Rules concerning work with radioactive substances at Kristineberg Marine Research Station.

This text represents only a selection of regulations from current radiation regulations and applies only as a local instruction for work with radioactive substances at Kristineberg Marine Research Station (KMRS). Complete regulations are found in Swedish code of statute (Swedish only) and in regulations from radiation safety authorities (SSMFS).

Everyone that works with radioactive substances is obliged to inform themselves about existing rules before the work is to be started or the substances are brought to Kristineberg. This text only considers work with ^{14}C and ^{3}H, if you plan to conduct work with other radioactive substances plans must be coordinated with the radiation safety officer (Lars Ljungqvist) and be in accordance with the local permit to handle radioactive materials. Radiation expert at the University of Gothenburg is Mats Isaksson.

Authorization

All personnel that works with radioactive substances has to be at least 18 years old, have undergone internal radiation safety course at the university and agreed to follow presented rules by signing a receipt.

Planning

When planning experiments involving radioactive substances, waste handling has to be considered. All experiments should be conducted in a way that minimizes radioactive waste. No waste should have to be sent for “permanent disposition of radioactive waste”.

Registering, Allowable Quantities & Storage

Radioactive substances are to be documented in the isotope journal upon arrival at Kristineberg. When the material is used up, this should be documented in the journal as well. Contact the radiation safety officer whenever anything is added to or removed from the isotope journal. Kristineberg is authorized to keep radioactive substances with a total maximum activity of 10 GBq (270 mCi).
Maximum radioactivity during work with ^{14}C and ^{3}H depends on the type of work:

Class I, work with gas or powder; 10 MBq (0,27 mCi) for ^{14}C and 100 MBq (2,70 mCi) for ^{3}H.

Class II, cell or animal experiments; 100 MBq (2,70 mCi) for ^{14}C and 1000 MBq (27,0 mCi) for ^{3}H.

Class III, basic work; 1000 MBq (27,0 mCi) for both ^{14}C and ^{3}H.

All radioactive substances (stock solutions, samples etc.) should be clearly labeled with respect to isotope (type and amount), substance, name of the owner and labeled with the radioactivity-symbol. They are to be kept in the refrigerators in radiation-lab 162 and 164. Scintillation samples that are to be saved for later are kept in the metal cabinet in scintillation room 163.

Designated laboratory space

When booking laboratory space at Kristineberg, it should be notified that work with radioactive substances will be handled. Define substance, isotope, radioactive content as well as staff competence. The basic rule is that all work with radioactive substances is carried out in radiation-lab 162 and 164. In exceptional cases, other areas can be used after consultation with the radiation safety officer. On the research vessels radioactive substances can only be used after consultations with the skipper and the radiation safety officer. When working with radioactive substances outside designated laboratories (162 and 164), information signs and radioactivity-symbols are to be positioned appropriately, isotope, radioactive content and person responsible should also be posted in the information.

Equipment

Radiation-lab equipment should not be moved; however, if it is necessary the radiation safety officer should be contacted. Equipment that is moved must first be checked for contamination and possibly sanitized (contact the radiation safety officer). If you suspect contamination, label the equipment (radioactivity-symbol, isotope and person responsible) and contact the radiation safety officer.

Use of other permanent equipment outside radiation-lab (e.g. centrifuges, dishwasher) should be carried out in a way that reduces the risk for contamination, after use equipment and surfaces should be checked. Other general equipment used in connection with radioactive substances should be properly sanitized after use. If the equipment is difficult or impossible to clean, it should be labeled with radioactivity-symbol. Observe that most plastic materials are impossible to clean completely from hydrophobic substances.

Protection measures & labeling

In order to be able to offer everyone a safe working environment and well-functioning research facilities, it is important that all personnel keep to the rules concerning security, protection and labeling.

Try to confine work with radioactive substances in as small an area as possible. Volatile substances or powdery substances are only to be handled in fume hoods. All surfaces that are used for work with radioactive substances should be covered with bench guard paper (the plastic

facing down). Label the bench paper with radioactivity-symbol, isotope, person responsible and date. Change papers when necessary and remove them when finished.

It is important, both for you and others, that one knows what is radioactive; show this by labeling with radioactivity-symbol. The labeling could be collectively for all items on the bench paper or in the labeled plastic container. Labeling also applies to scintillation sample containers.

Always use protective coat and gloves when working with radioactive substances. The coat is used only when working with radioactive substances and kept in the transit hall at radiation-lab when it is not used. Protective gloves (single use gloves) are to be changed often in order to reduce the risk of contamination. Be sure to remove the gloves when leaving the designated work area; this way water taps, fume hoods, and door knobs will not be contaminated.

Scintillation samples

In order to keep the scintillation counter in working order it is important that only clean vials are analyzed. i.e., make sure your work area is clean (fresh bench guard) and that the protective gloves are clean before handling the vials. Remember to tighten the cap properly and to check that the vials are completely dry on the outside. If you slop or drip any liquid on the outside, the vial must be carefully cleaned and checked for contamination before it is placed in the scintillation counter. Analyzed scintillation samples are kept in the metal cabinet in the scintillation room while waiting to be thrown in the radioactive waste (see below).

Cleaning, Smear Survey & Inspection

After completed work, remove all used equipment and bench guard paper. If there are any misgivings or suspicion of contamination of bench or equipment, perform a smear survey. Smear survey method and protocol is presented as annex below. Smear surveys are carried out regularly (every three months) by the radiation safety officer, or when contamination is suspected. Inform the radiation safety officer when work and cleaning is completed. This makes it possible to inspect for radioactive contamination before other scientists start their work.

Wastes

When planning experiments involving radioactive substances, waste handling regulations have to be considered. This is important as we would not want to produce wastes that we cannot dispose of! Use the maximum limits given in table 1 and 2 below as a guide when planning experiments.

Level definitions (exemption- and clearance-levels); Activity levels defined as exemption-levels (undantagsnivå) are found in regulations from the Swedish radiation safety authorities concern-

ing radioactive waste, SSMFS 2018:3, annex 1 (Swedish only). Activity levels defined as clearance-levels (friklassningsnivå) are found in regulations from the Swedish radiation safety authorities concerning radioactive waste, SSMFS 2018:3, annex 3 (Swedish only).

Solutions containing radioactivity can, if they **do not** contain poisonous or environmentally dangerous chemicals, be poured out in designated sinks in the fume hoods in each radiation-lab. **This on condition that the total activity each time does not exceed the exemption-level; and that the total activity does not exceed 10 times the exemption-level each month.** If more than one isotope is poured out, then the total activity should be less or equal to 1, when using formula 1 and values from table 1 below. More detailed information is available in SSMF 2018:1 and 2018:3, or contact radiation safety officer.

Formula 1.

$$\sum_{i=1}^{n} \frac{C_i}{C_{Ni}} \leq 1$$

where:
C_i is the total activity of radionuclide i, in Becquerel (Bq) or per mass-unit in kilo Becquerel per kilogram (kBq/kg) and

C_{Ni} is the exemption- or clearance-level-value assigned to radionuclide i, and n is the number of radionuclides.

Table 1.

Maximum activity or specific activity classified as exemption level according to SSMFS 2018:3, annex 1. (Maximum exemption level for each sink-solution-waste-occasion, or for each special-purpose-box)			
Radionuclide	Specific activity (kBq/kg)	Activity (Bq)	Activity (mCi)
^{3}H	$1x10^{6}$	$1x10^{9}$	27
^{14}C	$1x10^{4}$	$1x10^{7}$	0,27

(i.e; if what you send down the drain and/or send off as combustible radioactive waste is less than the activities found in table 1 above, you are keeping to the regulation!)

Check with the list at the sink what quantities have been poured out previously, to ensure that the limit is not exceeded. Note on the list (isotope, radioactivity, number of “max exemption levels”, name and date) when you have poured something out. Flush the sink with cold water

before, during and after pouring out, and make sure that it does not splash. **If the solution contains toxic or environmentally dangerous chemicals; it should be collected in a bottle and left as clearance-level waste, according to the regulations below.**

Combustible radioactive waste (NON hazardous waste) is divided into **Biological radioactive waste** and **Non-biological radioactive waste.** Biological waste is dead experimental animals and/or parts of animals and similar things (**not** sharps). **Non biological** is all other things, bench paper, pipette tips, gloves, sharps, glass etc., but **not** hazardous waste (see below). The waste is collected in a special purpose box with an internal plastic bag. The box is labeled with a specific sticker from SEKA miljöteknik AB, who takes care of the waste. The sticker has a radioactivity symbol and should be completed with information regarding isotope, radioactivity and a verification that the radioactivity does not exceed the maximum exemption level. It should also contain an ID-number (given by the radiation safety officer), your name and date. The box may, at most, contain 1 "maximum exemption level", i.e. 1000 MBq (27 mCi) ^{3}H, **or** 10 MBq (0,27 mCi) ^{14}C. ^{14}C and ^{3}H can be mixed in the same box but, if so, the maximum amounts may not be used for both nuclides (use formula 1 and values from table 1). Before placing the box in the room for hazardous chemical waste in the basement, the inner bag must be tightly closed and the surface dose-rate checked (see routine below), to ensure that the outside of the box is not contaminated. Always contact the radiation safety officer before leaving any radioactive waste to ensure proper documentation.

Hazardous radioactive waste (clearance-level waste)

Solutions containing toxic or environmentally dangerous chemicals, e.g. some scintillation solutions etc., should be classified as clearance-level waste according to criteria below. If you expect waste with radioactivity above clearance-level values to be produced in your experiment please contact the radiation safety officer. **We should not produce any waste with a concentration higher than 100 Bq/g for ^{14}C and 1000 Bq/g for ^{3}H (table 2 below).** If the hazardous waste contains more than one isotope you should calculate the sum of all values using formula 1 above and the values given in table 2 below, to make sure the clearance-level values are not exceeded. The waste is collected in a special purpose box with an internal plastic bag. The box is labeled with a specific sticker from SEKA miljöteknik AB, who takes care of the waste. The sticker has a radioactivity symbol and should be completed with information regarding isotope, radioactivity, what hazardous substance it contains and a verification that the dose-rate at the box surface does not exceed 5µSv/h. It should also contain an ID-number (given by the radiation safety officer), your name and date. Before placing the box in the room for hazardous chemical waste in the basement, the inner bag must be tightly closed and the surface dose-rate checked (see routine below) to ensure that the outside of the box is not contaminated. Always contact the radiation safety officer before leaving any radioactive waste to ensure proper documentation.

Table 2.

Maximum concentrations for classification as clearance-level waste. (Maximum clearance-level-activity per box)		
Radionuclide	kBq/kg	nCi/g
^{3}H	1000	27
^{14}C	100	2,7

Air emissions are not specifically regulated from the Swedish radiation safety authorities, but it is to be documented. You should calculate or estimate the released activity on the list at the sink.

All radioactive waste (including low-level waste) should be documented. For this reason, remember to tell the radiation safety officer when you leave anything in the room for hazardous waste, so that an ID number can be assigned to the box, making it possible to back-track the waste!

When preparing radioactive stock solutions containing toxic or environmentally dangerous substances, make sure that the radioactivity does not exceed values above. The waste handling issue is essential to have in mind at an early stage, when planning experiments and ordering substances.

Radioactive substances should not be stored for use in a distant future; when finished in the lab, clean out what you brought. If you feel uncomfortable with throwing away expensive substances, you could always consider donating them to other people. This is important to respect; in order to avoid unknown leftovers that are impossible to dispose of. It is also the one that uses the substance in question that knows best how to handle it safely when it is discarded.

Accidents or mistakes

It is important that all personnel try to minimize the risk of accidents and mistakes at all times when working with radioactive substances, to avoid contamination of persons as well as equipment. Contamination can cause radioactive substances entering the body, or produce incorrect results. If there are any misgivings or suspicion of contamination, always contact the radiation safety officer.

Measuring the dose-rate with the radiation detector

Measurements of the dose-rate is made with the radiation detector (a classic Geiger-counter, found in the room where the scintillation counter is). When using the instrument, please follow the instructions below. If you are uncertain about the function or how to use it, contact the radiation safety officer.

Measuring

1) Start the instrument by turning the knob to its third position (I on).
2) Study the reading of the instrument for ½ a minute in order to estimate the background radiation (should be approx. 0.5-1 CPS).
3) Measure by holding the G-M-tube (the black thing with a curly cord that looks like a microphone) close to the surface that you would like to measure without touching the surface! The G-M-tube is sensitive and thus should be handled with care and if it is contaminated measurements will not be correct.
4) If the instrument shows a higher reading than the background, the dose-rate is too high!

What to do if YOU are contaminated

1) Remove contaminated gloves, coat, shoes etc. on the premises, do not spread the radioactivity.
2) Check with radiation detector if the skin is contaminated.
3) Contaminated skin is cleaned with mild soap and water. Do not scrub. Never use solvents or spirits that could reduce the skin's protective function. Clean until additional cleaning is fruitless according to radiation detector.
4) Contact radiation safety officer and university radiation control if the reading still exceeds 3 times the background radiation according to radiation detector.

What to do if you SPILL and contaminate equipment or surroundings

1) Control the area, measure with appropriate radiation detector.
2) Remove spills with absorbent paper. Do not rub since this could lead to contamination of a larger area.
3) Cover the surface with bench guard papers.
4) Measure with radiation detector and note the result on the bench guard paper. Secure the area by arranging warning signs and tape.
5) Report to radiation safety officer and university radiation control if the reading still exceeds 10 times the background radiation according to radiation detector.

Severe accident – Block off the area by arranging warning signs and tape!

Always contact the radiation safety officer if there is an accident.

Updated 2020-04-16
Radiation safety officer
Lars Ljungqvist

SMEAR SURVEY (METHOD)

1) Add control points to protocol and label the vials.
2) Use protection gloves.
3) Take a swab with single use pliers. Soak the swab in 70% ethanol in a plastic jar.
4) Swab off the surface and estimate the surface.
5) Place the swab in a scintillation vial with the used side up.
6) Let the ethanol evaporate and then add scintillation cocktail.
7) Prepare a blank in a similar way.
8) Measure and record the results.
9) Report to university radiation control if the result exceeds 10 times the blank value.

Updated 2020-04-16
Radiation safety officer
Lars Ljungqvist

SMEAR SURVEY (PROTOCOL)

Laboratory ..... Contact ..... Tel .....

Date	Work station Sample no.	Isotope	Backgr. (cps)	Meas-uring time (min)	Sam-ples (cps)	Taken measure	Report to Radiation control	Signa-ture

Application to work with radioactive substances at Kristineberg Marine Research Station. (Filed by the radiation safety officer)

Read the statements and confirm (by checking and signing) that you have understood and agree to follow the rules!

- ☐ I agree to follow radiation safety regulations, official as well as Kristineberg's local ones.
- ☐ I will only work with radioactive substances in radiation-lab, If not, I will confer with the radiation safety officer.
- ☐ In case of spilling radioactive substances, I will immediately clean and then control (smear survey) that cleaning is satisfactory.
- ☐ After completed work, I will remove all used equipment, bench papers and other wastes according to current requirements.
- ☐ If I plan to work with others isotopes than ^{14}C and ^{3}H, I will contact the radiation safety officer **before** I order the substances.
- ☐ I will keep the isotope inventory list up to date, by reporting purchases and consumption.
- ☐ Before I start my experiments I will present a plan for handling the waste that will be produced.

Date

Name