Reference: DIR-SEC-RP-PR-I-5461

PROCEDURE FOR EXPERIMENTS WITH LOW-LEVEL RADIOACTIVE SAMPLES ON BEAMLINES OTHER THAN MARS BEAMLINE

Date of issue	Author	Checker	Approver	Modifications
2024/07/04	Radioprotection Ing. T. BRIOULT	Radioprotection Resp. J-B. PRUVOST	Head of safety group J-P. LAURENT	English translation
Mailing list	Site internet SOLEIL.			

INTERNE

La version électronique fait foi.

Synchrotron SOLEIL – Société Civile au capital de 12.000 €
439 684 903 R.C.S. EVRY – NAF 7219Z – SIRET 439 684 903 00016
L'Orme des Merisiers – Saint-Aubin – BP 48 – 91192 GIF-S/-YVETTE Cedex
www.synchrotron-soleil.fr

PROCEDURE FOR EXPERIMENTS WITH LOW-LEVEL RADIOACTIVE SAMPLES ON BEAMLINES OTHER THAN MARS BEAMLINE

TABLE OF CONTENTS

1. GENERAL INFORMATION

Generally, experiments on radioactive samples are carried out on the MARS beamline, which has been specially designed for this purpose. However, subject to satisfying a certain number of conditions, some experiments on very low activity samples can be carried out on beamlines other than MARS.
This document presents the conditions that must be met and the specific procedures to be respected so that these experiments can be carried out at SOLEIL Synchrotron outside the MARS beamline.

2. EXPERIMENTS ON RADIOACTIVE SAMPLES THAT CAN BE AUTHORIZED AT SOLEIL OUTSIDE THE MARS BEAMLINE AND ASSOCIATED REQUIREMENTS

2.1. FAMILY OF EXPERIMENTS

Only experiments carried out at ambient pressure and temperature during which no external stress (mechanical, chemical, hydraulic, etc.) is exerted on the radioactive sample may be authorised on beamlines other than the MARS beamline.
Any intervention on the radioactive sample, of any nature whatsoever, likely to modify or alter the physico-chemical characteristics of the sample is strictly forbidden during its presence on site at SOLEIL.

2.2. NATURE OF THE SAMPLES

Depending on their nature, the low-level radioactive samples that may or may not be allowed on beamlines other than the MARS beamline are listed below.

- Gaseous samples are prohibited. Samples likely to produce gases during the experiment are prohibited.
- Liquid samples in volatile solution are forbidden (organic or other solvents).
- Liquid samples in a aqueous solution are acceptable provided that the solution is not corrosive, and that the experimental device is compatible with the installation of a means of containment to limit the dispersion of the solution in the event of a breach of the double containment.
- Samples in the form of dispersible powder are prohibited. Subject to prior approval by the SRP, powder samples rendered non-dispersible by a binder may be permitted on a case-by-case basis.
- Solid samples are accepted.
- Samples containing radioactive halogens and/or tritium are prohibited.

2.3. SAMPLE CONTAINMENT

Regardless of their nature, to be authorised on beamlines other than the MARS beamline, low-level radioactive samples must be placed within a double sealed containment consisting of the sample holder.
To be used on a SOLEIL beamline, the sample holder must first have been approved by the SOLEIL safety group based on a detailed technical description provided by the scientific users. The sample holder should also be approved in advance by the beamline manager.
The sample holder has a reference that allows the precise identification of the sample(s) it contains.
The total activity of the sample(s) intended for analysis on beamlines other than the MARS beamline will be strictly below the exemption threshold defined in the regulations in force, regardless of compliance with the other acceptance criteria set by the SOLEIL safety group.

2.4. EXTERNAL EXPOSURE RISK

To meet SOLEIL's requirements regarding the risk of external exposure, and in particular the imperative to maintain the experimental hall and the beamlines in a non-restricted area (ZNR) with regard to radiological risk, the SOLEIL SRP has set the following conditions:

- The ambient equivalent dose rate (H*(10))[1] at 30 cm of the sample holder shall be strictly less than 0.1 µSv/h;
- The skin equivalent dose rate (Hp (0.07))[2] in contact with sample holder shall be strictly less than 10 µSv/h.

If several sample holders containing low-level radioactive samples are brought in for an experiment, these will be stored in a beamline room in a specific cabinet made available by the SOLEIL SRP. The equivalent dose rate will also apply around this cabinet.
To be accepted, samples brought in by users must simultaneously meet all these conditions.

2.5. INTERNAL EXPOSURE RISK

Regarding the risk of internal exposure, the objective of the SRP of SOLEIL is to ensure that the effective dose committed in the event of contamination is as low as possible regardless of the mode of intake.
In accordance with the requirements of the French Nuclear Safety Authority (ASN), the engaged effective dose[3] likely to be generated by a sample in the event of contamination must be strictly less than 25 µSv.
For radioactive samples to be accepted outside the MARS beamline, the SRP must verify that the engaged effective dose requirement in the event of contamination is met.

[1] H*(10): Ambient equivalent dose (under 10 mm of soft tissue), estimator of the whole-body dose that can be received.
[2] Hp (0.07): Skin equivalent dose (under 70 µm of tissue – corresponds to the basal layer of the epidermis), estimator of the dose that can be received to the skin.
[3] Engaged Effective dose: sum of the doses received in the various tissues or organs exposed as a result of the incorporation of radionuclides into the body integrated over the time elapsed since intake (implicitly 50 years for an adult individual).

The SRP considers intake by inhalation and ingestion and is based on the data from Annex III of the decree of 1 September 2003 by systematically retaining the most penalizing values.

Table 1 below presents, for information purposes, the maximum permissible activities that will satisfy all the criteria described in paragraphs §2.4 and §2.5 for some isotopes that will probably be proposed by future scientific users of SOLEIL.

Tableau 1

Isotope or radioelement	Max activity per eligible sample offline MARS (Bq)	Value of the exemption threshold (Bq)	Activity limited by
U_{nat}	**80**	1 000	Engaged effective dose
^{238}U	**270**	10 000	Extremity Dose Rate
^{235}U	**1 300**	10 000	Engaged effective dose
^{234}U	**1 250**	10 000	
^{234m}Pa	**1 250**	10 000	
^{234}Pa	**280**	1 000 000	Extremity Dose Rate
Th_{nat}	**120**	1 000	Engaged effective dose
^{232}Th	**280**	10 000	
^{14}C	**100 000**	10 000 000	
^{32}P	**400**	100 000	Extremity Dose Rate
^{33}P	**250 000**	100 000 000	Engaged effective dose
^{35}S	**80 000**	10 000 000	
^{36}Cl	**900**	1 000 000	Ambient Dose Rate
^{40}K	**700**	1 000 000	Extremity Dose Rate
^{45}Ca	**80 000**	10 000 000	Engaged effective dose
^{55}Fe	**180 000**	1 000 000	
^{63}Ni	**400 000**	100 000 000	

The activities presented here correspond to the maximum permissible activity for the isotope if it is the only one present in the sample(s).

3. WHAT TO DO BEFORE SUBMITTING A PROPOSAL

First, the main proposer must contact the manager of the envisaged beamline for the experiment **AND** the SRP of SOLEIL to discuss the feasibility of the proposal from a scientific and technical point of view and the acceptability of the experiment, the samples to be studied and their containment from a radiological point of view.

Regarding the radiological risk, the main proposer (MP) should provide the SOLEIL SRP with a written description of the experiment envisaged, the samples envisaged, including the isotopic composition for each of them as well as a detailed description of the sample holders to be used as double containment.
After examining the elements provided by the MP, the SRP will decide on the acceptability of the project on a SOLEIL beamline. If the project is acceptable to both the proposed beamline and the SRP, the MP may submit the SUNSET proposal to the attention of the corresponding program committee.

4. WHAT TO DO BEFORE THE EXPERIMENT BEGINS

4.1. DURING THE APPRAISAL OF THE PROPOSAL

During the appraisal of the proposal by the safety group and by the SRP of SOLEIL, the MP will be required to provide the following documents:

- A risk analysis corresponding to the experiment and the samples envisaged, including the description of the samples and their isotopic composition, their containment (PE), the sample preparation procedure and the controls carried out during this preparation, the description of the experiment, the means of prevention and control implemented. This risk analysis should also present a dosimetry evaluation of the experiment including a contamination incident. A risk analysis framework is available on the SOLEIL website.
- Any additional information that may be requested by the SOLEIL safety group during the investigation.

4.2. FOUR WEEKS BEFORE THE START OF THE EXPERIMENT

After acceptance and programming of the proposal by the beamline manager, the MP must transmit to SOLEIL at the latest four weeks before the start of the experiment, all the documents listed above, updated following exchanges with the SRP during the investigation period and completed with any missing information expected by the SOLEIL SRP.
In particular, the precise isotopic composition of the individual samples will have to be provided as well as the corresponding update of the risk analysis.

A certificate from the employer indicating that each of the participants in the experiment at SOLEIL has received, at least, information on the risks associated with ionizing radiation.
This four-week period is imperative to allow the security group to examine the entire project and to have enough time to iterate the various required documents with the users and the PM.
If, at the latest, four weeks before the start of the scheduled experiment, all the required information and finalized documents are not available, the experiment cannot be carried out.

4.3. ONE WEEK BEFORE THE START OF THE EXPERIMENT

At the latest, one week before the start of the experiment, the MP must transmit to the SOLEIL safety group the non-contamination report of the sample holders, the gamma spectrometry reports of each of the sample holders and, if applicable, the transport documents for the transfer of the sample holders from the users' laboratory to the SOLEIL Synchrotron.
The transport of sample holders to SOLEIL must be organised by the users, in consultation with the SOLEIL SRP and the person responsible at the reception beamline.
The on-site reception of the PE must be scheduled so that the EP controls are carried out by the SOLEIL SRP during the week, during working hours, i.e. from Monday to Friday, between 8:30 am and 4:30 pm.

5. WHAT TO DO DURING THE EXPERIMENT

During the experiment on the host beamline, without foreshadowing the means of prevention to be implemented from the risk analysis, the handling of the sample holders must be carried out while wearing a disposable gown and gloves.
A specific waste bin will be made available to users exclusively for this purpose on the beamline.
The MP, or a designated user, will be required to ensure the traceability of all sample movements between the storage cabinet and the beamline experiment station in a ledger; to be able to know, at all times, which samples (or sample holders) are in the storage cabinet or on the experiment station.

6. WHAT TO DO AFTER THE EXPERIMENT

At the end of the experiment, the MP must contact the SRP of SOLEIL in order to have the radiological control of all PE before their packaging for return and their reshipment to their laboratory of origin.
The return of the PE to their origin laboratory must be organized by the users, in consultation with the SRP of SOLEIL and the manager of the beamline so that it can be scheduled during the week, during working hours, i.e. from Monday to Friday, between 8:30 a.m. and 4:30 p.m.

7. SAMPLE HOLDERS AND CONTAINMENT

7.1. SAMPLE HOLDERS

A detailed description of the sample holder must be provided to the SOLEIL SRP. This description must clearly explain the degree of containment provided by the sample holder.

The sample holder must be perfectly adapted to the experimental set-up of the beamline and must guarantee the stability of the sample(s) it contains, considering its physical and chemical properties, throughout its stay at SOLEIL.
It must be impact-resistant. Thus, as an indication, the use of glass is formally prohibited for the sample holder.
Particular attention should be paid to the quality of the joints and any X-ray transparent "windows".
If the sample holder do not conform to the description provided by the main-proposer and validated by the SOLEIL Safety group, the experiment will be refused.

7.2. CONDITIONING

The requirements for the containment of samples are defined in §2.3. The detailed description of the containment provided by the PE should lead to the conclusion that the PE can be considered a double barrier of containment of the sample(s) it contains.
The SRP of SOLEIL will decide whether the PE can indeed be considered as a double confinement based on the information provided by the MP.

It should be noted that some types of sample holders, commonly used on the MARS beamline, could be used as a means of containment for experiments on other beamlines than MARS.
This point will have to be addressed during the discussions prior to the submission of the project, as it may require the prior approval of the MARS beamline team and/or the prior authorization of the CEA.

8. INTERVENTION ON SAMPLES AT SOLEIL

Any intervention of any kind on samples or PE is strictly prohibited at SOLEIL.
The preparation of samples and sample holders is carried out exclusively outside SOLEIL, in the users' laboratory.