Faculty of Health Sciences Institute of Clinical Medicine.	PET imaging center. Research and Development section
PETcore local radiation guidelines	
Corrected by Montserrat Martin-Armas. Version 4. 06.01.2022.	Approved by. Rune Sundset.

Aim

This document describes the radiation guidelines, general routines and procedures to handle and work with radioactive sources, materials and devices at PETcore.

Sections

Research facility requirements
Radiation competences
Radiation projects
Working with radioactive sources.
Radiation waste
Contamination control
Decontamination
Contingency plan

Scope

Persons working at PETcore must follow the described guidelines. PETcore is responsible to make sure and register that all users working with radioactivity in the area follow the radiation guidelines and work accordingly.

Contact

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Research facility requirements

PETcore is classified as Type B isotope laboratory, often defined as controlled area (lovdata § 27. *Arbeid med åpne radioaktive strålekilder og klassifisering av isotoplaboratorium*) and it is located within the comparative medicine department (AKM, by its Norwegian name) inside the animal barrier. PETcore access is restricted and only the AKM leader can authorize and

grant the entrance to the area. PETcore radiation competences are handled by the Faculty of Health Sciences, UiT.

PETcore comprises animal housing rooms for rats and mice, scanner imaging labs (PET/SPECT/CT, PET/MR, BLI/CT Image guided irradiator) and *in vitro/ex vivo* labs (cell lab, analysis lab and autoradiography lab). All laboratories and spaces are classified as controlled area (**Appendix 1**. PETcore labs location and classification)

Activities involving ionizing radiation are performed in all the rooms. Open and encapsulated sources together with X-ray radiation are routinely handled in the area.

All radiation exposure should be kept as low as possible. There is a risk of contact with and/or spread of radioactive material. Personnel entering the area can be exposed to radiation doses over 6 mSv/year. Pregnant or breast-feeding women are not allowed to enter the area. Use of the equipment and laboratories requires training. Only trained personnel will have access to the laboratories

PETcore radiation competences

The PETcore leader has overall responsibility for radiation protection. PETcore radiation safety contacts and user responsibilities regarding radiation sources and work with radioactivity are described as follows:

i) *PETcore radiation safety contact*

- Must be able to provide local training to employees, researchers, students and guests in the safe use of radiation sources at the area, as well as the use of protective equipment and waste management.
- Must ensure that PETcore have the necessary approval (radiation projects) for work with radiation sources.
- Must have an overview of PETcore radiation sources (equipment, purchasing, handling, storage and disposal)
- Must ensure that laboratories where radiation sources are used follow the appropriate requirements to work with radioactivity
- Must ensure that local procedures are prepared for work with radiation sources.
- Must annually report purchases, use and waste management to LSK and SSK and further to the Direktorat of Strålevern and Atom Sikkerhet (DSA)
- Must report records of dosimeters (visitors and PETcore workers) to LSK and SSK and further to the DSA
- Must participate in risk assessments of work with radiation protection.
- Must notify all deviations regarding the use of radiation sources LSK and SSK

ii) *Users*

All PETcore users handling radioactive sources and working with radiation devices or radioactivity must

- become familiar with the PETcore guidelines and local routines. Written local routines are available at PETcore. These describe general safety routines, use of protective equipment, waste routines and deviation routines. Local routines will be handed out to the users during the local training. Users will sign the different sections they have been trained in. PETcore will keep the records

- fulfill compulsory radiation protection training (local and central training). During the start-up, user must receive local training. Compulsory training ("Basic course in radiation protection for ionizing radiation" (20 hour course) must be completed within 1 year after start-up.
- Assess all work against the principle of ALARA (as low as reasonably achievable)
- carefully follow the activity limits that apply to the individual ionizing substances
- use necessary protective equipment.
- report errors and omissions to the PETcore SK. User reports and notifies deviations, accidents, accidents to LSK as soon as possible and no later than within 24 hours.
- become familiar with local evacuation/emergency procedures.
- take part in all information meetings and training sessions that SSK and LSK find necessary.

Radiation projects at PETcore.

Radioactivity projects involving radiation sources produced or ordered through the PET imaging center at UNN are registered at UiT by PETcore. Risk assessments and written general routines are available and accompany these projects. Users and users' training are registered and personal dosimeters (for employees and visitors), contamination records and plan for accidents are also available. Radioactivity annual reports are sent to LSK, SSK and further to DSA by PETcore.

Researchers participating actively in projects involving radioactivity (e.g. working with sources, samples, cells and/or animals) will need to present approved documentation showing they are certified to work with radioactivity. Records will be kept at PETcore.

In addition, users working only with ionizing radiation and no with animals must sign the AKM form "declaration for access to PETcore for users that will not work with animals. Only after the document is signed the users will be granted access to the area.

Users that will not handle active sources nor radioactive material are still obliged to follow local training and wear a dosimeter. Electrical personal dosimeters are available for visitors at PETcore. Readings will be recorded at the beginning and ending of the visit. Records will be kept at PETcore.

Radiation projects registered outside PETcore

Projects, involving radioactivity not registered by PETcore, will seek approval to the PETcore SK and risk assessments will be delivered (see further below). The PETcore SK will make sure users will comply with the radiation requirements to be allowed in the area. Personal dosimeters and radiation protective equipment must be used when working in the area. Local training will also be provided to all new users entering the facility. Training of all users must be documented in writing. Records will be kept at PETcore.

Project should be registered at UiT and risk assessment delivered to PETcore before the start-up. Risk assessment should be refined and updated during the ongoing of the project. The following sections should be described in the project:

- Responsible researcher
- Users overview
- Training

- Ordering of radioactive sources as well as type and activities to be used in the experiments
- Description of the work
- Use of PETcore equipment and laboratories
- Control of possible contamination
- Dosimeter overview
- Cleaning procedures
- Waste handling
- Protocol to handle potential accidents and contamination

Responsible researchers of these projects are in charge of their own report and records (Activity, dosimeters and contamination records).

Working with radiation sources

Aim

Procedure provide an overview on the handling of radioactive sources.

Scope

Procedures are applied to staff and PETcore users handling radioactivity. It is important to be familiar with these procedures.

Responsibilities

The PETcore leader has the overall responsibility for radiation protection. PETcore radiation safety contacts shall ensure local training and report, if necessary, to the UiT local and central radiation safety officers. Users have responsibility to follow procedures and notify to the radiation safety contact any deviation if necessary.

Procedures

Understand the nature of the hazard and get practical training. Plan ahead to minimize time spent handling radioactivity. Carry out a dummy run without radioactivity to check your procedures.

PETcore labs are used upon agreement with users. Users should be responsible to check the labs schedule and book them accordingly

Follow the ALARA principle when working with radioactive sources or material: i) The shorter the time the smaller the dose. ii) Distance yourself appropriately from sources of radiation. Doubling the distance from the source quarters the radiation dose. iii) Use appropriate shielding for radiation (Perspex or lead with suitable thickness for beta and gamma emitters respectively)

Wear appropriate protective clothing.

- Use nitrile gloves (purple ones) and arms overalls. Of note, two pairs of gloves provide better hand protection against contamination. The use of safety glasses is recommended when working with materials that can produce spilling or external radiation. Since gloves and overalls can be a source of contamination: i) Changes gloves often ii) Do not touch common lab equipment, door handles, telephone, tools, controls, keyboards while wearing gloves iii) after removing gloves, wash hands thoroughly and monitor for contamination (see contamination and decontamination procedures section).
- Lead shielding aprons are available when working with beta and low energy gamma emitters (eg Tc^{99m})
- Wear person dosimeters.

Contain radioactive materials in defined work areas. Use absorbent bench coat in working surfaces. Use always filter tips when dispensing radioactive solutions with pipette. Label the working area and containers (e.g. samples, tubes, slides, cell plates/flasks and animal cages) clearly indicating radionuclide, compound, activity, date and user name. Containers should be properly sealed. All equipment in the area is prepared for working with radioactivity- Lab equipment labelled with black radioactive sign (e.g. pipettes in G716) is dedicated to work with radionuclides emitting in beta. Do not switch equipment between labs.

Monitor yourself (hands and clothes), the working area and equipment continuously for contamination. Contamination check-up lists are available for each lab and these should be filled in after the work completion. If spillage or contamination occurs, see further contamination control, decontamination and contingency plan sections

Follow the local guidelines and keep safe ways of working. It is not allowed to eat, drink, smoke or apply cosmetics in the labs. Use paper handkerchiefs and dispose them appropriately. Never use any mouth operated equipment. Always work carefully and tidily.

Minimize accumulation of waste and dispose it by appropriate routes. Use the minimum quantity of radioactivity needed for the investigation. Disposal of all radioactive waste is subject to statutory control. Be aware of the requirements and use only authorized routes of disposal (see radiation waste section).

Radiation waste at PETcore

Aim

Radiation waste procedures provide an overview on the radioactive waste handling and disposal at PETcore.
Radioactive waste must be handled correctly so that radiation exposure of humans and animals is minimized. It should be handled in accordance with UiT guidelines and work routines for hazardous waste.

Scope

Procedures are applied to staff and PETcore users handling radioactivity. It is important to be familiar with these procedures.

Responsibilities

The PETcore leader has the overall responsibility for radiation protection. PETcore radiation safety contacts shall ensure local training and report, if necessary, to the UiT local and central radiation safety officers. Users have responsibility to follow procedures and notify to the radiation safety contact any deviation if necessary.

Procedures

Radioactive waste handled at PETcore can be solid (objects that have been in contact with radioactivity such as gloves, syringes, needles, animal corpses, bedding material of animal cages) or liquid waste (open sources, vial contents, samples). Radiation waste is defined by waste containing activity concentrations higher than the ones indicated by the limit values specified in Lovdata Kapittel §16. Vedlegg I. Radioaktivt avfall jf. § 2. Some examples: F18. 10 Bq/g. Cu64. 100 Bq/g

Considerations regarding waste disposal

- Waste must always be disposed of in shielded and marked waste containers.
- Liquid waste must not be disposed though the water systems (sink) without the consent of the LSK and SSK (UIT guidelines for hazardous waste)
- Radioactive waste should not be mixed with other waste and different types of radioactive waste should not be mixed if this could lead to a risk of contamination or create problems for the further handling of the waste.
- It is not allowed to dilute radioactive waste with the intention of lowering the limits for radioactive waste.
- Radioactive waste should be temporarily stored locally and properly shielded for decay. Thus, the waste must be kept in a shielded waste container until the activity is below the limit values. This depends on the type of isotope and activity concentration (Bq/activity).
- Risk assessments of waste disposal and transport are available (**Appendix 2.** Risk assessment for radioactivity handling procedures).

Radioactive waste storage and disposal

Radioactive waste stored further for decay will be monitored and labelled accordingly (radionuclide, date, material and activity as well as decay date). Waste monitoring will be performed by measuring activity dose with Radeye on top of the shielding container and on the middle of the shielded container.

Waste containing short-lived radionuclides (e.g. C11, F18) will be disposed in the PETcore labs. Waste materials disposed here will be lab consumables that have been in contact with radioactivity (e.g. contaminated gloves, needles, syringes, bench coats, vials, tubes, catheters, paper towels and smaller objects). Small yellow containers are placed in the L-block and lead caves (G716, G718 labs. 50 mm lead shielding.) as well as in LAF benches (G722, G718 labs, 50 mm lead shielding). Medium yellow containers are located in shielded cabinets (50 mm lead shielding) under the LAF bench (G722, G717 and G718).

Waste containing long-lived radionuclides (registered in the project with half-lives between 13h-8 days) will be stored for decay in the PET imaging center waste room (G506) and in the MH waste room (user restricted areas classified as B-labs). Here, animal waste containing ionizing radiation material with long half-lives (e.g. Zr89, Cu64) will be stored in yellow containers located in freezers properly shielded (50 mm shielding) for decay. Animal waste disposed consists mainly of animal carcasses and organs (in plastic bags) and bedding material from animal cages previously vacuum packed in bags to minimize volume. A logbook will be available in the waste rooms and details described above should be noted.

The waste should be stored until the recorded activity is no longer radioactive or below the disposal limits. Waste will be stored around 10 half-lives for decay. This depends on the radionuclide and the specific activity. For the long-lived waste (e.g Zr89 or Cu64), the time needed for the decay will be calculated. When doses will be similar to room background levels (0.05-0.1 Sv/h), waste will be handled as non-radioactive and disposed as hazardous biological waste at MH

Contamination monitoring

Aim

Procedures described in this section provide an overview on how to monitor the remaining radioactivity detected on a person (clothing, shoes, gloves, skin…), working surfaces or on equipment. The main purpose of monitoring contamination is to prevent further contamination to users and staff as well as to minimize emissions to the environment.

Scope

Procedures are applied to staff and PETcore users handling radioactivity. If an accident or a contamination occurs, appropriates measures will be conducted. Therefore, it is important to be familiar with these decontamination procedures.

Responsibilities

The PETcore leader has the overall responsibility for radiation protection. PETcore radiation safety contacts shall ensure local training and report, if necessary, to the UiT local and central radiation safety officers. Users have responsibility to follow procedures and notify to the radiation safety contact any deviation if necessary

Procedures

Use a suitable monitoring instrument to locate contamination (radiation detector such as radeye or a contamination monitor such as LB124). Electronic dosimeters should not be used.

- Checking the working surfaces
- Control of surfaces or hands in case of suspected spillage
- Contamination control of hands and feet, before leaving the handling area of radioactive sources or substances. Use hand and foot monitor in corridor next to the sluices

Contamination readings should be recorded. Staff and users should fill up the charts available in each lab (**Appendix 3**. Contamination control) after working with radioactive sources and before leaving the area

Preventive measures to avoid contamination

There will always be a risk of release of radioactive material. Containers may explode, implode, be crushed, be lost, be broken or fall. Unless precautions are taken, contamination can be spread by moving contaminated objects and/or by accidental contact with contaminated areas (e.g touching contaminated surfaces or by walking by contamination on floors). Air currents can move airborne contamination far away from the source.

However, contamination with radioactive substances can be avoided with appropriate safety measures. Good handling techniques, adequate controls, and procedures to contain radioactivity should be in place. To have good protocols to control the contamination is safer and more efficient than to decontaminate areas, equipment and personnel

- The most important way to prevent contamination is to have radioactive material in sealed containers and closed systems.

- Sealed containers should be used for storage of radioactive substances and for transport between working areas.
- Handle radioactive substances only in designated areas that are clearly marked to warn of entering the areas
- Airborne contamination can come from released volatile constituents. Therefore, handle possible volatile radioactive compounds in fume hoods or LAF benches rather than on an open bench.
- Non-volatile radioactive substances can be safely handled in open containers. However, be careful when opening or handling containers to avoid spills and use bench coat to contain these further
- All surfaces dedicated to radioactive work should be covered with absorbent bench coat.
- Radiation detector/contamination meter must be calibrated regularly
- Check for surface contamination after each work procedure and in case of suspected spillage.
- Use radiation detector and/or contamination monitor to locate and quantify possible contamination.
- Regularly check hands, shoes, clothing, equipment and surfaces in LAF bench and storage area for radioactive substances.
- Perform contamination check-ups in the lab at the end of the work. Measure dose rate and/or activity at a distance of 1m/0.5m and at the surface. Fill up the monitoring log. There is one available at each PETcore lab (**Appendix 3**. Contamination control).

However, if an accident occurs and contamination of radioactivity is detected, appropriate decontamination measures must be taken. See decontamination section below

Decontamination

Aim

Decontamination procedures described in this section provide an overview on how to remove/clean radioactive contamination from persons, equipment and area. Areas that can be contaminated can be hands, wrists, protective clothing, shoes, equipment, personal belongings, working areas (e.g. bench surfaces) and storage areas.

Scope

Procedures are applied to staff and PETcore users handling radioactivity. If an accident or a contamination occurs, appropriates measures will be conducted. Therefore, it is important to be familiar with these decontamination procedures.

Responsibilities

The PETcore leader has the overall responsibility for radiation protection. PETcore radiation safety contacts shall ensure local training and report, if necessary, to the UiT local and central radiation safety officers. Users have responsibility to follow procedures and notify to the radiation safety contact any deviation if necessary

General actions for decontaminating procedures

- Assess the extent of the contamination in relation to quantity and type of isotope.
- Verbally warn the persons in the vicinity about the contamination
- Ensure your own safety and the safety of the others
- Restrict unnecessary movement into and through the area
- Contact the radiation safety contact or, if necessary, the radiation protection officers (LSK, SSK)
- Follow the decontamination procedures described below
- Initial decontamination should be quick and thorough including only soap and water or rinsing with water.
- Wear protective equipment
- Try to avoid spreading the contamination to floors or other surfaces.
- Remove contaminated waste generated by decontamination. Place it a plastic lab properly labelled in appropriate containers or rooms (shielded areas at PETcore for short lived contamination or at the G506 waste room in the PET center for long-lived contamination). Store it until radiation dose is reduced to 7.5 μSv/h outside the bag.
- A spill kit can be found at PETcore containing decontaminating equipment. (**Appendix 4**. Spill kit**)**
- Decontamination procedures must be practiced and trained annually. Practices will be recorded in a log (**Appendix 5**. Contamination report).
- At the end of the procedure, contamination should not exceed the following values for gamma and beta radiation at the surface:
  4 Bq/cm^2 for body parts, clothing, inactive area.
  40 Bq/cm^2 for active area, protective clothing, glassware etc.

Decontamination of personnel

i) Skin or small areas in the body

Define the contaminated area with a radioactivity monitor and mark it with a pen if necessary

- Wash the skin thoroughly with water
- Use soap to rub the contaminated area slightly for 2 -3 minutes
- Rinse well the area with lukewarm water
- Repeat the procedure several times as long as the activity decreases each time
- Use carefully a soft brush for light scrubbing if necessary. Discontinue before skin damaging or scraping (Use hand cream if the skin crack).
- If hands are still contaminated, monitor specifically between fingers and under nails. Cut the nails if needed, to remove the attached contamination.

Harder decontamination methods and cleaning agents should only be considered after several attempts with soap and water. The benefits of decontamination should be weighed against possible harm from the use of harder decontamination methods.

ii) **Intensive decontamination / large quantities**

- Remove person from contaminated area
- Remove contaminated clothing
- Use the emergency shower, if necessary, to wash quickly off or dilute the radioactive contamination
- Flush eyes, ears, nose and mouth, if necessary. Use cotton swabs for further cleaning of ear and noses orifices
- Put on dry clothing.
- Clothing and materials used for decontamination are stored in separate risk boxes to decay further in the radioactive waste room (G-506) at the PET center, UNN

Decontamination of equipment

- Effective decontamination of equipment could enable the reuse of the equipment
- Monitor and label the equipment area to decontaminate with warning signs
- Prioritize decontamination agents and methods that can minimize the volume of the radioactive waste.
- Collect the decontamination materials needed: cleaning products, tools, protective clothing and monitoring equipment (Radiation detector and contamination monitor)
- In order to minimize the binding of the contaminant to the surface, decontaminate the equipment as quick as possible
- Decontamination should start from the least contaminated area to the most contaminated, unless the most contaminated area requires rapid cleaning to reduce external radiation
- Use absorbent paper to stop further the contamination. Dry absorbent paper on damp contamination and damp absorbent paper on dry contamination.
- Avoid damage to the equipment surfaces as damage to the surface will be more difficult to decontaminate
- Isolate the contaminated equipment, if possible, to prevent further contamination spread to the surroundings. Use shielded areas or fume hoods in case danger of airborne contamination
- Monitor the equipment to confirm that the level of contamination has been reduced to acceptable levels. The dose rate must not exceed 7.5 μSv/h. Consult with radiation safety coordinators (LSK, SSK).

- If decontamination is not successful, mark the contaminated area and classify the entire room as a controlled area until the contamination is gone.

Decontamination of small areas (working areas, surfaces or floors)

- The contaminated area should be defined and labelled with radioactive tape
- Use absorbent paper to stop further the contamination. Dry absorbent paper on damp contamination and damp absorbent paper on dry contamination.
- Clean the surface with water and soap (2-5% Decon90)
- Cleaning should be done inwards, starting from the outside to the center of the contaminated area
- Monitor the area to check that the contamination has been reduced to acceptable levels.
- Repeat the procedure if needed
- Remove contaminated waste generated by decontamination until radiation dose is reduced to 7.5 μSv/h outside the bag.

Decontamination of big areas

- Secure and mark the area immediately.
- Check and determine the full extent of the contamination and determine if anyone has entered the contaminated area.
- Assess suitability using the normal cleaning procedures with water and detergents for extensive low-level contamination. The assessment should take into account the expected amount of polluted water, disposal and the risk of generating airborne activity.
- Consider alternative decontamination procedures if large amounts of radioactive material have been spilled or if standard cleaning methods are impractical or will lead to an unacceptable amount of waste.
- For localized contamination, the same technique can be used as for decontamination of equipment or small areas
- Assess and the need of local ventilation or personal protective equipment if significant air activity can be measured or expected. To avoid air activity, one can e.g. spray over contaminated surface with finely atomized water or suitable chemicals
- Consider to isolate the area and let the activity decay when the contamination is short-lived. Monitor the area to confirm when it is ready to use again.

Contingency plan

Aim

The procedures describe how to deal with accidents and serious incidents related to the use of radioactivity and how to notify the events to the authorities

Scope

Procedures are applied to staff and PETcore users handling radioactivity. If an accident or a contamination occurs, appropriates measures will be conducted. Therefore, it is important to be familiar with these procedures.

Responsibilities

The PETcore leader has the overall responsibility for radiation protection. PETcore radiation safety contacts shall ensure local training and report, if necessary, to the UiT local and central radiation safety officers. Users have responsibility to follow procedures and notify to the radiation safety contact any deviation if necessary

Procedures

In the event of accidents or serious incidents, contact the radiation safety contact (SK) and the UIT radiation safety officers (LSK, SSK). Together, they will evaluate the severity of the case and determine the need to apply risk-reducing measures as well as the further reporting to DSA.

Notification to the Norwegian Radiation Protection Authority (DSA)

Serious or unresolved incidents must be notified immediately to DSA's 24-hour hotline, (Tel. 67 16 26 00).
Written notification must be sent to DSA as soon as possible, and no later than 3 working days
DSA contact information:
Tel: 67 16 25 00
Tel: 67 16 26 00 (24-hour hotline)
Email: dsa@dsa.no

Which accidents and serious incidents should be reported?

Accidents and abnormal incidents that should be notified to the DSA include (Radiation Protection Regulations § 20.

- Unintended exposure of workers, users and/or other persons significantly beyond normal levels
- Loss or thievery of radiation sources
- Accidental release of radioactive substances into the environment that may exceed the set limits
- Irradiation of the general public, so that an individual may be exposed to an effective dose above 0.25 mSv/year
- Technical failure of radiation protection significance at the radiation source
- Extensive contamination of the equipment
- Ownerless and unknown radiation sources in the area

- Spills of radioactive solutions (contamination) that cannot be easily removed.
- Skin contamination even after several washing attempts
- Skin damaged while working with radioactive substances.
- Intake of radioactive substances (inhalation, oral intake).
- Fire or water leakage involving open radiation sources.

DSA written report

The written notification to be submitted to DSA should at least contain:

Time and place of the accident.

Names and contact information of the involved institutions (UiT, UNN, or companies).

Description of the course of events (how many employees/others were involved, including information about the radiation sources, calculation/estimation of radiation doses to the persons involved.

Appendix and documents

Appendix 1. PETcore labs location and classification)
Appendix 2. Risk assessment for radioactivity handling procedures
Appendix 3. Contamination control
Appendix 4. Spill kit
Appendix 5. Contamination report

References

UiT Retningslinje for handtering av ulik type stråling
Dsa.no
Bruk av åpne radioaktive kilder i laboratorium. Veileder til forskrift om strålevern og bruk av stråling Statens Strålevern
Practical radiation technical manual. International Atomic Energy Agency
Lovdata. Forskrift om radioaktiv forurensning og avfall, §16, Vedlegg I, Radioaktivt avfall jf. § 2. Vedlegg II. Tilførsel av radioaktive stoffer som alltid trenger tillatelse, jf. § 4 annet ledd.
Dominguez-Gadea L et al 2011, Reports of practical oncology and radiotherapy 16,147-152

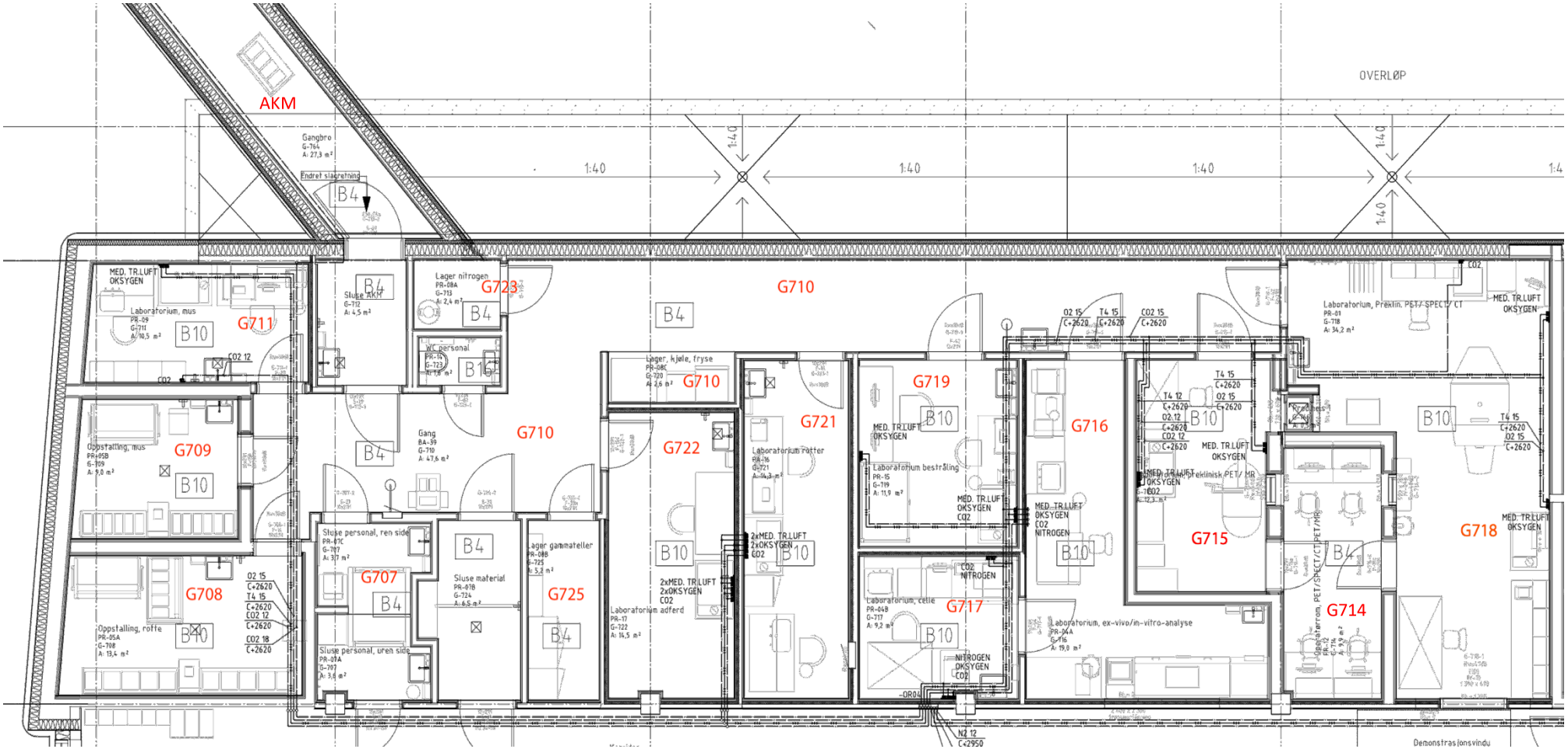
Faculty of Health Sciences Institute of Clinical Medicine.	PET imaging center. Research and Development section
PETcore labs location and classification	
Written by Ana Oteiza. Version 1. 26.02.2021.	Approved by. Rune Sundset.
Appendix 1 linked to the PETcore local radiation guidelines	

PETcore is connected located in the PET imaging center at UNN and is connected to the department of comparative medicine (AKM) at UIT via a spacewalk. PETcore labs are classified as B-labs. Only authorized personnel are allowed to come inside the area.

PETcore labs

Lab#	**Description**	**Classification**
G711	Mouse lab	Controlled area
G709	Mouse housing room	Controlled area
G708	Rat housing room	Controlled area
G707	Personal sluice	Monitored area
G710	Corridor	Controlled area
G712	AKM sluice	Monitored area
G724	Material sluice	Monitored area
G725	Counter room	Controlled area
G721	Rat Lab	Controlled area
G722	Autoradiography lab	Controlled area
G714	Control room	Controlled area
G715	PET/MR lab	Controlled area
G716	Analysis lab	Controlled area
G717	Cell lab	Controlled area
G718	PET/SPECT/CT lab	Controlled area
G719	Irradiation lab	Controlled area

An overview of the labs location can be found in the map (see next page)


AKM
OVERLØP
G708
G709
G711
G707
G725
G722
G710
G723
G721
G719
G716
G715
G717
G718
G714
Gangbro
G-764
A: 27,3 m²
Endret slagretning
Laboratorium, mus
PR-09
G-711
A: 10,5 m²
Oppstalling, mus
PR-05B
G-709
A: 9,0 m²
Oppstalling, rotte
PR-05A
G-708
A: 13,4 m²
Sluse AKM
G-712
A: 4,5 m²
Lager nitrogen
PR-08A
G-713
A: 2,4 m²
WC personal
PR-14
G-723
A: 1,6 m²
Gang
BA-39
G-710
A: 47,6 m²
Sluse personal, ren side
PR-07C
G-707
A: 3,7 m²
Sluse personal, uren side
PR-07A
G-707
A: 3,6 m²
Sluse material
PR-07B
G-724
A: 6,5 m²
Lager gammateller
PR-08B
G-725
A: 5,2 m²
Lager, kjøle, fryse
PR-08C
G-720
A: 2,6 m²
Laboratorium adferd
PR-17
G-722
A: 14,5 m²
Laboratorium rotter
PR-16
G-721
A: 14,3 m²
Laboratorium bestråling
PR-15
G-719
A: 11,9 m²
Laboratorium, celle
PR-04B
G-717
A: 9,2 m²
Laboratorium, ex-vivo/in-vitro-analyse
PR-04A
G-716
A: 19,8 m²
Laboratorium, Preklin. PET/ SPECT/ CT
PR-01
G-718
A: 34,2 m²
Laboratorium, preklinisk PET/ MR
PR-02
G-715
A: 12,3 m²
Laboratorium, PET/SPECT/CT/PET/MR
PR-12
G-714
A: 9,9 m²
Demonstrasjonsvindu
MED. TR.LUFT
OKSYGEN
CO2
NITROGEN
2xMED. TR.LUFT
2xOKSYGEN
CO2
O2 15
C+2620
T4 15
C+2620
CO2 12
C+2620
CO2 18
C+2620
T4 12
C+2620
O2 12
C+2620
1:40
B4
B10

PETcore	UiT. Faculty of Health Sciences. Institute of Clinical Medicine	UNN. PET Imaging center. Research and development section
Tasks assessed: Scanning procedures and experimental protocols with radioactive animals		
Participants: PETcore staff and users, AKM staff		
Labs: G718-PET/SPECT/CT lab. G715-PET/MR lab, G719-irradiator lab. G711-mouse lab, G721-rat lab.		
Written by Ana Oteiza	v2. 26-02-2021	Approved by Rune Sundset

Activities	**Risk factors**	**Current measures**	**Unwanted incidents**	**Causes**	**Assessment (1-5)** F	C	**Risk level** (FxK)	**Damage risk to**	**Further Risk reducing measures**	**Rest Ris (FxK)**
Transport of radioactive sources, animals, and/or biological samples	Transport through the corridor	Closed holders, cages or containers. Transport routines.	Spills, release of radioactive sources, samples or escape of radioactive animals. Radiation exposure of employees	Slippery floors, Accidents, Open cages or containers Damaged trolley, Careless operation, Stress. Thievery.	2	3	6	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Contamination control. Decontamination procedures.	**4** (2x2)
Handling of radioactive sources at the safety bench	Work with open radioactive sources at the safety bench	Open radioactive sources work is only performed in the lead reinforced safety benches at G718 and G722 labs. Use of equipment and clothing suitable for work with radioactive sources	Spills, accidents, absorption through damaged skin. Bench contamination. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure.	3	3	9	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Use absorbing dry materials in the bench Training in good practices Monitoring. Contamination control. Decontamination procedures	**6** (3x2)

Phantoms	i) Loading phantoms with radioactivity. ii) Handling the phantoms in the safety bench or the scanners (PET/SPECT/CT and PET/MR devices)	Use of equipment and clothing suitable for work with radioactive equipment	Spills, accidents. Contamination of scanner and components. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure, bad routines.	3	3	9	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training of good routines. Use absorbing dry materials in the bench and scanner. Monitoring. Contamination control. Decontamination procedures	**6** (3x2)
Injection in animals (anesthetized or awaken animals). i) Radiotracer injection ii) Compound injection in radioactive animals	i) Direct contact with needle/ cannula/catheter ii) Radiotracer injection iii) Direct contact with radioactive animals (see activity below)	Use of equipment and clothing suitable for work with radioactive sources. Use of syringe caps	Spills, accidents, needle stick injury, absorption through damaged skin. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure problems with injection, catheter or animal handling,	4	3	12	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license). Follow ALARA principle (time, distance and shielding). Increased attention. Training in good injection techniques. Monitoring. Contamination control. Decontamination procedures.	**8** (4x2**)**

Handling of radioactive animals	Direct contact with radioactive animals	Use of equipment and clothing suitable for work with radioactive animals. Proper labelling of animal cages (Radioactive sign, radionuclide, project, half-life, activity/dose, date)	Accidents, spills, radiation exposure through urine, bites and feces	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure. Bad routines, problems with animal handling,	4	3	12	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license) Follow ALARA principle (time, distance and shielding) Increased attention Training in animal handling techniques Reduce close contact with radioactive animals Monitoring Contamination control Decontamination procedures	**8** (4x2)
Scanning of animals	i) Direct contact with radioactive animals ii) Measuring biological parameters (blood sampling) while animal is in the scanner iii) PET, CT, SPECT, MR and irradiation procedures in the machine	Use of equipment and materials suitable for work with radioactive experimental animals	Accidents and spills. Scanner and scanner components contamination. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, Bad routines,	4	3	12	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license). Follow ALARA principle (time, distance and shielding). Use absorbing dry materials in the scanner imaging cell Reduced close contact with the animal Increased attention. Training in good routines Monitoring. Contamination control. Decontamination procedures.	**8** (4x2)

Experimental procedures in radioactive animals (e.g. biodistribution, autoradiography, pharmacokinetic studies)	i) Blood sampling ii) Organ collection	Use of equipment and clothing suitable for work with radioactive animals and samples	Needle stick injury, spills, splashes, accidents, absorption through damaged skin, inhalation. Contact with radioactive materials (blood, liquids, etc.). Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure, bad routines.	3	3	9	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license). Close blood and organ containers after collection. Use absorbing dry materials in the bench and working areas Follow ALARA principle (time, distance and shielding). Increased attention. Training of good routines. Monitoring. Contamination control. Decontamination procedures.	**6** (3x2)
Tissue fixation in specialized bench in rat lab (G721)	*In vivo* fixation	Collection of radioactive blood and perfusion solutions in a shielded container	Spills, splashes, accidents, needle stick injury. Contact with radioactive materials (blood, liquids, etc.). Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure, bad routines.	2	3	6	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license). Follow ALARA principle (time, distance and shielding). Use absorbing dry materials in the bench Keep the biological waste in closed containers under shielding for further decay. Increased attention Training on good routines. Monitoring. Contamination control. Decontamination procedures.	**4** (2x2)

Storage of radioactive samples for further decay e.g. (Radioactive animal carcasses)	Placing biological samples in storing areas (e.g. freezer)	Proper labelling of the samples (Radioactive sign, radionuclide, project, half-life, activity/dose, date) Use of equipment and clothing suitable for work with radioactive samples	Spills, accidents. Contact with radioactive materials (blood, liquids, etc.). Contamination of storage areas (e.g freezer) Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure, bad routines.	2	3	6	Employees and equipment	Research animals will only be handled by authorized and trained personnel (FELASA license). Follow ALARA principle (time, distance and shielding). Keep the biological samples in closed containers/bags Increased attention Training on good routines. Monitoring. Contamination control. Decontamination procedures.	**4** (2x2)

Procedures for waste disposal, contamination control, decontamination and contingency plan (PETcore local radiation guidelines document)

PETcore	UiT. Faculty of Health Sciences. Institute of Clinical Medicine	UNN. PET Imaging center. Research and development section
Tasks assessed: Housing and monitoring of radioactive animals		
Participants: PETcore staff and users, AKM staff		
Labs: G709-Mouse lab, G708-Rat lab.		
Written by Ana Oteiza	v2. 26-02-2021	Approved by Rune Sundset

Activities	**Risk factors**	**Current measures**	**Unwanted incidents**	**Causes**	**Assessment (1-5)** F	C	**Risk level** (FxK)	**Damage risk to**	**Further Risk reducing measures**	**Rest Ris (FxK)**
Transport of radioactive animals to the housing rooms	Transport thorugh the corridor	Transport of closed cages in trolleys. Transport routines.	Release/Escape of radioactive animals. Radiation exposure of employees	Slippery floors, Accidents, Open cages, Damage trolley, Careless operation, Stress	4	2	**8**	Employees	Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Contamination control. Decontamination procedures.	**4** (4x1)
Housing	Housing	Follow AKM guidelines and advices. Proper labelling of cages (Radioactive sign, radionuclide, project, Half-life, Activity/dose, date)	Radiation exposure of employees	Accidents, Stress, Lack of training Time pressure	4	2	**8**	Employees and other animals	Research animals will only be handled by authorized and trained personnel (FELASA licence). Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Reduce close contact with radioactive animals. Contamination control. Decontamination procedures.	**4** (4x1)

Monitoring and care of the housed animals	i) Handling of radioactive animals. ii) Changing bedding and nesting material iii) Provide mice with food and water	Follow AKM guidelines and advices. Proper labelling of cages (Radioactive sign, radionuclide, project, Half-life, Activity/dose, date)	Radiation exposure of employees through urine, bites and feces	Accidents, Stress, Lack of training Problems with animal handling Time pressure	4	2	**8**	Employees and other animals	Research animals will only be handled by authorized and trained personnel (FELASA license). Use cage overlays if needed and reduce the number of times the cages are changed. Reduce closed contact with animals. Share the duties of monitoring the animals to distribute the radiation doses between the users of the same group. Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Contamination control. Decontamination procedures.	**4** (4x1)

Transport of radioactive waste material out of the housing lab	Dispose the bedding material	Follow guidelines and advices from AKM Proper labelling of the material (Radioactive sign, radionuclide, project, Half-life, Activity/dose, date)	Radiation exposure of employees	Accidents, Stress, Lack of training Time pressure Lack of training	3	2	**9**	Employees and other animals	Research animals will only be handled by authorized and trained personnel (FELASA license). Use cage overlays if needed and reduce the number of times the cages are changed. Share the duties of monitoring the animals to distribute the radiation doses between the users of the same group. Reduce close contact with animals. Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Contamination control. Decontamination procedures.	**3** (3x1)

Procedures for waste disposal, contamination control, decontamination and contingency plan (PETcore local radiation guidelines document)
AKM: Unit of Comparative Medicine

PETcore	UiT. Faculty of Health Sciences. Institute of Clinical Medicine	UNN. PET Imaging center. Research and development section
Tasks assessed: Validation procedures (in vitro and ex vivo experiments, e.g. blood, cells and tissues analyses)		
Participants: PETcore staff and users, AKM staff		
Lab location: G716-analysis lab, G717-cell lab, G722-autoradiography lab, G725 Gamma counter.		
Written by Ana Oteiza	v2. 26-02-2021	Approved by Rune Sundset

Activities	**Risk factors**	**Current measures**	**Unwanted incidents**	**Causes**	**Assessment (1-5)** F	C	**Risk level** (FxK)	**Damage risk to**	**Further Risk reducing measures**	**Rest Ris (FxK)**
Transport of radioactive sources, animals, and/or biological samples	Transport through the corridor	Closed holders, cages or containers Transport routines.	Spills, Release of radioactive sources, samples or escape of radioactive animals. Radiation exposure of employees	Slippery floors, Accidents, Open cages, Damage trolley, Careless operation, Stress. Thievery	2	3	6	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training and monitoring. Contamination control. Decontamination procedures.	**4** (2x2)
Handling of radioactive sources at the safety bench	Work with open radioactive sources at the safety bench	Use of equipment and clothing suitable for work with radioactive sources. Work with open radioactive sources is only performed in the lead reinforced safety bench at G718 and G722	Spills, accidents, absorption through damaged skin. Bench contamination. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, time pressure	3	3	9	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Use absorbing dry materials in the bench. Training of good practices Monitoring. Contamination control. Decontamination procedures	**6** (3x2)

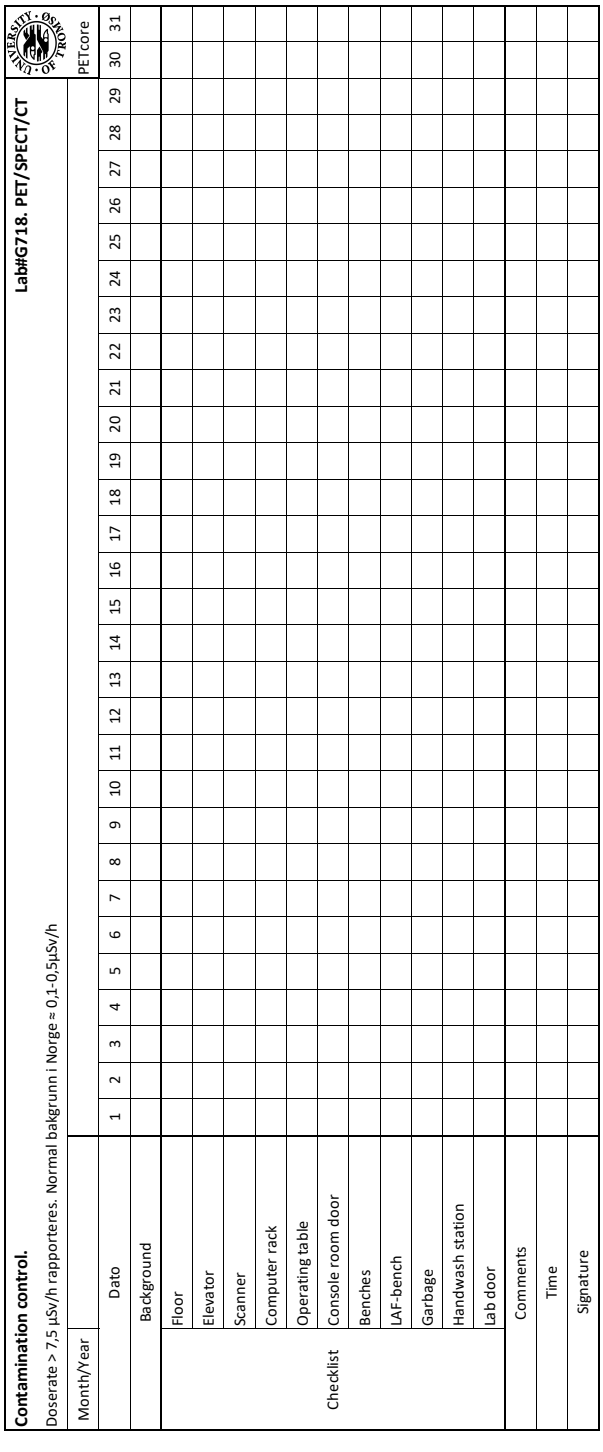
Handling of radioactive samples. Examples: i) Dilution of radioactive solutions ii) Incubation of samples with radiotracers iii) Further analyses of radioactive biological samples	Direct or close contact with radioactive samples or specimens	Use of equipment and clothing suitable for work with radioactive material	Spills, splashes, absorption through damaged skin, inhalation. Contact with radioactive materials (blood, liquids, etc.). Contamination of the working surfaces. Radiation exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, bad routines, time pressure	4	3	12	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training of good protocols. Use absorbing dry materials in the bench. Monitoring. Contamination control. Decontamination procedures.	**8** (4x2)
Centrifugation	Spill of radioactive material in the centrifuge	Balance the centrifuge Closed tubes	Spills, splashes. Accidents Centrifuge contamination. Radiation. exposure of employees.	Inaccurate job, accidents, carelessness, lack of training, stress, bad routines, time pressure	3	3	**9**	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training of good techniques. Monitoring. Contamination control. Decontamination procedures	**6** (3x2)
Cryosectioning of radioactive organs in the cryostat	Direct or close contact with radioactive specimens	Use of equipment and clothing suitable for work with radioactive material	Spills, cryostat contamination Radiation. exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, bad routines, time pressure	2	3	6	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training of good practices Monitoring. Contamination control. Decontamination	**4** (2x2)

Gamma counter	Radioactive samples in the gamma counter	Follow the SOPs and PETcore guidelines	Spills, technical problems with the counter. Forgetting the samples in the device after counting. Counter contamination Radiation. exposure of employees	Inaccurate job, accidents, carelessness, lack of training, stress, bad routines, time pressure, counter failures	4	2	8	Employees and equipment	Follow ALARA principle (time, distance and shielding). Increased attention. Training of good practices Monitoring. Contamination control. Decontamination procedures	**4** (4x1)

Procedures for waste disposal, contamination control, decontamination and contingency plan (PETcore local radiation guidelines document)

Faculty of Health Sciences Institute of Clinical Medicine.	PET imaging center. Research and Development section
Contamination control	
Written by Ana Oteiza. Version 1. 26.02.2021.	Approved by. Rune Sundset.
Appendix 3 linked to the PETcore local radiation guidelines	

Example of contamination control charts available in each PETcore lab



Contamination control.

Doserate > 7,5 µSv/h rapporteres. Normal bakgrunn i Norge ≈ 0,1-0,5µSv/h

Lab#G718. PET/SPECT/CT

PETcore

Month/Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Dato																																
Background																																
Checklist	Floor																															
	Elevator																															
	Scanner																															
	Computer rack																															
	Operating table																															
	Console room door																															
	Benches																															
	LAF-bench																															
	Garbage																															
	Handwash station																															
	Lab door																															
Comments																																
Time																																
Signature																																

* If background levels are detected, just mark with OK/checked in comments field. However, if levels above the normal background appeared, note them down on the specific location.

Faculty of Health Sciences Institute of Clinical Medicine.	PET imaging center. Research and Development section
Spill kit	
Written by Ana Oteiza. Version 1. 26.02.2021.	Approved by. Rune Sundset.
Appendix 4 linked to the PETcore local radiation guidelines	

There is an available auxiliary equipment for decontamination at PETcore. It is located in front of the material sluise

Spill kit contents

The spill kit should always be available and should contain:

- Several radiation warning signs to be posted to warn personnel of the spill.
- Radiation warning tape to seal items which may be contaminated and to label areas and perimeters
- Several pairs of disposable gloves to be worn by personnel involved in the clean-up.
- Small plastic bags for wet or dry waste material.
- Large plastic bags to contain waste material, whether or not contaminated
- Personal protection equipment: Gloves, googles, arm and shoe covers.
- Masking tape to seal items which are not contaminated.
- A pencil
- Pair of scissors
- Tongs or forceps to handle contaminated items.
- Containers to contain sharp objects or broken glass.
- Gauzes and paper towels to absorb spills.
- Detergent solution to emulsify the spilled material and make it easier to clean from surfaces.
- Filter papers to perform wipe tests

Replace the spill kit contents after use. An inventory list is placed together with the kit. This should be kept updated. Do not misplace it

Faculty of Health Sciences Institute of Clinical Medicine.	PET imaging center. Research and Development section
Contamination report	
Written by Ana Oteiza. Version 1. 26.02.2021.	Approved by. Rune Sundset.
Appendix 5 linked to the PETcore local radiation guidelines	

This report is to be complemented by the PETcore radioactive safety contacts and approved by the PETcore head. Report should be submitted to UiT LSK and SSK.

Type of contamination		
Time/date		
Lab		
Location (e.g bench, floor..)		

Contamination monitoring instrument used

Decontamination measures used

Wipe test record of spill area (e.g. H^3 contamination)

Wipe test #	Wipe test 1 Bq/cm2	Wipe test 2 Bq/cm2	Wipe test 3 Bq/cm2	Wipe test 4 Bq/cm2	Wipe test 5 Bq/cm2
Point A					
Point B					
Point C					
Point D					
Point E					

Please provide a description of the wipe tests points (wipe test map)

STOP!!!
Please remember:
Dosimeter, Mask, gloves, cap, the green uniform, socks and shoes

- **No food, snus or drinks are allowed in the barrier**
- **All personal belongings (keys, mobile phone) should be in a zip lock bag**