on workbenches
- substances that can get airborne must be handled in a fume box or suchlike
- use protective clothing and gloves. If there is a risk for splashes use protective goggles and scrub cap- change your gloves often
- after completing your work – contamination surveys of workspaces, equipment, clothing and hands should be conducted using a suitable contamination monitor.

The short range of the alpha- and beta particles makes it easy to shield from the external radiation of these compounds. However if they enter the body the short range of the particles will result in a high dose when they are locally absorbed in the tissue.

**Avoiding skin contamination**

Any spillage on the skin from concentrated radioactive solutions may result in locally high-absorbed radiation doses. This is particularly valid for alpha- and beta-emitters with short ranges in tissue.

- Always use gloves, if the radioactive concentration is high, use double gloves.
- Check for contamination.

Instructions to handle suspected skin contamination are available on page 17.

**Contamination control**

**Contamination control with a radiation monitor (not applicable to \(^{3}\)H)**

Levels of radiation must be routinely monitored both within and around all controlled and supervised areas to keep working conditions under review.

The monitoring instruments used must be appropriate to the task and properly maintained. On completion of work, workspaces and clothing should be checked for contamination.

- First note the level of background radiation by measuring in an area of the laboratory where you have not been working with radioisotopes.
- Report to the department of Nuclear Medicine if a detected contamination remains post cleaning.
- Make an entry in the radiation safety file including a short description of decontamination measures.

**Level 1 laboratory** - Perform contamination checks of both the premises and personnel after every time working with open radioactive sources. The document of the result of premises should be kept in the radiation safety file.

**Level 2 laboratory** - Perform and document contamination checks at least every third month even if contamination does not occur.

**Level 3 laboratory** - Perform and document contamination checks when necessary.

Records of monitoring and checks on instruments must be kept for at least 2 years. For decontamination measures see page 16.

Instructions how to conduct contamination surveys are described in the in the document management system Centuri.
Contamination control with a wipe test

Control of contamination by $^3$H (Tritium) is always performed with wipe tests and analysed in a beta counter. Report to the section for nuclear medicine if contamination is still present after decontamination.

Records of monitoring must be kept for at least 2 years. For decontamination measures see page 17.

Instructions for wipe test are available in the document “Strykprov instruktion” found in the document management system Centuri.

Personnel dosimetry

All personnel belonging to category A should wear a dosimeter for four weeks intervals.

If staff categorised as B perform labelling of radioiodine dosimeters should be used during this work.

More information is available in the document “Riktlinjer för persondosimetri inom verksamheter med joniserande strålning” found in the document management system Centuri.

Ventilation control

Laboratories labelling radioiodine require special ventilation control of the workstation (fume hood etc.):

- Before work begins the fume-cupboard, glove box or ventilation hood should be tested to be in working order.
- In laboratories with negative air pressure the gauge must be tested at least every 6 months and the results documented.

Practical radiation protection

When working with unsealed radioactive sources there are several regimes to pursue. Following rules are general. Each laboratory should define specific rules that apply to the current workspace and the work conducted there. These rules should be kept available to all personnel.

1. Always use protective clothes and gloves and change often. Your hair and eyes should also be protected whenever you may be exposed to splashes. Always wash your hands after you have completed your work.
2. Used gloves should always be treated as radioactive waste.
3. Always cover the working benches with absorbing paper with plastic backing. Change regularly.
4. Keep your containers with the radioactive solutions labelled with radionuclide, the amount of activity and time of measurement.
5. Within a laboratory handling radionuclides, eating, drinking, smoking and snuffing are strictly forbidden. No food may be stored in the laboratory.
7. Work on the largest possible distance from the source. Avoid using your fingers to move bottles and syringes containing radioactive solutions. Use syringe shields and special distance tools such as pliers and tweezers.
8. If possible use radiation shields such as Perspex (Lucite) shields when you work with beta-emitters and use lead or lead glass when working with gamma-emitters.
9. Use syringe shields when injecting radioactive substances.
10. Always store your radioactive material within and/or behind a radiation shield.
11. Always use a fume-cupboard or a glove-box when working with volatile radioactive material (gas, steam, splashes, dry radioactive compounds).
12. After work is finished, make a habit of monitoring the working areas, the tools, the clothing as well as your hands.
14. Whenever forced filtration is applied always use suction and never pressure
15. Dispose of radioactive waste as soon as possible after working. Leave the laboratory neat, clean and tidy.
**Pregnant or breast-feeding personnel**

Once the pregnancy has been established it must be notified to the Department of Nuclear Medicine in order to ensure that the dose to the foetus is unlikely to exceed 1 mSv during the remainder of the pregnancy.

Pregnant personnel have the right to deny work which includes the risk of being exposed to ionising radiation.

Breast feeding personnel must contact the Department of Nuclear Medicine for advice.

**Change of or discontinued use of radionuclides**

If the workgroup cease working with radioactive substances this must be reported to the department of Nuclear Medicine.

If there is a change or discontinued use of the premises where radionuclides are used this must also be reported to Nuklear Medicine who will clear the premises before they can be used again.
Order and delivery of radionuclides

Radionuclides for human use
1. Order of radionuclides for human use is made via the Karolinska Pharmacy, radiopharmaceutical laboratory, telephone 517 75354.
2. All radioactive compounds to be used on patients are to be fetched at Karolinska apoteket, radiopharmacy laboratory, A2:U1.
3. All ordered and delivered radionuclides will be registered and control measured by the department of Nuclear Medicine.

All other radionuclides
1. All purchases of radionuclides should be supervised by the radiation protection supervisor to ensure that the maximum activity limits are not exceeded.
2. Ordering can be done directly from the supplier by the radiation protection supervisor.
3. Ordered substances are delivered directly to the laboratory.
4. Records are kept on purchased radionuclides by the radiation protection supervisor containing information on type of radionuclide, reference date and activity. The simplest way of doing this might be to just keep all signed delivery notes.
Storage

1. All radioactive solutions should be kept under lock and be stored safely with respect to fire safety.
2. Radioactive material must be correctly labelled indicating the radionuclide, the amount of activity and the time of measurement.
3. Storage spaces must be marked with warning signs. This also applies to radioactive waste. Regulatory signs may be obtained from the Department of Nuclear Medicine.
4. In the parts of the laboratory, where the staff is working temporarily the radioactive material must be stored and shielded in such a way that the dose rate remains below 20 μSv/h.
5. In those parts of the laboratory continually occupied by the staff the radioactive material must be stored and shielded in such a way that the dose rate remains below 2 μSv/h.
Transportation within the hospital

1. Radioactive material must always be correctly labelled indicating the radionuclide, the amount of activity and the time of measurement.
2. Under no circumstance may radioactive substances be left anywhere in the premises of the hospital without supervision during transportation.
3. When stock solutions are being transported to and from the Department of Nuclear Medicine, ensure that all containers are well sealed and radiation shielded to prevent contamination or unnecessary radiation exposure during transport.
4. In case of an accident during a transport, the place where it occurred must be guarded to prevent any spread of radioactive material. Contact hospital physicist at Nuclear Medicine as soon as possible.
Disposal of radioactive waste

Liquid waste

Within each laboratory only one sink should be used for disposal of radioactive solutions. This sink must be labelled with a special sign “Utsläppsplats för flytande radioaktivt avfall” with an instruction specifying which radionuclides and what amounts may be released into the sink. Before starting to use a sink for waste disposal please contact the department of Nuclear Medicine for information and applicable signs.

Always flush an extensive amount of water after each discharge of radioactive solutions.

- Liquid scintillation solutions should in most cases be treated as chemical waste. Contact the department of Nuclear Medicine if you need help determining if your scintillation solution should be sent as chemical or radioactive waste.
- The remains of your stock radio pharmaceuticals may be returned in the original protection container to the premises of the Department of Nuclear Medicine in the basement of the main hospital building (A2:U1). The container must be well sealed, shielded and carry a sign giving the laboratory identity number, radionuclide, the chemical compound, an estimation of the remaining activity and the date of measurement. If you want to be able to access the trapdoor, contact the department of Nuclear Medicine.

Sealed radioactive sources

Whenever sealed radioactive sources, for standard or calibration purposes, are to be discarded they have to be handed over to the Nuclear Medicine.

Please observe that whenever instruments, like for example automatic liquid scintillation counters are to be discarded they may contain a sealed radioactive source for “external standardisation”. The source must of course first be removed. Please contact physicist at the Department of Nuclear Medicine before leaving any sources at the radiation waste storage (P5:U1 015).

Organic waste

Biological material, including organs, tissues and remaining organic waste contaminated with radionuclides should be packed in double sealed plastic bags in a black plastic container. A radioactive waste label with correct information concerning radionuclide, date, estimated remaining activity, name and telephone number must be attached to the black plastic box together with the label “biologiskt avfall”. The plastic box and the label “Biologiskt avfall” are ordered from Medicarrier.

The biological waste must be frozen so please contact physicist at Nuclear Medicine before leaving it at the waste room.

Plastic and lead containers

Empty plastic containers must not be deposited as ordinary waste unless all labels and tapes indicating radioactivity have been removed.

Empty lead containers should be treated in the same way and may be taken cared of at the Department of Nuclear Medicine A2:U1. Contact the Department of Nuclear Medicine if you want to get rid of lead containers.
Other radioactive waste

Remaining radioactive waste should be put in green plastic waste containers (50 liters). Mark the container with the label “Radioaktivt avfall” properly completed with following information:

- sender (laboratory)
- signature
- telephone number
- date
- contents
- radionuclide
- estimated activity

The content of one container must not exceed 100 MBq $\textsuperscript{3}$H or 1 MBq $\textsuperscript{14}$C. There is no restriction for other radionuclides.

The waste containers from each laboratory should regularly be transported to the decay room situated in a basement corridor under Radiumhemmet (room P5 U1:015). Deposit your container in the wagons situated immediately inside the entrance and register them in the computer situated in the room (see instructions on the wall).

Contact the Department of Nuclear Medicine if you need to access the waste room or if you want labels for your radioactive waste. Green plastic waste containers for radioactive waste are ordered from Medicarrier.

Estimation of activity in waste
To estimate the amount of activity in one waste container you start with the total activity in the original stock solution and then make an estimation of the below mentioned amounts of activity in order to subtract these from the total amount.

Subtract:
- the amount that vanishes as liquid waste
- the amount that vanishes as scintillation solution
- the amount that is left in the stock solution
- the amount that vanishes as biological waste.

If there is more than one stock solution used to the same waste container, add the information from all of these.
Measures in case of accidents

In case of personnel contamination

When a person is contaminated, they should
1. remove gloves, protective clothes and shoes, etc and leave them in the room
2. check with a radiation monitor to ensure that the skin is not contaminated
3. contaminated clothes should be placed in a sealed plastic bag to decay in a well shielded place
4. contaminated skin should be washed with a mild soap and lukewarm water. Never scrub!

Never use alcohol or any cleaner stronger than soap as this may remove the natural protection of the skin. Continue washing until your instrument readings indicate that further efforts are meaningless.

If contamination remains after washing:
- Contact the Department of Nuclear Medicine.
- Description of the incident and estimation of radiation dose.
- If necessary the supervisor should contact occupational health care and arrange for a medical examination.
- If the Radiation Safety Authority’s annual dose limit has been exceeded the staff member involved shall not continue working with radioactive materials for the rest of the current year
- The incident should be reported in accordance with general routines
- Routines and methods will be assessed to minimize the risk of recurrence

Spill without personnel contamination

- survey the suspected area with a suitable contamination monitor
- in case of wet spillage use an absorbing tissue to soak it up. If the spillage is dry use dampened materials such as paper towels
- work from the outer border of the contamination towards the centre. Never rub as you may easily contaminate a larger area
- when as much contamination as possible has been soaked up, clean with lukewarm water and soap. Measure after cleaning
- repeat this procedure as many times as necessary until you can no longer reduce activity
- place the contaminated material in a designated and marked plastic bag or container. Cover the contaminated surface with paper with plastic backing.

If decontamination is not successful:
- cover the contaminated surface with paper with plastic backing
- measure with the instrument and note the result on the cover paper and in the radiation safety file
- mark the area with warning tape and write the name of the radionuclide, measurement value after decontamination together with name and phone number to someone with information concerning the accident
- notify concerned staff of the accident
- all personnel involved in the accident and the decontamination should be checked for contamination
- if any contamination remains after decontamination please contact the Department of Nuclear Medicine.

Radiation related incidents

Each time a radiation related discrepancy occurs it must be reported, not only to your employer, but also to the Department of Nuclear Medicine (telephone number page 3)
Local radiation safety documentation

Each laboratory has a radiation safety file in which documents / test records not found in Centuri can be kept. Only the designated radiation protection supervisor may conduct revisions and changes of the file. At each laboratory the following must be documented, signed and kept available for inspection:

- received and stored radionuclides, specified with the activity, and calibration date of each shipment (the simplest way of doing this might just be to keep all signed delivery notes)
- possession of calibration sources or other sealed radiation sources
- results of ventilation controls
- results of contamination controls
- results for personal dosimetry measurements
- radiation related mishaps and accidents.

Changes in terms of radionuclides used, amount used, facilities, procedures and other circumstances, which may affect the radiation protection environment, must promptly be reported to the department of Nuclear Medicine.

Designated areas

Written procedures in the form of Local Rules must be produced for any Controlled Area and, depending on the nature of the work, any Supervised Area.

Controlled areas

All workspaces classified, as controlled areas should document their work with radionuclides in a journal kept on the premises. The following should be noted in the journal:

- radionuclide(s) and activity(ies)
- date(s)
- name(s) of the worker(s)
- any incidents of importance from the radiation protection point of view
- results for all contamination measurements including any subsequent decontamination

Nuclear Medicine units or cyclotrones

The radiation safety authority (SSM) places higher demands on the radiation safety documentation in units such as Nuclear medicine departments and Cyclotrons, The Department of Nuklear Medicine inform these departments on what is required.
Cleaning of designated areas

Radiopharmaceutical and radiochemistry laboratories
- the cleaning staff should wear gloves, protective clothing and special shoes. The cleaning materials should also be kept at the site.
- cleaning personnel should recognise warning signs and markings surrounding contaminations.
- cleaning personnel should be informed on where they can clean and where radioactive substances and waste are being kept in the laboratory.
- Radioactive waste is not handled by cleaning personnel.

Laboratories labelling compounds with radioactive iodine
- cleaners should always wear protective gloves
- the fume cupboards, where the labelling is carried out, should only be cleaned by the laboratory staff
- cleaning personnel should recognise warning signs and markings surrounding contaminations.
- cleaning personnel should be informed on where they can clean and where radioactive substances and waste are being kept in the laboratory.
- Radioactive waste is not handled by cleaning personnel.

Remaining laboratories
- cleaners should always wear protective gloves
- the cleaners should recognize signs and warning tapes etc. used around contaminated areas. they should also be aware of which wastebaskets to empty and which not
- cleaning personnel should be informed on where they can clean and on where radioactive substances and waste are being kept in the laboratory
- Workbenches are cleaned by the person who conducted the work.