ES&H DIVISION
Radiation Protection Dept.
SLAC – I – 82B – 00100 – 001

RP DEPARTMENT SSRL Radioactive Material Experiments Radiological Work Controls PROCEDURE

RP Dept. Document, FO # 013

SLAC National Accelerator Laboratory

TABLE OF REVISIONS

REVISION	DATE	SECTION(S	REASON FOR REVISE
1	26 July 2002		Add CAM alarm response change
2	8 May 2006	All	Revised wording Added air sample frequencies and CAM guidelines.
3	27 August 2008		Added use of Chain of Custody, new Radioactive material label and general updates.
4	1 June 2010	All	Update to 06/08/2007-Amended 10CFR835 Added new SLAC logo and name onto cover page. Added effective date into header. Added QA Section
5	30 July 2010	I.1.i, TOC, Attachments	Added requirement of daily operational check of CAM heads Included example of CAM Operational/Performance Check form in attachments Updated Table of contents and formatting to reflect new numbering scheme. Minor edits. Revised attachment list to match references in document. Changed roles and responsibilities of Radioactive Material Review committee Added documentation section
6	4 February 2013		Clarify radiological controls for non-detectable radioactive material samples and for detectable radioactive samples of Unat and U-238. Removed references that were not present. Added attachments with the 30/7/1 day notices process and labeling job coverage, and a link to job aids. Minor edits.

7	07/28/2015	4.1,4.13.4,14.3 4.7 Attachment 11	Replacement of 403PRA for a specific briefing sheet targeting the different types of experiment. Allowing SSRL GERT users to handle non-transuranic, non-detectable sample holder. Updating the chain of custody process to reflect the use of the new database. Attachment 11, updating the notification process as how users, safety officer, HP and HPT are notified that samples are being submitted. Minor clean up in various sections.

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1 Introduction

The following Standard Operating Procedures (SOP) contains radiological work control guidelines which should be followed anytime radioactive materials, other than sealed sources, are being prepared for placement and use in a SSRL Beamline Hutch. For use of sealed sources see SLAC-760-2A30C-005.

These guidelines are based on good radiological and management work practices and are consistent with the 10CFR835[1] and *SLAC Radiological Control Manual*[2]

These operating procedures discuss the minimum requirements and work practices and shall be followed by SLAC/SSRL employees, Users and Contractors. The responsibility to ensure that safe radiological work practices are implemented and enforced lies with SLAC and SSRL managers.

2 Planned Use of Radioactive Material Samples at SSRL

SLAC including the SSRL facility are classified as below a Hazard Category 3 Facility (Radiological Facility) per DOE-STD 1027-92[3], change of notice 1. To maintain this category, SLAC maintains quantities of radioactive materials less than Hazard Category 3 quantities per tables contained in this DOE standard and supplemental guidance NA-1 SD G 1027. Further, the total quantity of radioactive material in non-certified containers must not exceed one-half of the Hazard Category 3 DOE-STD-1027-92 change of notice 1, thresholds as specified in "Guidance on Using Release Fractions and Modern Dosimetry Information Consistently with DOE STD 1027-92, Hazard Categorization and Accident Analysis Techniques for compliance with DOE Order 5480.23, Nuclear Safety Report, Change of Notice 1[4]", at any one of the following four Radiological Facility locations::

1. The 2-mile accelerator housing, including the beam switchyard, the research yard, the end stations, SLC, LCLS experimental halls and hutches and the PEP-II tunnels and interaction regions
2. SSRL, including the linac, booster, SPEAR, and the experimental halls.
3. The waste management facility, including the Radioactive Material Storage Yard (RAMSY)
4. The campus area outside of the Accelerator Area fence, including the Central Laboratory, Test Laboratory, Electronics Building 24 including the radiological and fabrication areas.

Experiments at SSRL involving radioactive materials, except for sealed sources, especially transuranic elements require the implementation of unique safety precautions to prevent the release and dispersion of the radioactive material.

A SSRL Radioactive Materials Experiment Safety Evaluation Committee is established and available to the Radioactive Material Experimental Program Manager to review such experiments. Members of the committee are appointed by the RP Dept. Head and are drawn from the SSRL and ES&H departments. The Radioactive Material Experiment Program Manager authorizes the shipment of all radioactive material for experiments. The Program Manager may utilize the committee as needed to assist in decision process for experimental reviews. The roles are as follows:

3 Roles and Responsibilities

3.1 The Radioactive Material Experiment Program Manager

- Coordinates with SSRL the review and approval of the radiological controls for all radioactive material experiments, including containment configuration.
- Seeks assistance from SSRL Radioactive Materials Experiment Safety Evaluation Committee when applicable to review certain experiments and containment applications.
- Ensures radiological controls for user experiments are approved in a timely manner.
- Ensures that appropriate radiological controls are in place.
- Provides safety and compliance oversight.
- Ensures that inventories of radioactive material are up to date and in compliance with SLAC policies.
- Ensures records of all experiments including authorization memo to ship radioactive materials to SLAC are maintained as paper or electronic copies in RPD files.
- Ensures the best management practices (BMP) in the radiological field are utilized at SSRL.
- Ensures the Self- Assessment Program is implemented to assess these activities.

3.2 The SSRL Radioactive Materials Experiment Safety Evaluation Committee

- Review proposed experiments and significant modifications to approved experiments to determine compliance with the policy and procedural requirements established in the Safety Analysis Document.
- Evaluate sample holder/containment system for samples holders not on the approved sample holder catalog at:
  http://www-group.slac.stanford.edu/esh/rp/fo/SSRLsampleholderscatalog.pdf
- Evaluate the planned conduct of the experiments to determine if changes are required in the radiological safety procedures.
- May assist the RMEPM to determine from the isotopic composition of the radioactive materials that are to be used in an experiment that the radioactive control limit for the SSRL facility or other facilities at SLAC will not be exceeded per STD-1027-92.

Meetings, in-person or via email, will be held as necessary at the request of the Chairperson, or any three Committee members. The committee shall review experiments when deemed necessary by the RMEPM involving radioactive materials including actinide materials, Uranium and Thorium, and may review experiments involving other radioactive materials at the discretion of the RMEPM.

Upon completion of evaluations, comments for experiments shall be forwarded to the RMEPM.

3.3 RPFO Group Leader

- Ensures approved experiment(s) are performed in compliance with governing procedures.
- Notifies Radiation Safety Officer of any discrepancies.
- Ensures proper approvals are in place prior to authorizing RPFO support for experiments.
- Confers with the Radioactive Materials Experiment Program Manager when questions arise on how to implement radiological procedures.

3.4 Health Physics Personnel

Health Physics Personnel include SLAC HPTs and other support personnel who perform SLAC HPT tasks. Responsibilities include:

- Following approved procedures as required
- Following directions from RPFO Group Leader
- Supporting the approved experiment on the floor
- Notifying RPFO Group Leader of any discrepancies from approved procedures

4 Radiological Controls

4.1 Non-detectable radioactive material samples

For radioactive material samples* which are non-detectable by a hand held instrument, the following radiological controls apply:

- Samples will be labeled as "Radioactive" by placing a Radioactive Material sticker on sample trays where samples are placed(inside the hutch) until they are inserted in the beam
- Non-detectable radioactive material by a hand held instrument, may not be labeled as radioactive material as long as the material is located inside an area posted as CA/RMA or RCA/RMA
- Hutch(es) will be posted as -RMA, SSRL floor is posted as Controlled Area
- Shipping and receiving of packages will be performed by RPFO
- Training requirements: GERT, SSRL RAM Specific Experiment Briefing Sheet
- Waste generated through experimental process, will be considered radioactive waste

Samples that fall under this category are subject to the controls of section 4.1 only. All other samples shall follow the controls listed below.

* This section does not apply to Actinides other than U-238 and Unat

4.2 Graded Approach for Radiological Controls for Uranium samples

For U-nat and U-238 samples with activities of equal or less as those shown in Table 1 per sample holder, radiological controls for deploying air sampling and use/installation of HEPA filtered ventilation may be lifted at beam lines during X-ray experiments. The materials in Table 1 are divided

into 3 types (in order of Release Fractions): non-dispersible solids (e.g., soil sediment, slurry/paste, and solid with particle size > 10 micron), liquids, or dispersible powders (particle size ≤ 10 micron)[6]*. All other radiological controls apply.

**Note: This exemption does not apply to nano particles, which should be addressed through the SSRL Sample Safety Review Process.*

Table 1. Activity equivalent to 1 mrem CED for different material forms; a level equal or below which does not require air sampling or HEPA ventilation.

Radionuclide	Non-dispersible Solid particle size > 10 micron	Liquid	Powder particle size ≤ 10 micron
U-nat, U-238	32(µCi) 1.18E06(Bq) 95(g)	0.32(µCi) 1.18E04(Bq) 0.95(g)	0.032(µCi) 1.18E03(Bq) 0.095(g)

Assumptions: Release Fractions: 10^{-5} solid, 10^{-3} liquid and 10^{-2} powder.

The radiological controls indicated below apply to all other samples. The following radiological controls shall be used for all experiments involving radioactive materials at SSRL.

4.3 Radiological Posting

4.3.1 Radiologically Controlled Area (RCA)

Any beamline containing radioactive samples which are detectable with field instrumentation shall be posted as a Radiologically Controlled Area (RCA) and Radioactive Material Area (RMA). Room 114 Sample Room shall also be posted as a RCA and RMA.

4.3.2 Radiation Area, High Radiation Area

When radioactive samples, or packages of radioactive material have a dose rate of > 5mR/h at 30 cm from any sample surface, a Radiation Area sign shall be posted. The sign should be placed at the access of a physical boundary of the beamline hutch, Room 114 Sample Room, or other enclosure when feasible. For dose rates > 100 mR/h at 30 cm a High Radiation Area sign shall be posted.

4.3.3 Contamination Area

When samples are being unpacked after transportation, the Room 114 Sample Room is typically not posted as a Contamination Area unless the package has been damaged. If the outer packaging appears damaged, post the Hood/glovebox located in Room 114 Sample Room as a Contamination Area until radiological surveys indicate no radioactive

contamination is present, unless package does not fit inside the hood then post the entire Room 114 sample room as a contamination area.

Beamline hutches which house prepared radioactive samples do not need to be posted as contamination areas unless radiological surveys indicate unexpected loose contamination. (Samples with loose radioactive contamination shall be bagged and tagged and removed from beamline hutch). Experimenters will not use samples with loose surface contamination. Building 131, Room 113 small anaerobic chamber maybe be posted as a Contamination Area see local procedure for details.

4.3.4 Radioactive Material Area (RMA)

When radioactive material is located inside of a room or beam hutch a Radioactive Material Area sign shall be posted at the entrance to the area.

4.4 Radiological Surveys

Health Physics (HP) personnel shall perform the following surveys as a minimum:

- Pre-job contamination survey of the Room 114 Sample Room work area and the beamline hutch.
- The inner and outer packaging and exterior surface of sample containment immediately after receipt and on samples immediately upon opening of shipping package.
- The exterior surface of prepared samples prior to removal from the beamline hutch.
- The exterior surface of prepared samples prior to packaging for off-site shipment, if the previous step was performed in the last 24 hours.
- The beamline hutch at the completion of experiments, prior to returning the hutch to a non-radiological status. These surveys shall be direct frisk surveys.

The radiation detection instrument used depends on the isotopes of the samples.

4.5 Air Monitoring

Radioactive materials are classified into four hazard class levels per the toxicity classification table of The Health Physics and Radiological Handbook[7], and the Nuclear Air Cleaning Handbook[8]. Level 1 hazard class is the most restrictive. It addresses radionuclides that pose the greatest risk. Level 4 hazard class addresses radionuclides having the least risk. For air sampling and monitoring, the following policies will be used:

4.5.1 Hazard Classifications 1 and 2 with alpha emitters

When radionuclides of hazard class radiotoxicity 1 and 2 with alpha emitters are used in a beamline hutch, then air sampling shall be continuous and monitoring of the samples shall be continuous. SSRL uses Canberra's Continuous Alpha Monitoring systems (CAMs) for detecting airborne alpha radioactivity. When CAMs are in use, there shall be a qualified User (GERT + CAM alarm response training) in the area at all times, monitoring the CAM Manager (local or remote setup) to respond to warnings and alarms. Filters should be changed

out and analyzed as needed by HP personnel to reduce false alarms and buildup of radon daughter products.

Documentation of CAM Alarm Response training is completed through the User Briefing sheet.

4.5.2 Hazard Classifications 1 and 2 without alpha emitters

When radionuclides of Hazard Classifications 1 and 2 without alpha emitters are used in a beamline hutch, air sampling shall be continuous and monitoring of the samples shall be periodic. SSRL uses a continuously running air sampler, with removable air sample filter. The filter paper is periodically removed, monitored and evaluated by HP. For this type of sampling and monitoring a User does not need to be continuously present in the area while samples are in the hutch enclosure or open beamline. (The need to be in attendance will be determined by RP Department and SSRL Safety Officer after reviewing operational conditions and other hazards associated with the experiment.)

4.5.3 Hazard Classifications 3 and 4

When radionuclides of Hazard Classifications 3 and 4 are used, the air sampling may be continuous or periodic and the monitoring of the samples may be either continuous or periodic.

- HP personnel will determine the choice of air sampling method and monitoring frequencies: CAMs, continuous running device such as a "giraffe", or integrated air sampling equipment.
- All air samples should be monitored and evaluated by HP personnel.
- If samples are nano scale materials, use approved glassine air sampling filters.
- Air samples greater than MDA (minimum detectible activity) shall be measured initially and approximately 30 minutes after first count to verify presence of radon daughter activity. The counts should be reduced by at least 30% from the initial reading. As needed, HP personnel should also take adjacent area air samples to verify radon/background levels.
- Air sample filters, whether from continuous running sampling device, integrated air sampler or CAMs, shall be retained and recounted until radioactivity is less than the Minimum Detectable Activity (MDA) for a given instruments efficiency and background to demonstrate radioactivity is from short lived natural occurring radon daughter products.

4.5.4 CAMs not required

When CAMs are not required then a qualified User need not be present at the beamline. SSRL Duty Operators however will be kept informed of the radiological status of the beamline hutch and shall receive instruction on how to contact the User(s), HP personnel and SSRL Safety Officer in case of problems.

4.6 Preparing hutch to receive radioactive samples

4.6.1 Placing radioactive samples in beam hutches for experiments

HP personnel perform the following tasks prior to placing radioactive samples in beam hutches for experiments:

- Set up and complete performance check of air monitoring system as required. (A minimum of two CAM Heads for Hazard Classification 1 & 2 alpha emitters).
- Any hutch where radioactive samples will be placed shall have HEPA filtered ventilation such that there is a negative pressure with air flow into hutch when door is opened about 2 feet. (see section 4.15 of this document*)*
- Frisking and Monitoring instrumentation is in place prior to handling or manipulating samples.
- Conduct instrument checks - calibration due date, source and battery check. Instrument response checks shall be conducted daily while in use.
- Conduct ventilation checks
- DOP or other approved testing method must be completed annually or after modification to a system.
- Airflow must be negative into hutch/tent with physical boundaries (doors) closed to a body width. If ventilation unit exhausts inside of hutch/tent then this requirement may be waived as long as airflow is tested at sample location into the spot ventilation.
- Airflow across filter(s) should be at least 100 fpm.
- Post beamline instructions – CAM alarm response instructions when in use and personnel contact information in the event of an alarm or instrument malfunction.
- Install an experiment table containment/disposable surfaces as needed.
- Post hutch with appropriate radiological signs and authorization sheets.
- Complete Chain of Custody form and have User sign for receipt of samples when delivered to beamline.
- Notify the SSRL Duty Operator of hutch status.
- When possible and feasible zipper up the tent containment access door

4.6.2 Returning the hutch to non-radiological status

The following tasks shall be completed by HPT to return a hutch to a non-radiological status.

- Survey and remove all radiological samples.
- Survey the hutch for radioactive contamination using appropriate instrumentation for radionuclides being used (GM pancake probe for ^{99}Tc, Scintillation detector for ^{238}U etc.) and document the results. Direct frisking is always preferred.
- Survey for surface contamination and remove tabletop containment/disposable surfaces. Dispose or store for future use as necessary.
- Remove/secure air sampling equipment as needed.
- Remove radiological postings from the hutch and authorization sheets
- Transfer samples to Room 114 Sample Room or Room 113 and RPFO accepts custody from user. User signs Chain of Custody form as applicable.
- Notify the SSRL Duty Operator of hutch status.

4.7 Sample transfer and relocation

- All radioactive sample material shall be transferred by HP personnel or be accompanied by HP personnel.
- SSRL Bargar's group may transfer samples from room 113 to hutches without HP personnel after samples have been surveyed by HP personnel from anaerobic chamber.
- Installing samples into experimental fixtures within a beam hutch may be accomplished by HP personnel or by Users/Experimenters.
- Tertiary containments, after sample removal, may be released to Users/ Experimenters after survey by HP personnel.
- When moving samples between the Room 114 Sample Room or Room 113 to any other location including beamline hutches, a Chain of Custody form shall be completed. The Chain of Custody form transfers the custody between Health Physics/Radiation Protection personnel and any User (see Attachment 1 database picture). Chain of custody shall be initiated upon opening any package of radioactive material samples (unless package contents falls under section 4.1) until repackaged and shipped out of SLAC.
- All radioactive samples when removed from its shipping container or from Room 113 glove box or from a beam hutch shall be identified as Radioactive Material using the Radioactive Material label.
- Any packages of nanoscale material shall also be identified using proper nano[9] specific labels and posting, and may be applied by SSRL duty operators, HP personnel, Users, or SSRL Safety Officer.

4.8 Containment of samples

The SSRL Safety Office, the Radioactive Materials Safety Evaluation Committee and the Program Manager reviews all containments involving radioactive materials when new containment types or modifications of existing approved containments are proposed. Final approval for containments is granted by the Radiation Safety Officer (RSO), or Program Manager. This approval includes: a review of the planned containment of samples, containment materials, specific type of experiment to be run and type of radioactive material to be used. Unusual and new configurations and containment materials may need to have further review. Requests for experimental approval shall be made to the SSRL Safety Office. Reviews may be internal using personnel working at SLAC or external depending on the recommendations of the Radioactive Materials Safety Evaluation Committee, RMSEC, PM or RSO.

The number of layers of containment for radioactive samples will depend on the Hazard Classification, Attachment 8, and the radionuclide and the physical structure of the sample material.

An approved containment is identified in the SSRL radioactive material experiment catalog that is managed by RP.

4.8.1 Hazard Classification 1 or 2

Radionuclides of Hazard Classification 1 or 2 shall as a minimum have 2 layers of containment in sample preparation rooms* and 3 layers of containment in beam hutches.

4.8.2 Hazard Classification 3

Radionuclides of Hazard Classification 3 shall have as a minimum 1 layer of containment in sample preparation rooms* and 2 layers in beam hutches.

4.8.3 Hazard Classification 4

Radionuclides of Hazard Classification 4 shall have as a minimum 1 layer of containment at all times. Some limited preparation of Hazard Classification 4 samples are allowed at SSRL, with prior approval of the SSRL Safety Office and RP Field Operations Group Leader and an approved written instruction or document.

**Sample preparation rooms with ventilation and engineered barriers (i.e. tent) and sealed shipping containers are considered as a third level of containment for Hazard Classification 1 & 2 radionuclides and the secondary level of containment for Hazard Classification 3 radionuclides. At SLAC, the Room 114 Sample Room constitutes the SSRL sample preparation room.*

4.9 Health Physics Coverage

Health Physics personnel may be SLAC National Accelerator Laboratory Health Physics Technicians or other DOE laboratory Radiological Control technicians approved by SSRL and RPD to conduct health physics tasks. Health Physics personnel conducting these tasks shall be a DOE qualified RCT.

- HP personnel shall be available either on call or onsite anytime radioactive samples are located in a beamline hutch for experiments.
- HP Personnel do not need to be present while samples are installed in a beam hutch. Additionally, HP personnel do not need to be present for Users to manipulate samples if the manipulation will not endanger or alter the integrity of the sample containment.
- HP personnel will provide coverage for transfer of materials as stated in Section 4.7.
- HP personnel shall be in attendance anytime radioactive samples are moved outside of a beamline hutch. The HP personnel shall complete a contamination survey prior to the physical movement of a sample outside of a hutch.
- HP personnel may pre-stage samples for use by Users. Samples (with appropriate levels of containment) shall remain in the Hutch at all times.
- HP personnel perform local accountability of samples at all times while at SSRL.
- HP will initiate chain of custody form(s) for each sample holder removed from either Room 114 Sample Room or Room 113.

- HP personnel shall review labels of samples and experiment notices, (i.e. 1 day notice) and URM (USER Radioactive Material experiment database) to ensure samples are delivered to proper beam hutch locations.
- HP personnel are not required to be present at SLAC when CAMs are used. A qualified User shall be present at the beamline hutch to monitor CAMs at CAM Managers.
- HP personnel shall establish and maintain appropriate survey instruments at beamline hutches for use by Users/Experimenters. As a minimum the survey instruments shall be set up for the frisking of hands.

4.10 Radiological Controls for handling samples

4.10.1 Protective Clothing

HP personnel perform contamination surveys. In general, if survey results are negative for contamination, then no protective clothing is necessary to handle samples. However, there may be times when prudent practices require some protective clothing to be worn.

For example, handling samples after the samples have been exposed to beam. Minimum requirements would be that personnel wear gloves to handle/manipulate samples in the beamline hutch until HP personnel can perform contamination surveys. If other protective clothing controls are required, then the User/Experimenter will be instructed in its appropriate use and limitations.

Personnel shall wear gloves (disposable, nitrile or latex) to handle radioactive samples after removal from experimental fixtures if the sample containment has not been surveyed for loose contamination by HP personnel.

Lab coats and gloves (secured at wrists) shall be worn by personal working in a glove bag, glove box, bench top and fume hoods or open ventilated hoods posted per 10CFR835.602 and 603.

Users shall practice contamination controls. Gloves shall be removed and placed in bags prior to exiting beamline hutches when used and before monitoring hands for potential contamination.

4.11 Use of CAMs and Alarm Settings

See section 4.5 of this procedure to determine when CAMs are used.

4.11.1 CAM monitoring locations

CAMs shall monitor the inside of the hutch at the sample area, a second location should be sampling the adjacent area inside of the hutch near the ventilation intake if possible. One CAM Head should be installed outside of Hutch, monitoring the area where personnel are. See Attachment #3 for sketch.

4.11.2 CAM Manager

Planning and layout of CAM Managers is dependent on beamline hutch configuration. Up to 8 CAM Heads may be connected to one CAM Manager. The CAM Manager may monitor several CAM Heads at different hutches at the same time. The CAM Manager shall be placed such that a Contamination Area is not needed to be entered to review the CAM Manager.

4.11.3 Pumps

Pumps are installed outside of hutches when practical. Each pump may supply vacuum to one or more CAM Heads depending on rated volume. Each pump shall provide at least 2 cubic feet per minute (cfm) capacity per CAM Head. If the vacuum drops below 1.5 ft^3 or exceeds 2.5 ft^3, the CAM will alarm with a flashing amber light and a horn, warning of mechanical failure.

4.11.4 Calibration

See Attachment #2 for routine settings of the CAM Manager. Most alarm settings will not change, however from time to time and depending on the isotope(s) being monitored, the following variables, DAC-factor and Alarm DAC-hr may have to be altered.

4.11.5 Alarm Settings

See DAC factors in Appendix A of 10CFR835[1] table. Use the most restrictive factor after reviewing all isotopes being used.

The DAC-hours should be set at **8** for isotopes with a DAC factor of < 4E-11 uCi/ml and **12** for those isotopes with DAC factors > 4E-11 uCi/ml. DAC-hr settings may temporarily be set higher but not more than 24 DAC-hours due to background radon particulate daughter levels. The RPFO Group Leader approval is required for a setting higher than 24 DAC-hours.

4.11.6 Performance checks

As a minimum all CAM Heads shall be response checked at least weekly while in use, using a Pu-239 sealed source. The response check shall include a check of alarms and alarm indicators.

4.11.7 Filter change

Filters should be changed as necessary to prevent a buildup of naturally occurring isotopes on filter paper(s), or to prevent particulate overloading of filter leading to low airflow, both of which could potentially cause false alarms.

4.11.8 Alarm response instructions

Post Alarm instructions next to the CAM Manager including warning and alarm indicators and User response actions.

4.11.9 Operational check

All CAM Heads shall be operationally checked daily while in use. The operational check includes verifying positive airflow and non-zero background activity by reviewing the CAM Manager. The operational check is documented onto the CAM Operational/Performance Check Form. Attachment #10 includes an example of this form.

4.12 Responding to a CAM alarm

There are three possible CAM alarm types: Instrument malfunction, Chronic, and Acute. The actions taken for these alarms, depends on the nature of the alarm, the available personnel, and the conditions of the beam hutch. Attachment # 4 and 5 summarizes the actions.

HP personnel shall be familiar with the energy ranges of alpha emitter expected for isotopes in use at all experiments requiring continuous air monitoring.

Chronic and Acute alarms may be caused by naturally occurring radon daughter product isotopes. When evaluating whether alarms are due to radon daughter products, review the spectrum on the CAM manager. Excessive counts in the 6.5-8 MeV range indicate naturally occurring radionuclides. Alarm setting for DAC hours may be temporarily increased during periods of high radon levels.

Attachment #7 shall be immediately available at all active CAM Managers and personnel assigned to watch CAMs shall be familiar with the CAM alarm response requirements. Each Beam Line may have slightly different instructions.

Notification of alarms, as a minimum, shall be to SSRL Beamline Duty Operator and HP personnel. Current contact phone numbers are listed in the CAM alarm response sheet (Attachment #7) posted near the CAM Manager.

4.13 Dosimetry requirements

As a minimum personnel who handle radioactive material and enter an RCA shall be assigned a SLAC personnel dosimeter. For radioactive material with dose rates greater than 100mR/h at 30 cm from the source, a supplemental dosimeter shall be used.

For work where an individual exposure to an extremity could exceed 100 mrem per year, then extremity monitoring should be used.

4.14 Training

Personnel involved in beam hutch operations with radioisotopes shall, as a minimum, have the following training qualifications prior to going online. The level of training will depend on their expected tasks.

4.14.1 Escorted Individuals (Visitors)

Visitors shall be escorted at all times while at SSRL. Visitors shall not handle radioactive materials. Visitors may not enter Contamination Areas, Radiation Areas or High Radiation Areas.

4.14.2 Safety Orientation

Safety Orientation is required for Non-SLAC employees who will be working at SLAC and need unescorted access to SLAC laboratory and industrial areas. Completion of safety orientation does not permit unescorted access to Controlled Areas, Radiologically Controlled Areas (RCA) or Radioactive Material Areas (RMA). GERT is the minimum training required for unescorted access to those areas.

4.14.3 General Employee Radiological Training (GERT)

GERT is required for:

- **SSRL GERT USERS** *who are specifically trained on the experiments per briefing sheet to handle encapsulated samples of non-transuranic radioactive material in appropriate and RP approved holders in amounts which are non-detectable by a hand held instrument capable of detecting activity type.*
- Unescorted access to a Controlled Area, RCA or RMA.
- Personnel who monitor CAMs. Additional training in the form of a briefing on immediate response actions for CAM alarm is required to monitor CAMs

4.14.4 Radiological Worker I (RWT I)

RWT I is required for:

- Personnel who will handle radioactive samples, except in cases that meet section 4.14.3
- Entry to Radiation Areas and High Radiation Areas,

Additional training is required for personnel who may handle radioactive samples after removal from the experimental fixture prior to a HP contamination survey (4.14.5).

4.14.5 SSRL Users Radiological Controls- Briefing Sheet

SSRL Briefing sheet is required for personnel who handle radioactive samples. Topics include:

- proper use of personal protective equipment (PPE)
- how to perform self -frisking
- Use of survey instruments
- Use of Chain of Custody transfer
- Review of applicable sections of this procedure

All Users/Experimenters associated with handling or manipulating radioactive samples, or personnel who maintain watch over CAMs shall receive this briefing.

4.15 Unpacking Radioactive Samples

HP personnel shall unpack and survey radioactive samples prior to use.

4.15.1 Hazard Classifications 1 or 2

For hazard classifications 1 and 2 the following controls shall be used:

- As a minimum, gloves and lab coat will be worn.
- A full face respirator shall be worn if damage of primary or secondary containments is suspected.
- Unpacking area, usually in Room 114 Sample Room, should be posted and controlled as a RCA. If packages are damaged or suspected to have internal contamination, the Room 114 Sample Room shall be posted as a Contamination Area.
- Packaging and samples will be opened/surveyed utilizing certified tested radiological ventilation, preferably in a fume hood.

4.15.2 Hazard Classifications 3 or 4

For hazard classifications 3 and 4 gloves shall be worn, as a minimum. If samples are handled in a hood then a laboratory coat is required.

4.15.3 Unpacking shipping containers

Personnel shall follow the SLAC policy regarding shipping and receiving of radioactive materials

- Inspect outer packaging for damage.
- Perform a radiation and contamination survey of the outer packaging, if not previously completed.
- Inspect inner packing materials and sample containments for damage.
- Perform a radiation and contamination survey of the inner packaging materials.
- Do not remove or open installed sample containment layers.
- All packing materials should be saved for return of the experimental sample materials when feasible.
- Inspect sample containment/holder to ensure that holder(s) packing slip is correctly identified on the 1 Day notification of shipment.
- Perform both contamination and dose rate surveys of outer surfaces of the sealed sample

- All sample/holder has a unique identifier assigned to it by the PI and entered into URM SSRL database.

- The survey results are recorded on standard RPFO survey forms.

4.16 Accountability of Radioactive Samples

Radioactive samples shall be locally tracked and accounted for upon arrival at SSRL. Accountability shall be updated upon opening of package(s) and when relocating samples from their package in Room 114 Sample Room, beam lines or other SLAC storage locations. Health Physics personnel shall use an accountability log (electronic or paper).

Samples which are surveyed and result in no detectable radioactivity, their movement do not need to be entered into a SSRL URM database sample log. All samples which are surveyed and result in detectable radioactivity shall be entered in the SSRL URM database accountability log regardless of the Dept. of Transportation (DOT) category (i.e. Regulated or Non-Regulated).

The SSRL Database (URM) accountability log should at least identify:

- Sample(s) Identification, unique ID number
- Origin of sample
- Isotope
- Date
- Area where the sample is located, such as beam hutch number
- Health physics personnel initials

All samples, when not in use, *shall be secured/locked* in the Room 114 Sample Room.

4.17 Ventilation

Any hutch where radioactive material samples will be placed and which values are greater than or not listed in Table 1 section 4.2, shall have HEPA-filtered ventilation such that there is a negative pressure with air flow into the hutch when its door is opened about 2 feet.

Beam hutches should have at least one intake such that it can be positioned near the radioactive sample.

4.17.1 Ventilation certification

- DOP or similar tests must be completed annually or after modification to a system.
- Airflow must be negative into hutch/tent with physical boundaries (doors) almost closed to 2 feet.
- Airflow across filter(s) should be at least 100 fpm.

5 Quality Assurance

As part of the quality assurance program RPFO HPTs will review the documentation associated with this procedure as part of the QA checklist. RPQA/RPFO may perform walkthroughs when RAM experiments are in progress. Retrospective air sampling will be taken randomly on hutches where small amounts per Table 1 of Unat and U 238 are present.

5.1 Records Created

Documents and records created during this procedure include:

- CAM Operational/Performance Check Form
- RPFO Surveys
- RPFO Shipping documents including receipt and shipment surveys
- Chain of Custody form/ Accountability log

5.2 Who Retains Records

RPFO will maintain all surveys and records generated by this procedure.

6 References

1 Amended 10CFR835-06/08/2007-
2 SLAC Radiological Control Manual latest revision
3 DOE–STD-1027-92 Hazard Categorization and Accident Analysis Techniques for compliance with DOE ORDER 5480.23, Nuclear Safety Report, Change of Notice 1, September 1997
4 NA-1 SD G 1027 Guidance on Using Release Fractions and Modern Dosimetry Information Consistently with DOE STD 1027-92, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE ORDER 5480.23, Nuclear Safety Report, Change of Notice 1, November 28, 2011.
5 RPD Program Manual for Radioactive Material Experiments at SSRL FO#44, latest revision
6 EPA- Characteristics of Particles- Particle Size Categories- Link: http://www.epa.gov/apti/bces/module3/category/category.htm
7 Health *Physics and Radiological* Health Handbook (1998)
8 Nuclear Air Cleaning Handbook DOE-HDBK-1169-2003
9 Nano Material Safety Plan SLAC-I-730-0A9M-008

7 Attachments

8.0 Attachment #1 - Chain of custody tag and process
8.1 Attachment #2 - CAM settings
8.2 Attachment #3 - CAM placement configuration diagram
8.3 Attachment #4 - CAM Alarm Response table (HP coverage onsite)
8.4 Attachment #5 - CAM Alarm response table (HP coverage offsite)

8.5 Attachment #6 - CAM guide, filter change
8.6 Attachment #7 - CAM Alarm Response
8.7 Attachment #8 - Hazard Classifications
8.8 Attachment #9 - MDA and counts for instruments
8.9 Attachment #10 - CAM Operational/Performance Check Form
8.10 Attachment #11- USER Radioactive Material (URM): User Workflow
8.11 Attachment #12 - Job Aids Link

7.1 Attachment #1 – Chain of custody form and procedure

A Chain of Custody (COC) form shall be completed for each individual radioactive sample holder immediately upon opening a shipping package containing radioactive material sample holders in room 114 or room 113, except for samples covered under section 4.1. The chain of custody form shall be completed as sample holders are removed from their shipping package(s), with the exception of samples immediately going into the anaerobic chamber of room 113, which requires a chain of custody form update immediately upon removal from the anaerobic chamber.

Once samples are unpacked from their shipping container, HP shall attach a radioactive tag for individual sample holder(s) or attach a radioactive tag outside the secondary container where the samples are located. The radioactive tag does not necessarily need to be directly attached to a sample if the sample is located inside of a glove bag containment already identified as Radioactive Material, located inside of a beam hutch prepared for analysis, or located inside a secondary container used for transportation to and from the hutch, already identified as Radioactive Material.

Each time a sample is moved, the "From" and "To" the URM database shall be completed with a printed name, location, signature of the receiver, and date. RP is the initial "receiver" when receiving shipments of sample holders or when removing from the Room 113 anaerobic chamber glove bag.

The chain of custody form shall remain updated. The radioactive tag shall remain with or near the sample until packaged for shipment or until disposed of as waste or placed back into the anaerobic glove bag. The Chain of Custody record shall be maintained in the URM database as part of RP records.

Chain of Custody Form

Holders For Proposal/Stream 3746/1

PDF For Selected Holders

To create a PDF or add a movement, first select one or more holders.

row (s) 1 - 78 of 78

Holder	Seq	Moved From	Moved To	Relinguish/Receive Date	Relinquished By	Received By
GTSC1070	1	RM 114	11-2	13-May-2015 02:55PM	Murray, Darryl Robert	Lukens, Wayne
	2	11-2	RM 114	15-May-2015 07:46AM	Lukens, Wayne	Russ, Ray
GTSC1355	1	RM 114	11-2	13-May-2015 02:57PM	Murray, Darryl Robert	Lukens, Wayne
	2	11-2	RM 114	15-May-2015 07:46AM	Lukens, Wayne	Russ, Ray
GTSC1356	1	RM 114	11-2	13-May-2015 07:24PM	Russ, Ray	Lukens, Wayne
	2	RM 114	11-2	15-May-2015 07:46AM	Lukens, Wayne	Russ, Ray
GTSC1357	1	RM 114	11-2	13-May-2015 07:25PM	Russ, Ray	Lukens, Wayne
	2	11-2	RM 114	15-May-2015 07:46AM	Lukens, Wayne	Russ, Ray

Action For Lukens Wayne

Cancel

On 25-Sep-2015 0210PM **Torres Marcia Maria Campos** moved 27 holders for your 1-Day Notice, part of Notice Stream 1 in Proposal 9090Z.

Please confirm the location of each holder.

Confirm Moved Holders

Submit

Confirm	Holder Name	Seq	Moved From	Moved To	Relinquish/Receive Date	Relinquished By	Received By
Yes	GTSC1269	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne
Yes	GTSC1270	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne
Yes	GTSC1271	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne
Yes	GTSC1272	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne
Yes	GTSC1273	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne
Yes	GTSC1274	1	RM 114	11-2	25-Sep-2015 02:10PM	Torres, Marcia Maria Campos	Lukens, Wayne

Action For Torres Marcia Maria Campos

Cancel

On 25-Sep-2015 0347PM **Grunhaus Elie Eliezer** moved 2 holders for your 1-Day Notice, part of Notice Stream 1 in Proposal 9090Z.

Please confirm the location of each holder.

Confirm Moved Holders

Submit

Confirm	Holder Name	Seq	Moved From	Moved To	Relinquish/Receive Date	Relinquished By	Received By
Yes	GTSC1269	8	11-2	RM 114	25-Sep-2015 03:47PM	Grunhaus, Elie Eliezer	Torres, Marcia Maria Campos
Yes	GTSC1270	5	11-2	RM 114	25-Sep-2015 03:47PM	Grunhaus, Elie Eliezer	Torres, Marcia Maria Campos

CAUTION: Radioactive Material Chain of Custody (Front)

User/Group: Wayne W Lukens (LBNL)
Beamline: 11-2
Isotope(s): Tc-99
Physical Form: Solid
Contact Dose Rate: .02 mR/hr
Contamination, Outside (ßγ /α): No

Holder Name: GTSC1070
Total Activity (BQ): 2.20E+05

No Comment

Contamination, Inside (ßγ/α): No

No Comment

Performed By: Ray Russ **Date:** 13-May-2015
Verified By: Darryl Robert Murray **Date:** 13-May-2015

CAUTION: Radioactive Material Chain of Custody (Back)

Current Holder Storage Location: RM 114

From	To	Relinquisher / Receiver	Date
RM 114	11-2	Murray, Darryl Robert / Lukens, Wayne	13-May-2015 02:55:00PM
11-2	RM 114	Lukens, Wayne / Russ, Ray	15-May-2015 07:46:00AM

7.2 Attachment #2 – CAM settings

The communications parameters must be set correctly at the ASM1000 keypad before the ASM1000 can communicate with the Setup computer or the Remote Monitoring Computer. The ASM1000 Standard RS-232 Port communication parameter **must** be set to **Setup** to run the ASPC Setup program and must be set to **Printer** to communicate with the Remote Monitoring Computer.

ALARM SETUP FROM ASPC

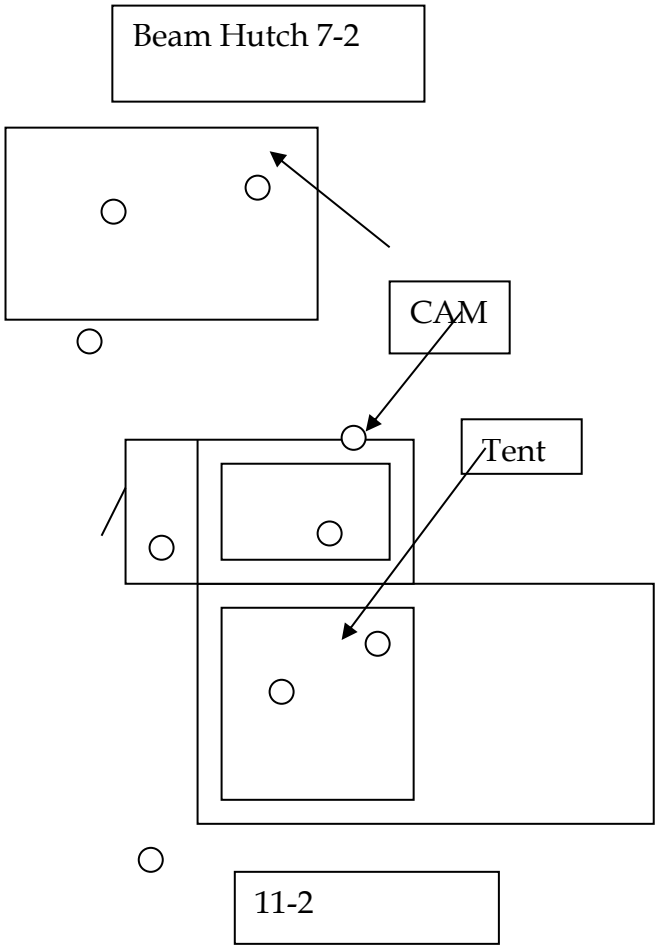
ASM1000 ANNUNCIATORS							
Alarm Condition	**Red Lamp**	**Yellow Lamp**	**Horn**	**Exposure Relay**	**Trouble Relay**	**Screen**	**Alarm Log Entry**
Acute	**X**		**X**			**X**	**X**
Chronic	**X**		**X**			**X**	**X**
Instrument		**X**				**X**	**X**
High		**X**				**X**	**X**
Stop Alarm			**X**				

CAM HEAD ANNUNCIATORS				
Alarm Condition	**Red Lamp**	**Horn**	**Exposure Relay**	**Trouble Relay**
Acute Release	**X**	**FAST**		
Chronic Release	**X**	**FAST**		
Instrument Fault				
High Background				
Stop Alarm Button		**X**		

ASM1000 SETUP FROM KEYPAD

PARAMETER SETUP				
Alarms	Alarm Limits		DAC-hrs (or DAC)	**8.0** (0.1 to 99.9)
			Low Flow	**1.500** (0.5 to 9.999)
			High Flow	**2.500** (0.5 to 9.999)
	DAC-hr Computation		Confidence Level	**1.65** (0.01 to 9.9)
			DAC factor (Pu^{239})	**5.00E-12** (1E-9 to 9.99E-14)
			Upper Energy Limit (MeV)	**5.800** (0.0 to 9.99)
			Analysis Window (MeV)	**2.800** (0.0 to (9.99)
			Count Cycle (minutes)	**15** (5 to 999)
			Acute Interval (seconds)	**12** (6 to 996)
Units	Air Flow			**2 cfm** (or L/m)
	Reported Concentration		Activity	**µCi** (or pCi, dpm, Bq, kBq)
			Volume	**ml** (or cm^3, m^3, L)
Communications	Standard RS-232 Port		Config.	**Setup** for ASPC **Printer** for remote computer
			Baud	**19200** (or 1200, 2400, 9600)
	Optional RS-485 Host Interface Port		Address	**depending on location on network** (0 to 255)
			Baud	**19200** (or 9600)
			Delay Characters	**2** (2 to 19)
Miscellaneous			Altitude	**310'** (0 to 14,999)
			Temperature	**298^0K** (0 to 999)
Timeouts (minutes)			Log In	**15** (0 to 99)
			LCD Backlight	**0** (0 to 99)
Effcy. Calib.			Frequency (days)	**365** (0 to 9999)
			Warn Ahead (weeks)	**2** (0 to 255)
			Activate Trouble Light	**yes** (no or yes)
Flow Alarm Inhibits Cycle				**no** (no or yes)
SOURCE INFORMATION				
Count Time (minutes)				**1.0** (0 to 899.9)
Acceptable Performance Check Range		% Above Efficiency		**20.0** (0 to 99.9)
		% Below Efficiency		**20.0** (0 to 99.9)
Units				**dpm** (or µCi, pCi, Bq, kBq)
Activity				**use activity of designated check source** (0 to 9,999,999)
Energy				**MeV for ^{239}Pu** (0 to 9.99)

7.3 Attachment #3 – CAM placement configuration diagram



7.4 Attachment #4 – CAM Alarm Response table (HP coverage onsite)

ALARM Type / Personnel	HP Technician at SSRL
Instrument Malfunction ***Amber light at MGR***	Log In HP verify IM Grab Air sample

Acute or Chronic Alarm ***Red light with Horn at MGR*** ***Red light at CAM Head***	1 CAM alarm inside hutch	2 CAMs alarm inside hutch	**1 CAM alarm inside hutch and 1 CAM alarm outside hutch**
	Do Not Open Hutch. HP run spectrum. HP evaluate	Do not open Hutch. Notify Duty Operator. Evacuate immediate area outside of hutch. HP Evaluate	Do Not open Hutch. Notify Duty Operator. **Evacuate Building**. HP responds with PC and respirators.

Radon Daughters Suspected **(For HP use Only)** **Alpha energies:** **Rn daughters->6 MeV** **Pu238-5.4MeV** **Pu239, Pu240- 5.1MeV** **Pu241-4.8MeV** **Pu242-4.9 MeV** **Np237-4.7MeV** **Cm244-5.8MeV** **Th232-4.0MeV**	Detailed display. Run Spectrum. Know alpha peaks for Isotopes in Hutch. Change CAM filter. Save for I/2 life verification	Detailed display. Run Spectrum. Know alpha peaks for isotopes in Hutch. Change CAM filter. Save for I/2 life verification	

7.5 Attachment #5 – CAM Alarm response table (HP coverage offsite)

ALARM Type /Personnel	User at SSRL No HP Technician
Instrument Malfunction ***Amber light at MGR***	Notify HP Tech Do Not Open Hutch HP Tech come in.

Acute or Chronic Alarm ***Red light with Horn at MGR*** ***Red light at CAM Head***	1 CAM alarm inside hutch	2 CAMs alarm inside hutch	**1 CAM alarm inside hutch and 1 CAM alarm outside hutch**
	Do Not Open Hutch. Notify Duty Operator Notify HP. HP responds to SSRL	Do not open Hutch. Notify Duty Operator Notify HP. Evacuate immediate area outside of hutch. HP responds to SSRL.	Do Not open Hutch. Notify Duty Operator. Notify HP. **Evacuate Building**. HP responds with PC and respirators.

ALARM Type /Personnel	No HP Tech Alarm in Radioactive Material Storage Area/ Sample Prep Room
Instrument Malfunction ***Amber light at MGR***	SSRL Beamline Duty Operator to notify HP HP to come in.

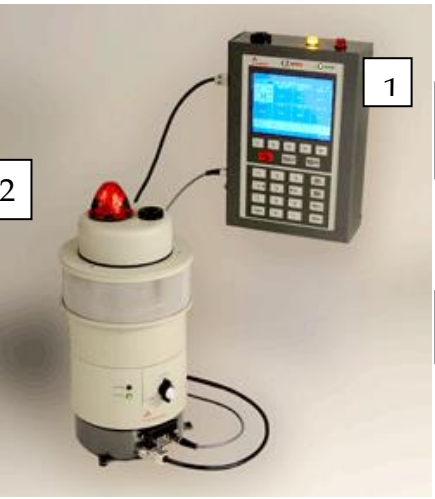
Acute or Chronic Alarm ***Red light with Horn at MGR*** ***Red light at CAM Head***	SSRL Beamline Duty Operator to notify HP. HP to come in.

7.6 Attachment #6 - CAM guide, filter change

To Response Check and Change Filter of CAM

- Log Into Manager, a password is necessary.
- Choose Network Display,
  Observe bar graph. One bar shows air flow rate (~2 cfm). One shows DAC Hours
- Choose Performance Check
  Observe which CAMs locations are ready, wait until display shows "Primed".
- Open CAM Head, remove filter for counting and analysis.
- Place ^{239}Pu check source in holder, close holder.
- Observe CAM Head and manager for proper operation of Acute Alarm lights and warnings (~ 30 seconds).
- Remove source.
- Place new filter in CAM Head.

7.7 Attachment #7 – CAM Alarm Response



1. CAM Manager with red light and alarm for acute/chronic release.

2. CAM head with red light to indicate acute/chronic release.

CAM ALARM RESPONSES

In the event of two audible CAM alarms with two red lights; either one CAM inside and one outside of the experimental hutch or 2 CAM's inside of the hutch.

Evacuate the building. Make Notifications.

In the event of two audible CAM alarms with red lights both inside experimental hutch.
Do not open the Hutch. Make notifications

In the event of one audible CAM alarm with a red light either inside or outside the experimental hutch
Do not open the Hutch. Make notifications.

In the event of a CAM alarm with an amber light
Do not open the Hutch. Make notifications.

		Notify
SSRL Duty Operator @ 4040		
Marcia Torres	**Cell**	**1-630-881-2966**
Jim Allan	**Cell**	**1-707-853-0193**
Darryl Murray	**Cell**	**1-404-273-6026**
Ray Russ	**Cell**	**1-415-601-1548**
Matt Padilla (SSRL)	**Cell**	**1-408- 893-9775**

7.8 Attachment #8 – Hazard Classifications

Very High Radiotoxicity (Group 1)

210 Pb	228 Ra	229 Th	232 U	236 Pu	241 Pu	243 Am	244 Cm	248 Cm	251 Cf
210 Po	227 Ac	230 Th	233 U	238 Pu	242 Pu	240 Cm	245 Cm	248 Cf	252 Cf
223 Ra	227 Th	231 Pa	234 U	239 Pu	241 Am	242 Cm	246 Cm	249 Cf	254 Cf
225 Ra	228 Th	230 U	237 Np	240 Pu	^{242m}Am	243 Cm	247 Cm	250 Cf	254 Es
226 Ra									255Es

High Radiotoxicity (Group 2)

22 Na	90 Sr	^{110m} Ag	124 I	140 Ba	170 Tm	212 Pb	228 Ac	242 Am	253 Es
36 Cl	91 Y	^{115m} Cd	125 I	144 Ce	181 Hf	207 Bi	232 Th	241 Cm	^{254m} Es
45 Ca	93 Zr	^{114m} In	126 I	152 Eu(13a)	182 Ta	210 Bi	230 Pa	249 Bk	255 Fm
46 Sc	94 Nb	124 Sb	131 I	154 Eu	192 Ir	211 At	236 U	246 Cf	256 Fm
60 Co	106 Ru	125 Sb	134 Cs	160 Tb	204 Tl	224 Ra	244 Pu	253 Cf	Th Nat

Moderate Radiotoxicity (Group 3)

7 Be	52 Fe	82 Br	97 Zr	105 Ag	134 Te	143 Ce	171 Tm	198 Au	237 U
14 C	55 Fe	74 Kr	90 Nb	111 Ag	120 I	142 Pr	175 Yb	199 Au	240 U
18 F	59 Fe	77 Kr	^{93m} Nb	109 Cd	123 I	143 Pr	177 Lu	197 Hg	240U+
24 Na	55 Co	87 Kr	95 Nb	115 Cd	130 I	147 Nd	181 W	^{197m} Hg	240 Np
31 Si	56 Co	88 Kr	^{95m} Nb	^{115m} In	132 I	149 Nd	185 W	203 Hg	239 Np
32 P	57 Co	86 Rb	96 Nb	113 Sn	^{132m} I	147 Pm	187 W	200 Tl	234 Pu
33 P	58 Co	83 Sr	90 Mo	125 Sn	133 I	149 Pm	183 Re	201 Tl	237 Pu
35 S	63 Ni	85 Sr	93 Mo	122 Sb	135 I	151 Sm	186 Re	202 Tl	245 Pu
38 Cl	65 Ni	89 Sr	99 Mo	121 Te	135 Xe	153 Sm	188 Re	203 Pb	238 Am
41 Ar	64 Cu	91 Sr	96 Tc	^{121m} Te	132 Cs	^{152m} Eu (9h)	185 Os	206 Bi	240 Am
42 K	65 Zn	92 Sr	^{97m} Tc	^{123m} Te	136 Cs	155 Eu	191 Os	212 Bi	^{244m}Am
43 K	^{69m} Zn	90 Y	97 Tc	^{125m} Te	137 Cs	153 Gd	193 Os	220 Rn	244 Am
47 Ca	72 Ga	92 Y	99 Tc	^{127m} Te	131 Ba	159 Gd	190 Ir	222 Rn	238 Cm
47 Sc	73 As	93 Y	97 Ru	^{129m} Te	140 La	165 Dy	194 Ir	226 Th	250 Bk
48 Sc	74 As	86 Zr	103 Ru	131 Te	134 Ce	166 Dy	191 Pt	231 Th	244 Cf
48 V	76 As	88 Zr	105 Ru	^{131m} Te	135 Ce	166 Ho	193 Pt	234 Th	254 Fm
51 Cr	77 As	89 Zr	105 Rh	132 Te	^{137m} Ce	169 Er	197 Pt	233 Pa	
52 Mn	75 Se	95 Zr	103 Pd	^{133m} Te	139 Ce	171 Er	196 Au	231 U	
54 Mn			109 Pd		141 Ce				

Low Radiotoxicity (Group 4)

3 H	^{60m} Co	81 Kr	^{91m} Y	^{96m} Tc	133 Te	125 Cs	138 Cs	207 Po	243 Pu
15 O	61 Co	^{83m} Kr	88 Nb	^{99m} Tc	^{120m} I	127 Cs	137 Ce	227 Ra	237 Am
37 Ar	^{62m} Co	^{85m} Kr	89 $^{(66m)}$Nb	^{103m} Rh	121 I	129 Cs	^{191m} Os	235 U	239 Am
51 Mn	59 Ni	85 Kr	89 $^{(122m)}$Nb	^{113m} In	128 I	130 Cs	^{193m} Pt	238 U	245 Am
^{52m} Mn	69 Zn	80 Sr	97 Nb	116 Te	129 I	131 Cs	^{197m} Pt	239 U	^{246m}Am
53 Mn	71 Ge	81 Sr	98 Nb	123 Te	134 I	^{134m} Cs	203 Po	U nat	246 Am
56 Mn	76 Kr	^{85m} Sr	^{93m} Mo	127 Te	^{131m} Xe	135 Cs	205 Po	235 Pu	249 Cm
^{58m} Co	79 Kr	^{87m} Sr	101 Mo	129 Te	133 Xe	^{135m} Cs			

7.9 Attachment #9 – MDA and counts for instruments

Minimum Detectable Count Rates Example
Link Excel sheet for MDA's

Ludlum 2929

Minimum Detectable Count Rate

$2.71/t_s+3.29\ \sqrt{(Rb/ts+Rb/ts)}$

Input	Background Rate	35.0
Input	Time bkg	10.0
Input	Time sample	10.0
	SQRT	2.6
	MDCR, gross	**44.0**
	MDCR, net	**9.0**

Bkg. Alpha cpm	MDCR net
0.1	0.7
0.2	0.9
0.3	1.1
0.4	1.2
0.5	1.3
0.6	1.4
0.7	1.5
0.8	1.6
0.9	1.7
1	1.7
1.1	1.8
1.2	1.9
1.3	1.9
1.4	2.0
1.5	2.1
1.6	2.1
1.7	2.2
1.8	2.2
1.9	2.3

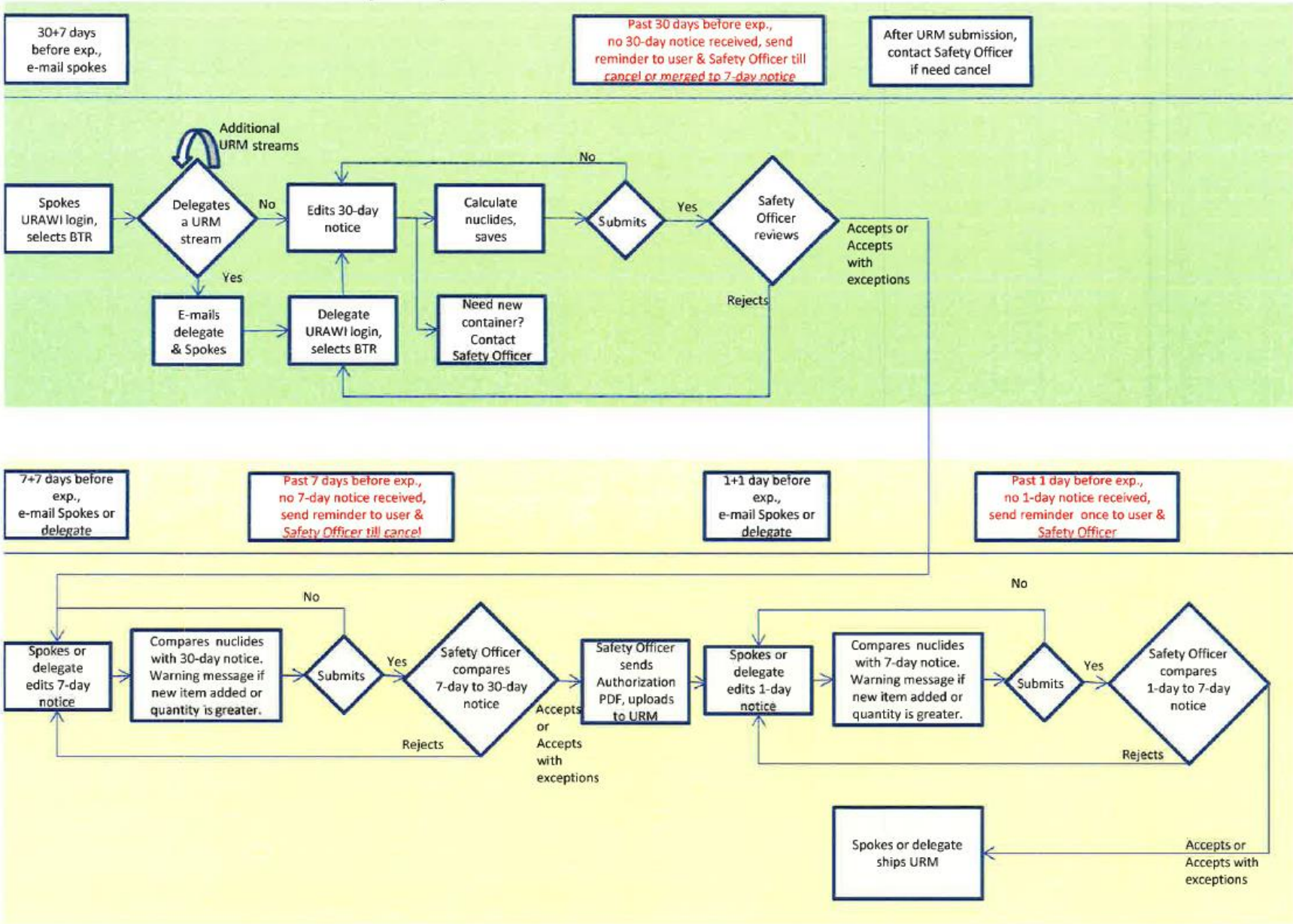
Bkg beta cpm	MDCR net
35	9.0
36	9.1
37	9.2
38	9.3
39	9.5
40	9.6
41	9.7
42	9.8
43	9.9
44	10.0
45	10.1
46	10.3
47	10.4
48	10.5
49	10.6
50	10.7
51	10.8
52	10.9
53	11.0

7.10 Attachment #10 - CAM Operational/Performance Check Form

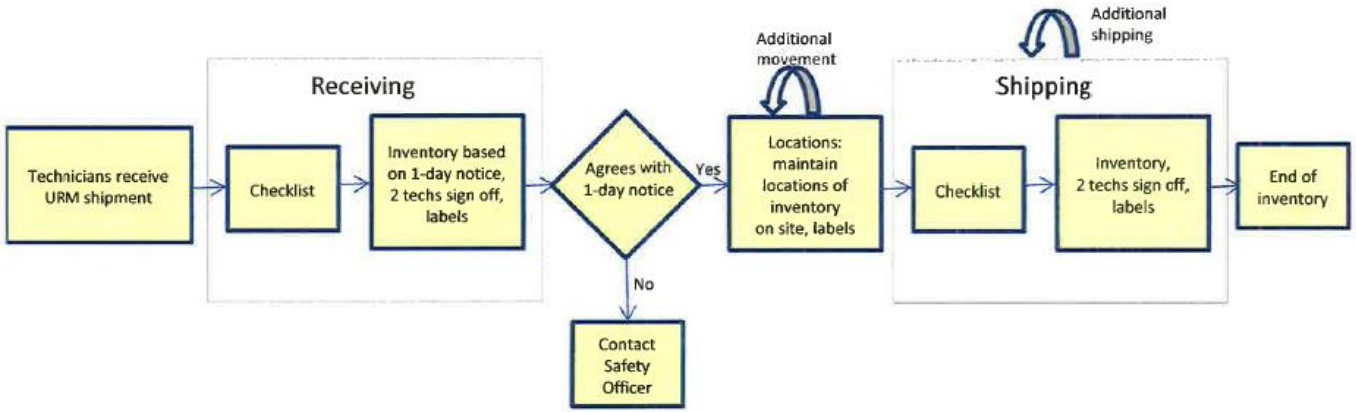
https://portal.slac.stanford.edu/info/esh/rp/fo/forms/Completed%20SSRL%20Forms/CAM%20Operational%20Perfomance%20Checksheet.xlsx

7.11 Attachment #11-30/7/1 Day Notification Process, USER Radioactive Material (URM)

User Radioactive Material (URM): User Workflow



User Radioactive Material (URM): Techs Workflow



7.12 Attachment #12 – Job Aids Link:

https://portal.slac.stanford.edu/info/esh/rp/fo/forms/Completed%20SSRL%20Forms