EUROPEAN SPALLATION SOURCE

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ESS EXPERIMENT SAFETY REVIEW PROCEDURE

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1. PURPOSE

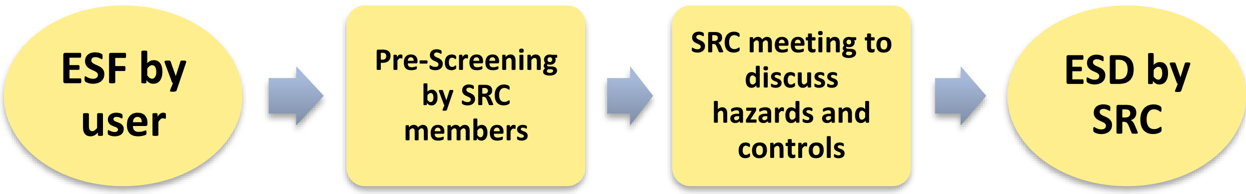
Based on the *NSS Concept of Operations* (ESS-0005817) [1], *Neutron Scattering Systems - System Design Description* (ESS-0377817) [2], the *Neutron Scattering Systems - Radiological Hazards and Radiation Safety Provisions for Operations and Maintenance* (ESS-2972939) [3], and as part of the *ESS Sample Management Procedure* (ESS-0024109) [4], the main goal of the ESS Experiment Safety Review Procedure is to make sure hazards connected to samples and sample handling, governed by the *ESS Sample Handling Procedure* (ESS-0024112) [5], are discovered before scheduling a proposed (user) experiment and that controls are defined to ensure safe (user) experiments. The ESS Experiment Safety Review Procedure achieves this goal by considering the rules described in the *ESS Handbook for Radiation Protection Chapter 2. General Radiation Protection Rules* (ESS-0239718) [6] and the *Swedish Authority Provision AFS 2014:43 (chemical risks); Swedish Authority Provision AFS 2014:1 (biological samples)* [7].

2. PROCEDURE APPLICABILITY

The Experiment Safety Review Procedure is applicable to the safety review of all proposed and accepted work through the ESS user program. It is part of the Sample Management Procedure [4].

3. EXPERIMENT SAFETY REVIEW PROCEDURE

3.1. Procedure map



The proposal team fills out an Experiment Safety Form (ESF) that is reviewed by the members of the Safety Review Committee (SRC pre-screening). Experiments are rated according to the Experiment Hazard Level (EHL) as low-hazard, medium-hazard or high-hazard by the members of the Safety Review Committee (SRC). Experiments that are not categorised as low-hazard in the pre-screening are discussed in the SRC meeting. The outcome is an Experiment Safety Document (ESD) created by the SRC that is handed over to the personnel involved in the experiment.

3.2. Procedure details

The flow chart in Figure 3-1 is meant to assist in understanding the details of the Experiment Safety Review procedure. The blue boxes represent the two-step procedure – a pre-screening followed by the SRC meeting. At the end of the process, the Experiment Safety Document (ESD) shall be signed by the SRC members and the SRC chair-person before it is moved further.

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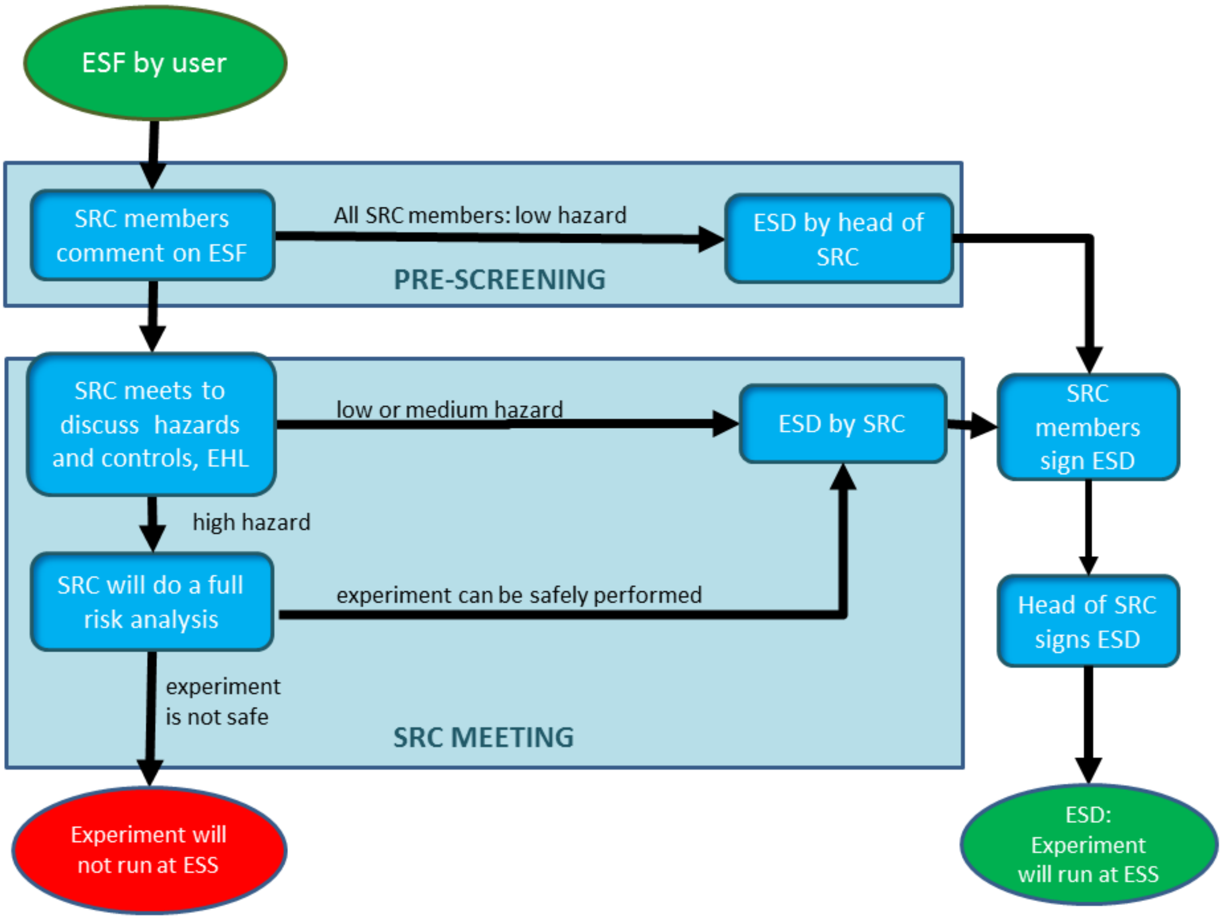

Figure 3-1 Flow chart describing the steps in an ESS Experiment Safety Review

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3.2.1. Input

When the scientific review by the ESS science review panel and the experimental feasibility review by the ESS instrument team has confirmed that an experiment will be performed at ESS, the sample management process starts with the safety review procedure. The ESS Experiment Safety Form (ESF) for the experiment, generated for each scientific proposal submitted to the ESS, is the input to the Experiment Review Procedure. When the Experiment Review Procedure starts, the ESF has already been filled out by the proposal team and covers the sample material as well as the hazards connected to planned activities and experiments during the stay of the users at ESS.

<table>
<tr><td colspan="2">3.2.2. Pre-Screening: SRC comments on ESF</td></tr>
<tr><td>Before the meeting, the SRC members read all ESFs submitted by the users with a focus on their expertise. They give written comments to the chair-person of the safety review committee (SRC) concerning:
• hazards not listed in the ESF or corrections to listed hazards
• recommendations of administrative and engineering controls needed
• need of clarification (questions to ask the user, instrument personnel, sample environment or laboratory responsible)
• rating of the Experiment Hazard Level EHL (low, medium, high).</td><td>Responsible:
SRC members
Pre-Screening by SRC members</td></tr>
<tr><td>Output/product</td><td>Written comments on hazards, controls and EHL sent to the SRC chair-person.</td></tr>
</table>

3.2.3. Pre-Screening: Prepare drafts of ESDs

The SRC chair-person will compile all comments and corrections given to him/her by the safety review committee members and create the first draft of the Experiment Safety Document (ESD). This safety document contains all applicable hazard provisions and controls for the respective experiment and the samples.	**Responsible:** SRC chair-person **Pre-Screening by SRC members**
Output/product	Written draft of ESDs sent to members of the SRC

3.2.4. Pre-Screening: prepare ESDs for low-hazard proposals

All experiment proposals considered to be in the low-hazard category (EHL=low-hazard) by <u>all</u> members of the committee are not discussed at the SRC meeting. The SRC chair-person finalises the draft of the ESD and sends it to the SRC members for signature.	**Responsible:** SRC chair-person **Pre-Screening by SRC members**
Output/product	Completed ESDs sent out to the SRC members to sign.

3.2.5. SRC meeting: defining hazards and controls

Responsible: SRC members

SRC meeting to discuss hazards and controls

The SRC meets to discuss experiments classified as medium- or high-hazard (EHL) by any member of the SRC during the pre-screening. The safety review committee

- identifies all hazards connected to the experiment (sample and equipment)
- evaluates accident scenarios to determine that in case of a likely accident radiological contamination will be <40 kBq/m^2 for β and γ emitters and/or < 4kBq/m^2 for α-emitters for a spill (based on the contamination limits in a supervised area [6]).
- Further evaluations from RP will be based on dose assessments
- defines administrative and engineering controls needed for the specific experiment, e.g. sample tracking, sample containment, handling instructions and similar
- defines special roles and responsibilities of ESS personnel if required and when they differ from standard responsibilities.
- discusses "what if… scenarios" as appropriate (What If? Answer. Likelihood? Consequences? Recommendation?)
- determines if sample tracking is required (this applies to all high-hazard samples, maybe some medium-hazard samples)
- confirms the final Experiment Hazard Level (EHL) classification of the experiment (low, medium, high)

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• provides a summary of the process with an ESD stating all hazards, all controls and all responsibilities	
Output/product	Written hazards and controls added to the draft ESD.
3.2.6. SRC meeting: Decision on EHL and possibility to run experiment	
If the SRC decides that the final EHL is low- or medium-hazard, the SRC finalises the ESD containing all hazards and a full risk analysis does not need to be performed. If the SRC decides that the EHL is high-hazard, the SRC is required to perform a full risk analysis. If the experiment cannot be performed safely with reasonably achievable controls, the SRC writes comments on the ESD and the experiment will not run. If the experiment can be performed safely, the SRC adds the necessary controls to the ESD.	**Responsible:** SRC members **SRC meeting to discuss hazards and controls**
Output/product	Finalised ESD.
3.2.7. Finalised ESD	
Each SRC member reviews and signs the ESD form. Then the SRC chair-person signs the ESD and sends the signed ESD to the instrument team responsible for the experiment.	**Responsible:** SRC members, SRC chair-person **SRC meeting to discuss hazards and controls**
Output/product	The signed ESD is forwarded to the instrument teams responsible for the experiment.

3.2.8. Output

Each ESD is signed by all committee members and the chair-person of the SRC before it is released to the instrument team responsible for performing the experiment. The head of the SRC sends the signed ESD to the instrument team responsible for the experiment. At this point, the Safety Review Procedure is finished.

4. RULES, REGULATIONS, CONSTRAINTS, GUIDELINES

4.1. Safety Review Committee (SRC)

The ESS safety review committee consists of at least one local ESS expert in each of the following fields:

- radiation hazards
- chemical hazard
- biological hazards

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- conventional safety (electrical hazards, noise, pressure, cryogens, etc.)

The SRC members are required to have knowledge in their field either through their profession or relevant experience. Concerning the SRC chair-person, it is an advantage but not a requirement to have a chair with a general safety background who is able to cover a broad spectrum of hazards.

4.2. Safety Review Committee Meeting

All members of the SRC shall be present during the SRC meeting. The SRC chair-person shall be responsible for calling the SRC meeting and for supplying the draft ESDs to the SRC members. During the review days, instrument teams shall be available for questions about the experiment. The instrument teams are encouraged to attend the safety review meeting of their experiments, but they are not required to be present.

4.3. Hazard Classifications

The Experimental Hazard Level (EHL) classifications help categorise the risk involved in performing an experiment and trigger standard procedures on how to handle those risks. They are only a classification and will not determine the controls automatically. The ESD contains the administrative and engineering controls that are specific to the experiment and guides the personnel involved in the experiment. The classification takes into account all types of hazards, e.g., radiation hazards, chemical hazards (including explosives), biological hazards, electrical hazards and others.

Note: During the SRC meeting, the Experiment Hazard Level (EHL) may be adjusted as appropriate if committee members agree.

Low Hazard: This experiment is allowed to be done with standard precautions under the general supervision of the instrument team. Laboratory or sample environment personnel might be involved. Handling of the sample is defined in the safety document and is allowed to be performed under standard precautions (checkboxes that apply to the experiment are checked in the safety document). Loss or spill of the sample would cause contamination less than 40 kBq/m^2 for β and γ emitters and less than- 4 kBq/m^2 for α-emitters. So even if a likely accident happens, contamination stays within the requirements for a supervised area. The chemical and biological hazards can be minimised by the use of PPE and appropriate containment. General hazards are within the scope of normal operation, e.g., standard sample environment equipment that has been assessed for hazards by the producing company (certification like ISO, DIN, TUV, CE) or by ESS previously, standard operation of the instrument and standard procedures in the labs.

Medium Hazard: This experiment might need additional administrative and engineering controls that are not standard on the given instrument but are not unusual. It might be downgraded to a low-hazard level after the implementation of the necessary controls and could be run under the general supervision of the instrument personnel only. If the additional controls cannot remove the hazards, this experiment might require additional support personnel, additional barriers and other controls that cannot be handled by the instrument team or user alone. The required controls will reduce the possible contamination in case of an accident to be less than 40 kBq/m^2 for β and γ emitters and less than 4 kBq/m^2 for α-emitters. The chemical and biological hazards can be minimised by additional engineering controls such as double containment or limited handling. General hazards might need additional controls, e.g., high-pressure that does not allow access near the compressor relief valve.

High Hazard: It is only possible to run this experiment safely with special precautions and controls. This will usually require additional support from radiological control technicians. It might require additional postings and changes in area classification and it has additional extensive administrative

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and engineering controls. This experiment is not allowed to run under the supervision of the instrument team only. The chemical and biological hazards might have to be handled in special PPE and might require additional personnel. The sample shall be tracked during its lifetime at ESS.

The boxes in Figure 4-1 give an overview of the preliminary hazard qualification for radiological hazards concerning contamination not volume activation. This is defined by the limits for the supervised area as defined in [6]:

Low Hazard:

Loss or spill of the sample will not lead to contamination or health risks.

A possible accident could result in radiological contamination of NO MORE THAN

- 40 kBq/m² for β and γ
- 4 kBq/m² for α

Medium Hazard:

Loss or spill of the sample might lead to contamination and/or health risks.

Additional **administrative and/or engineering controls** must be in place so a possible accident could result in radiological contamination of NO MORE THAN

- 40 kBq/m² for β and γ
- 4 kBq/m² for α

High Hazard:

Loss or spill of the sample will lead to contamination and/or serious health risks.

Non-standard administrative and engineering controls must be in place so a possible accident could result in radiological contamination of NO MORE THAN

- 40 kBq/m² for β and γ
- 4 kBq/m² for α

Figure 4-1 Hazard qualification categories for samples

Note: There should be enough time allowed between the Safety Review Committee (SRC) meeting and the actual experiment so that it is possible to put controls in place.

Note: At a later point in time, subject matter experts will define the hazard qualifications in more detail and refine the scope.

4.4. Experiment Safety Form (ESF)

When users submit a scientific proposal, they are required to fill out an ESS Experimental Safety Form (ESF). This form includes, but might not be limited to, the following 5 areas:

1. General	• Instrument and contact information
2. Samples	• Sample description (type, quantity, hazards, lifecycle)
3. Expe-riment	• Short paragraph stating how experiment will be performed (experimental plan for complete experiment)
4.Equip-ment	• Information on the equipment that will be used on the instrument (ESS equipment or user-produced equipment)
5.Aux. Labs	• Information on which laboratory will be used (experimental plan for laboratory)

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Figure 4-2: Sections of the Experiment Safety Form (ESF).

The following list shows in some detail the information that might be required as a minimum:

1. General information: This section contains information about the contact details for key personnel and at which instrument the experiment will be performed, e.g.
    a. Title of proposal
    b. Instrument and date for the experiment
    c. Person in Charge (PIC) of the instrument team (useful contact person for the safety review)
    d. PIC of the user team (one user dedicated for communication)
2. Sample Description: The samples for the neutron scattering experiment are listed along with information on their hazards, their physical state and how they will arrive at ESS, e.g.
    a. Chemical formula of the sample, IUPAC name, sample description
    b. Mass/volume of the sample, and density if possible
    c. Physical State (solid, powder, liquid, thin film, nanoparticle, gas, other)
    d. Sample Disposition (retained and stored at ESS, disposed through ESS, shipped to home institution, other)
    e. Will the sample arrive in a sample container suitable for neutron scattering? (Yes/No, approved by ESS or not)
    f. Will the sample be contained during the neutron experiment? (Yes/No, In what? Vanadium can, quartz, substrate, other)
    g. Chemical hazards of the sample (toxic (T,T+,Xn), corrosive (C, Xi), flammable (F,F+), oxidiser (o), explosive (E), carcinogenic, mutagenic, aquatic acute danger (N))
    h. Biohazards (1-4) [7]
    i. Radiological hazards (Yes, No, Naturally active, activated via previous beamtime, nuclides, activity (Bq))
3. Experiment Description: The experiment is described by the user. This description provides a detailed plan for all work that will be performed at the ESS, including all parameters that will be changed during the neutron scattering experiment. It states which samples will be in what sample container in what sample environment at what temperature/pressure/flow, etc.
4. Equipment Description: The equipment is listed by the user. Here the user is expected to disclose the equipment that will be used and whether or not additional safety reviews are needed for user-provided equipment.
    a. Sample environment equipment to be used from ESS (picked from a list of available items or confirmed with instrument team)
    b. User-provided sample environment to be brought in (described by users, shall meet ESS requirements)
5. Auxiliary Laboratory usage requires a detailed plan that explains which samples will be moved between the experimental hall and the chemistry laboratories. This includes information as

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to what sample holders will be used, since samples will frequently be loaded/unloaded into approved ESS containers in the laboratories or on the instruments.

a. Will the sample be loaded into a sample holder at the ESS? (Yes/No, what conditions are needed, inert atmosphere)

b. Will sample preparation (procedures before the sample goes into the beam) be performed at ESS? (Yes/No)

c. Will sample modification (procedure during the beamtime after the sample went into beam) be required? (Yes/No, detailed plan)

d. What type of laboratory is required during the experiment? (Chem/Life Science)

e. What type of chemicals/equipment are required?

f. What type of chemicals/equipment are brought onsite? Will they stay at ESS for longer periods of time?

g. What type of work will be performed? (a short paragraph describing hazards, quantities, and waste generated)

h. Will the sample have to be unloaded at ESS? (Yes/No, what conditions are needed, inert atmosphere, nanoparticle?)

i. What other equipment will be used and when? (Optical spectrometers, X-ray diffractometers, furnaces, other; before or after the neutron scattering experiment?)

4.5. Experiment Safety Document (ESD)

The purpose of the Experiment Safety Document (ESD) is to identify all hazards connected to the experiment which includes samples and equipment. The ESD is done by safety experts from the SRC and contains a summary of the hazards as well as requirements for controls for the experiment. It contains part or all of the ESF generated by the user, but the final hazards are determined by a Subject Matter Expert (SME). The ESD has, but is not limited to, the following 6 sections, see Figure 4-3.

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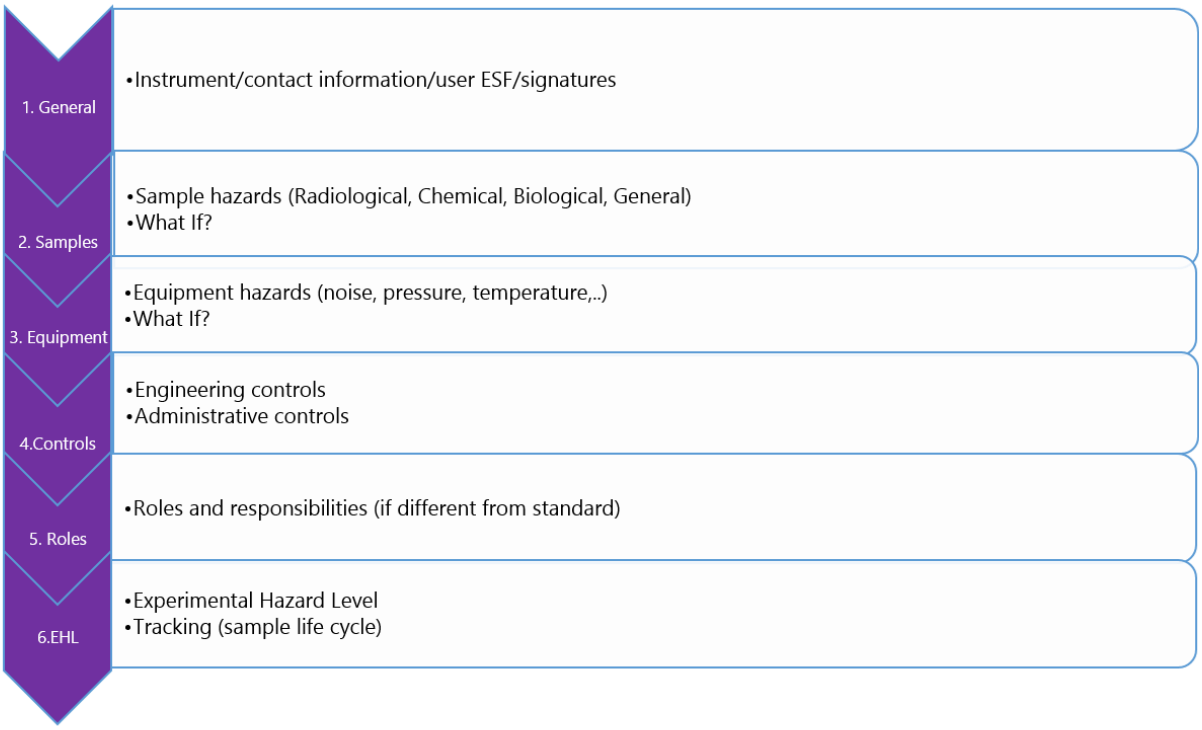

Figure 4-3: Sections of the Experiment Safety Document (ESD).

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5. GLOSSARY

Term	Definition
EHL	Experiment Hazard Level; there are 3 hazard levels: low-, medium- and high-hazard
ESD	Experiment Safety Document (*)
ESF	Experiment Safety Form (*)
ESH	Environment, Safety & Health
ESR	Experiment Safety Report
ESS	European Spallation Source, ERIC
ESS Users	Scientists and engineers using ESS scientific services.
Instrument Team	ESS scientists and engineers hosting an experiment on a specific instrument.
NSS	Neutron Scattering Systems
OHS	Occupational Health and Safety
PIC	Person in Charge
PPE	Personal Protection Equipment
Principal Investigator (PI)	Main proposer identified on the experiment proposal.
Proposal Team (PT)	Everyone designated by the PI with the right of access to ESS scientific services.
RP	Radiation Protection
SD	Science Directorate
SME	Subject Matter Expert
SRC	Safety Review Committee

(*) The described procedure, forms and documents can be supported in digital form as needed.

6. REFERENCES

[1] NSS Concept of Operations (ESS-0005817)
[2] Neutron Scattering Systems - System Design Description (ESS-0377817)
[3] Neutron Scattering Systems - Radiological Hazards and Radiation Safety Provisions for Operations and Maintenance (ESS-2972939)
[4] ESS Sample Management Procedure (ESS-0024109)
[5] ESS Sample Handling Procedure (ESS-0024112)
[6] ESS Handbook for Radiation Protection Chapter 2. General Radiation Protection Rules (ESS-0239718)
[7] Swedish Authority Provision AFS 2014:43 (chemical risks); Swedish Authority Provision AFS 2014:1 (biological samples)

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DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	Monika Hartl	2015-09-17
2	Update of template, references and some amendments related to sample retirement and digitalisation.	Arno Hiess	2023-04-26
	Comments resolved, changes accepted	Monika Hartl	2023-05-11
3	Changes and adaptions due to several review comments. Main changes: Page 5: added as response to Per Ross' comments and the internal JIRA thread. "• Further evaluations from RP will be based on dose assessments • defines administrative and engineering controls needed for the specific experiment, e.g. sample tracking, sample containment, handling instructions and similar " on page 17, adjustment of activities as pointed out by Ana Cintas The updates add clarity and do not contradict the conclusions reached in the previous revision. This has no impact on the radiation safety case for trial operations of the SCL linac. The revision does not change the way we work at ESS.	Monika Hartl	2023-11-24

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Appendix A: Scenarios

These are a few theoretical scenarios with typical user proposals. This appendix will show a summary of a possible ESF done by the user, the possible reactions of the safety review committee and the final ESD colour coded in green (ESF) and purple (ESD). All the numbers and statements have not been generated by a real SRC and are just for demonstrating purposes.

ESF

1. General
2. Sample description
3. Experiment description
4. Equipment to be used
5. Laboratories to be used

ESD

1. General (copied from ESF)
2. Sample hazards
3. Equipment hazards
4. Controls (engineer./admin.)
5. Experiment Hazard Level/Tracking

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Scenario 1:

Experiment Safety Form (ESF):

1. General: User X has approved beamtime on a diffractometer with instrument team member Y being the PIC. Title: "Temperature dependent diffraction pattern of nano-Silica"
2. Sample Description:
    a. Silica (SiO_2)
    b. 4 samples with 1g/sample
    c. Material is a powder.
    d. Sample should be shipped back to home institution after the experiment.
    e. Sample will not arrive in sample container. Sample will arrive in a glass vial.
    f. A Vanadium can from ESS will be used as sample holder.
3. Experiment Description: They will measure 4 silica samples of varying particle size (from nanopower to crystalline silica) at 5 temperatures from 10K to 300K. Samples will be filled into the V cans at ESS under inert atmosphere. After the experiment they want to unload the sample in inert atmosphere.
4. Equipment: They are using the cryostat supplied by the diffractometer (standard equipment) for the temperature dependant measurements. They will not bring equipment from home.
5. Aux. Laboratory usage: Sample will be loaded at ESS in an inert atmosphere. One sample needs to be heated to 100°C in vacuum. No sample modification after sample has been in the beam. No other labs are needed. Sample will be unloaded in inert atmosphere. No other equipment is needed.

- ## Pre-screen:

Rad-Hazard SRC member: The flux on the diffractometer is 2 x 10^9 n/s/cm^3 and if 1g of the sample is in the beam, it will have a volume of $V=m/\rho=1g/0.9\ g/cm^3 = 1.1\ cm^3$. Samples typically take at the most 6 min/scan to obtain good statistics (integral neutron flux: $8*10^{11}$ n). For 5 temperatures that would be 6min*5=30 min of exposure to beam at $2.2*10^9$ n/s.

500.0 mg Silicon: 16.54 mg Si-30 (n,G) -> 9.684 kBq Si-31 (157.3 m)
500.0 mg Oxygen: 1.124 mg O-18 (n,G) -> 13.25 Bq O-19 (26.91 s)

Values for activation are below requirements. Si-31 being produced during the experiments the dose is approx 0.5 uSv if all is inhaled. NO additional controls are needed. EHL: LOW

Chem hazard: Silica is not hazardous, however nano-sized silica powder and crystalline quartz might cause harm to lungs if inhaled. Question to user: Is powder nano? If so it is strongly suggested to use hood or glove box when handling. Heating the sample in vacuum to 100 °C in the furnace lab is low hazard. EHL: LOW

Bio hazard: No comment – not a bio material

General hazard: Equipment is standard-no additional controls. Nanoparticle safety requires material to be handled in hoods or gloveboxes. EHL: low

Experiment is classified as Low hazard. ESD will be written and finalised by head of SRC.

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Experiment Safety Document (ESD)

1. General information as in ESF
2. Samples are non-hazardous. Comment: If sample is nanosized, please always handle in hood or glove box.
3. Equipment: Follow rules and regulation supplied by instrument team for the use of the standard equipment.
4. No change in roles/responsibilities for the experiment. Chemistry laboratory training needed for use of laboratory and furnace.
5. **EHL: low, no tracking needed.**

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Scenario 2:

- ## Experiment Safety Document (ESF)

1. General: User X has approved beamtime on SANS instrument with instrument team member Y being the PIC. Title: "Magnetic SANS on Iron soaps"
2. Sample Description:
   a. Ferric Oleate, $Fe(C_{18}O_2H_{33})_3$
   b. One sample with 4g ferric oleate, powder but not nanoparticle
   c. Material is a liquid
   d. Sample can be disposed at ESS after the experiment.
   e. No sample can. Sample will arrive in a glass vial.
   f. 11 quarz cuvettes from the users will be used as sample holder. Will need laboratory to weigh samples (0.2g/sample), mix them with 10ml H_2O/D_2O mixtures and load sample holders
3. Experiment Description: They will mix 11 different samples containing 0.2g ferric oleate and 10ml H_2O/D_2O mixture. Each sample will contain a varying ratio of H_2O/D_2O: 0:10,1:9,2:8,3:7,4:6,5:5,6:4,7:3,8:2,9:1,10:0. They will also measure 11 respective H_2O/D_2O mixtures without ferric oleate for comparison. Samples will be filled into the quartz cuvettes (max volume=1 ml) in the chemistry laboratory. Cuvettes will be placed into magnet and measured at 10T. After one set of samples (11 samples) they want to reuse their cuvettes.
4. Equipment: They are using the standard sample changer supplied by at room temperature. They will not bring equipment from home.
5. Aux. Laboratory usage: Sample will be mixed and loaded at ESS. After the measurement, they want to look at the IR signal from the sample in the spectroscopy lab at ESS. Will use optical spectrometer in the laboratory.

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- ## Pre-screen:

Rad-Hazard SRC member: The flux of the SANS machine is 10^9 n/s/cm^3. H_2O and D_2O activation is negligible. If 0.2g of ferric oleate is dissolved in 10 ml water and only 1ml will be in the beam, there will be 0.02g of ferric oleate in the beam. Sample will need a maximum of 30 min in the beam to obtain good statistics (integral neutron flux: $2*10^{12}$ n).

1.200 mg Iron: 67.22 µg Fe-54 (n,G) -> 24.71 mBq Fe-55 (2.700 a) => 0.025 Bq/m^2
3.734 µg Fe-58 (n,G) -> 16.35 mBq Fe-59 (44.53 d) => 0.016 Bq/m^2
2.100 mg Oxygen: 4.723 µg O-18 (n,G) -> 25.29 mBq O-19 (26.91 s) => 0.025 Bq/m^2
14.40 mg Carbon: 171.4 µg C-13 (n,G) -> 75.11 nBq C-14 (5.730e3 a) => negligible [Bq/m^2]
2.100 mg Hydrogen: 608.9 ng H-2 (n,G) -> 304.7 nBq H-3 (12.35 a) => negligible [Bq/m^2]

Values for activation are below requirements. If samples are dispersed over 1 m2, the corresponding values are low. No additional controls are needed. Sample can be carried between instrument and labs. Breakage of quartz cell is not a concern but it is suggested to use secondary containment for carrying the sample from the instrument to the labs. Samples can be emptied into container on instrument bench using googles and gloves. Container needs to be surveyed by the radiological control team (RCT). EHL: LOW

Chem hazard: There is no MSDS sheet for ferric oleate. Sodium oleate (which is an equivalent compound) is non-hazardous as is oleic acid (fatty acid). Iron is a heavy metal, however most Fe(III)salts are benign. No hazards are foreseen for dissolving these salts in water or loading the cells. EHL: LOW

Bio hazard: No comment – not a bio material

General hazard: A magnet will be used that is not standard equipment on the SANS machine. Additional administrative or engineering controls have to be put into place to avoid personnel from getting too close to the magnetic field. No personnel with heart pacers are allowed in the instrument hutch while the magnet is placed there. EHL: medium

Experiment is classified as medium hazard since one of the members classified it as medium. A draft ESD will be written and finalised by SRC.

Draft Experiment Safety Document (ESD)

1. General information as in ESF
2. Samples are non-hazardous.
3. Equipment: Hazard through the magnetic field.
4. Follow rules and regulation supplied by instrument team for the use of the standard equipment. Put controls in place for the magnet.
5. No change in roles/responsibilities for the experiment. Chemistry laboratory training needed for use of laboratory.
6. EHL: medium

Draft ESD will be discussed at SRC meeting and finalised.

Experiment Safety Document (ESD)

1. General information as in ESF
2. Samples are non-hazardous.
3. Magnetic field poses a hazard. Equipment: Follow rules and regulation supplied by instrument team for the use of the instrument. Administrative and engineering controls will be put into place for the use of the magnet. The magnet is interlocked with the door of the instrument cave. As soon as the door is opened the magnet is shut down. There will be signage on the door and on the instrument that there is a magnet in use. Users with pacemakers will be informed of this. Under these controls, the experiment can be classified as EHL: low
4. No change in roles/responsibilities for the experiment. Chemistry laboratory training needed for use of laboratory and furnace.
5. **Final EHL: low, because of administrative and engineering controls, no tracking needed**.

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Scenario 3:

Experiment Safety Document (ESF):

1. General: User X has approved beamtime on an inelastic spectrometer with instrument team member Y being the PIC. Titel: "Phononmodes of the high explosive TATP at 10-100K".
2. Sample Description:
   a. Triacetonetriperoxide ($C_9H_{18}O_6$)
   b. 1 sample with 1g/sample
   c. Material is a powder.
   d. Sample should be destroyed after experiment.
   e. No sample can. Sample will arrive in a plastic vial.
   f. An aluminium pouch in a large Al can from ESS will be used as sample holder.
3. Experiment Description: They will load the sample onto the Al foil at ESS. The foil will be rolled and placed into a large Al sample can with an open valve on the top (release of pressure should the sample decompose).
4. Equipment: They are using the cryostat supplied by VOR (standard equipment) for the temperature dependant measurements. They will not bring equipment from home.
5. Aux. Laboratory usage: Sample will be loaded at ESS. Sample needs to be destroyed at ESS. No other labs are needed. No other equipment is needed.

- ## Pre-screen:

Rad-Hazard SRC member: The flux on the spectrometer is 10^7 n/s/cm^3 and 1g of the sample is in the beam. The sample will take 1 hr of beamtime (large amount of hydrogen) to obtain good statistics (integral neutron flux: 4*10^{11} n).

81.00 mg Hydrogen: 23.48 µg H-2 (n,G) -> 235.1 nBq H-3 (12.35 a) => negl. [Bq/m^2]
432.0 mg Oxygen: 971.7 µg O-18 (n,G) -> 52.04 mBq O-19 (26.91 s) => 0.052 Bq/m^2
486.0 mg Carbon: 5.786 mg C-13 (n,G) -> 50.7 nBq C-14 (5.730e3 a) => negl. [Bq/m^2]

Values for activation are below requirements. Should the sample be spread out over 1 m^2, the surface contamination for the sample is well below the requirements for the supervised zone. NO additional controls needed. EHL: LOW

Chem hazard: TATP is a high explosive. It is sensitive to shock, heat and friction when dry. Sample should be loaded at home institution and kept below 10°C for shipping and storing. A smaller quantity is suggested for the experiment to minimise the effects in case of an accident. Secondary sample containment as provided by the user should be used. If secondary container is large enough or has a large enough opening for the evolving gas to be vented, the container can be made of Aluminium. Otherwise a softer material (teflon) is suggested. A detailed risk analysis is requested. Tracking of sample necessary. EHL: high

Bio hazard: No comment – not a bio material

General hazard: Equipment is standard-no additional controls. High-explosive. EHL: high

Experiment is classified as high hazard. ESD will be written and finalised by SRC.

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Draft Experiment Safety Document (ESD)

1. General information as in ESF
2. Sample is high explosive.
3. Equipment: standard equipment
4. Follow rules and regulation supplied by instrument team for the use of the standard equipment. Put controls in place for high explosive
5. possibly change in roles/responsibilities for the experiment.
6. Tracking necessary. EHL: high

Draft ESD will be discussed at SRC meeting and finalised. A risk analysis is performed and it is agreed that with additional reduction in sample amount to 100 mg and the sample being shipped in the sample container it will be measured in, the experiment is feasible.

Experiment Safety Document (ESD)

1. General information as in ESF
2. Sample is high explosive, but amount used in experiment has very little energy stored in it. Sample will be shipped with special transport arranged by user to ESS and stored at temperatures below 10 °C in the refrigerator in laboratory XY to prevent decomposition. The refrigerator will not be used by other users during that time. The sample will be brought over to the experiment and immediately cooled down in the cryostat. After the experiment the sample will be removed while it is still cold. The sample will be put back into the refrigerator until a dedicated chemist can dissolve it in water (after dissolving it is no longer explosive) in a hood. The products will be brought to the RCT for survey before it will be further destroyed.
3. Equipment is standard. However, the sample vial will sit in a vacuum containment not in He gas, so in case of a decomposition of the sample, there will be a large volume for the gas to expand in.
4. Equipment: Follow rules and regulations supplied by instrument team for the use of the instrument. Only restricted personnel is allowed in the hutch for the sample change. There will be a chemist with experience available at the beginning and end of the experiment for sample change. There will be a dedicated chemist taking part in the experiment. The responsibility for the experiment will be shared between instrument team and the ESS chemist. Chemistry laboratory training is needed for use of laboratory.
5. **Final EHL: medium because of administrative and engineering controls, tracking needed**.

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Scenario 4:

Example for a high hazard: measuring a nanopowder of Plutonium – needs secondary containment, administrative controls, testing of the containment for suitability.

- ## ESF:
  1. General: User X has approved beamtime on the diffractometer with instrument team member Y being the PIC "Measuring nanopowder of Plutonium at various temperatures between 10K and 300K".
  2. Sample Description:
     a. Plutonium Powder
     b. 1 sample with 0.5g/sample
     c. Material is a powder.
     d. Sample should be sent to home institution after experiment.
     e. Sample will arrive in a plastic vial in a lead drum.
     f. A Vanadium can from ESS will be used as sample holder.
  3. Experiment Description: They will load the sample into the V can at ESS.
  4. Equipment: They are using the cryostat supplied by the diffractometer (standard equipment) for the temperature dependant measurements. They will not bring equipment from home.
  5. Aux. Laboratory usage: Sample will be loaded at ESS. Sample needs to be sent back. No other labs needed. No other equipment is needed.

- ## Pre-screen:

Rad-Hazard SRC member: This is a naturally radioactive sample. Sample needs to be contained in a break-safe container. Use ESS approved Vanadium can with double containment. Empty sample can be shipped to home institution and sample should be loaded there. Sample container has to be closed air-tight and not opened at ESS. Sample container will be surveyed by ESS RCT upon arrival for contamination. Sample will be tracked during its stay at ESS. Sample will be kept in a locked radioactive materials cabinet during stay at ESS and the key will be issued to persons A and B (one user/one instrument team). Sample will be surveyed before it is loaded into the instrument and after the experiment by RCT. Sample will be stored in locked radioactive materials cabinet after the experiment and until shipping. Sample will be unloaded at home institution. Sample transport needs to follow the transport regulations. Constant RCT support will be available during the experiment. Check for other high-hazard experiments at the same time (amount of actinide in facility, high-explosive experiments?)
EHL: High

Chem hazard: Pu is highly toxic. If sample is supposed to be handled at ESS, it needs to be done in a restricted area with safety precautions (glove box, double gloves).Can sample be loaded at home institution? Tracking of sample necessary. EHL: high

Bio hazard: No comment – not a bio material

General hazard: Equipment is standard-no additional controls. Naturally radioactive sample and powder – EHL: high

Experiment is classified as high hazard. ESD will be written and finalised by SRC.

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Draft Experiment Safety Document (ESD)

1. General information as in ESF
2. Sample is radioactive material AND nuclear materials
3. Equipment: standard equipment
4. Follow rules and regulations supplied by instrument team for the use of the standard equipment. Put controls in place for radioactive materials/nuclear materials
5. change in roles/responsibilities for the experiment: 2 people responsible for sample tracking/handling
6. Tracking necessary. EHL: high

A risk analysis is performed and it is agreed that with the sample being shipped in the sample container it will be measured in, the experiment is feasible.

Experiment Safety Document (ESD)

1. General information as in ESF
2. Sample is radioactive material AND nuclear materials
3. Equipment: standard equipment
4. Follow the rules and regulations supplied by instrument team for the use of the standard equipment. Put controls in place for radioactive materials/nuclear materials. change in roles/responsibilities for the experiment: 2 people responsible for sample tracking/handling
5. **Tracking necessary. EHL: high**

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