CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO

Environmental Health and Safety Department

Radiation Safety Program

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Radiation Safety Program

Review and/or Update Log

The radiation safety program shall be reviewed and updated every year. The revision and update shall be documented in the form below:

Date	Revised by:	Approved by:	Program reviewed* (x)	Program updated**	Comments:
3-12-2019	Rominna Valentine Ico	Teresa Fricke		X	Edited for content and removed DRAFT watermark
5-2-2019	Rominna Valentine Ico	Teresa Fricke		X	Added X-Ray to Rad Safety Program per audit findings
7-11-2019	Rominna Valentine Ico	Teresa Fricke		X	Added “Program Review” page for data logging
7-22-2019	Kathy Pierson	Teresa Fricke		X	Minor changes RE: roles & responsibilities
9-4-2019	Beiwei Tu	Teresa Fricke		X	Change cover page and update x-ray section
9-10-2019	Rominna Valentine Ico	Kathy Pierson	X		Formatting issues corrected
9-11-19	Kathy Pierson	Teresa Fricke		X	Update and approve changes, x-ray section

*Review: Program was either edited for grammatical errors and formatting, small changes occurred

** Update: Program was edited for changes in content

We certified at the time of review, the information provided on this plan is complete and accurate

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1. Introduction

CSUSB operates under a broad scope radioactive materials (also referred to as isotopes or radionuclide's) license issued by the California Department of Health. Therefore, the provisions of Title 17, California Code of Regulations in conjunction with Title 10, Code of Federal Regulations, govern the use of all radioactive materials and radiation-producing machines. Furthermore, The Radiation Safety Program operates under the ALARA (As Low As Reasonably Achievable) Principal. The purchase and use of radioactive materials are only allowed by authorized individuals for specific approved projects (page 3 on Radiation Safety Manual). Any user of radioactive materials or radiation-producing machines is additionally responsible for handling the materials/ equipment in the safest possible and practical manner; any user that violates any of these regulations or the ALARA Principal is guilty of a misdemeanor.

The law requires that a policy determining Radiation Safety Committee (RSC) and a Radiation Safety Officer (RSO) exist for any broad-scope license. The Committee consists of at least five members who represent operating groups and administration. Those operating groups are Colleges of Natural Sciences, Social and Behavioral Sciences, Environmental Health & Safety (EH&S) Department, and Office of Academic Research. The appointment of the Chair of the RSC is by committee vote. The RSO is appointed by the Institutional Official. The Committee discharges its obligations at meetings requested by the Chairman or Radiation Safety Officer with a mandatory meeting at least once each year. More frequent meetings can be held as required.

The Committee reviews and approves all proposed uses of radiation and radionuclide's other than exempted sources. It also reviews all instances of abuse of radiation producing machines/materials. As a result of such investigations, the RSC/RSO may suspend the violator from all duties that involve the use of radioisotopes and/ or that his/her isotopes/radiation machines are impounded for a predetermined period of time.

A. Responsibilities of the Radiation Safety Committee (RSC):

1. The Radiation Safety Committee shall be composed of:

    a. Committee Chairman
    b. Radiation Safety Officer
    c. University Environmental Health & Safety Specialist
    d. At least two faculty/staff other than the Chairman or Radiation Safety Officer.
    e. There shall be at least five members on the Committee.

2. The Committee shall meet at least once a year. The Chairman or Radiation Safety Officer may call special or emergency meetings.

3. A quorum shall consist of a simple majority that must include the Radiation Safety Officer or his/her designee.

4. Requires Project Authorization for all projects involving the use of non-exempted quantities

of radionuclides or sources of radiation. The only exceptions are for sealed exempted sources and naturally-occurring sources in geological specimens. See Appendix A of this program for exempt quantities. Users of exempted sealed sources must still notify the RSO regarding purchase and storage location of sources. This notification may be done by email (kpierson@csusb.edu) or written memo (to Environmental Health and Safety).

5. Each member in the committee is a voting member over all radiation use and policies.

6. The Committee shall have final approval overall Project Authorizations.

7. The Committee shall prepare and approve new or up-dated documents and procedures that are required or needed in order to administer the radiation health and safety program.

8. The Committee shall have final approval over all policies regarding radiation use.

9. The Committee shall survey the use of radionuclides and source materials and provide assurance to the Radiation Safety Officer and the Institutional Official that health and safety is adequately protected and that the codes, standards, and regulations are complied with.

10. The Committee will have authority to handle all disciplinary actions regarding radiation use. This shall include, but is not limited to, the following:

11. Suspension of User Authorizations.

12. Seizure of Isotopes or Radiation Producing Equipment.

B. Responsibilities of the Radiation Safety Officer (RSO):

1. Is a member, but not the Chair of the Radiation Safety Committee (RSC).

2. Evaluates prospective users of isotopes.

3. Conducts radiation surveys, leak checks and inspections as required by law.

4. Is responsible for having survey meters and other surveying monitoring equipment calibrated when needed. Is responsible for due dates for any fees, renewals, correspondence, monitoring, disposal, and calibration of instruments and completion is done in a timely manner.

5. Records receipt, transfer, and disposal of all radioactive materials and radiation equipment received at California State University, San Bernardino.

6. Maintains a continuous record of personnel exposure. Reviews dosimetry results at least quarterly. Provides services for training of Authorized Users when requested or needed.

7. Maintains an organized record of all official correspondence and documents pertaining to radiological regulations to be housed in the Office of Academic Research. Copies of State and Federal regulations are available from the RSO.

8. Provides advice and direction to University personnel regarding radiation protection

procedures.

9. Initiates procedures for safely storing, packing, and disposing of radioactive wastes produced by CSUSB Authorized Users.

10. Provides direction, leadership, and assistance during radiation emergencies.

11. Conducts Quarterly Management Safety Audits of Authorized Users and their use locations.

12. Has right of entry into each area where a radionuclide or source material administered under the License is stored, used, or disposed of and in areas included under a Project Authorization.

13. Has the authority to issue and remove “Stop Use” Orders

14. Determines the need for preparing new and up-dating existing documents and procedures that relate to the radiation health and safety program.

15. Has the authority to restrict entry, place and remove radiation warning labels, ribbons, and signage.

16. Assures the availability to the Radiation Safety Officer (RSO), the Institutional Official, the Radiation Safety Committee (RSC) and each Authorized User under a Project Authorization, of required and necessary codes, standards, and regulations.

C. Responsibilities of the Chair of the Radiation Safety Committee (RSC):

1. Is a member of the Radiation Safety Committee, but cannot be the Institutional Official, Administrative Representative, or Radiation Safety Officer

2. Has the right of entry into areas under the jurisdiction of the Radiation Safety Committee.

3. Calls meetings of the Radiation Safety Committee. An annual meeting is required in June. Additional meeting may be called as necessary throughout the fiscal year.

4. Presides over Radiation Safety Committee meetings.

5. Signs for actions taken by the Radiation Safety Committee.

D. Responsibilities of the Associate Provost for Research/ Institutional Official:

1. Is the responsible administrator for the radioactive material program under California Radioactive Material License number 1874-36.

2. Requires a policy of complying with all required codes, standards, and regulations as well as requiring that exposures to and releases of, radionuclide's shall be as low as practicable.

3. Administrates the overall program as it affects each academic department.

4. Appoints the Radiation Safety Officer and the Administrative Representative.

5. Has the right of entry into each area where a radionuclide or source material administered under license is ordered, stored, used or disposed of.

6. Has the authority to issue “Stop Use” Orders.

7. Delegates the responsibility and authority to the RSO and the Administrative Representative. Ensures each committee member of the RSC understands their duties and responsibilities.

E. Responsibilities of the Administrative Representative:

1. Is a member of the Radiation Safety Committee

2. Appointed by the Institutional Official

3. Represents the Institutional Official on the Radiation Safety Committee.

4. Prepares the minutes of the Radiation Safety Committee Meetings.

5. Maintains the central record system for all matters requiredunder or pertaining to, California Material License number 1874-36.

6. Tracks protocols submissions and approvals in addition to any renewals needed.

2. Radiation Use Approval & Restrictions

A. Application Procedures

Anyone who wishes to use radioactive nuclides or instruments emitting radiation, as an independent user, must submit the following completed forms to the Radiation Safety Officer (RSO) and Committee:

- Statement of Training and Experience (Form RH-2050-A)
- Application for Project Authorization

The prospective user will also be issued a copy of this Radiation Safety Program and the Radiation Safety Manual. The forms mentioned above are required for any project, investigation, or student laboratory involvement with radioactive materials or radiation producing equipment, including those using license exempt quantities of radionuclides. These forms are available from the CSUSB Environmental Health and Safety Department (909) 537-5179 and website located at: www.csusb.edu/ehs and Office of Academic Research website located at: https://www.csusb.edu/academic-research/research-support-and-resources.

B. Qualifications and Responsibilities for an Independent (Authorized) User under a Project Authorization

Individuals who are proposed as independent users or who will supervise use of radiation

sources by others must have the following minimum qualifications:

A college degree or the equivalent in the physical or biological sciences or engineering.

At least 20 hours of training or practical experience involving the characteristics of ionizing radiation, radiation dose quantities, radiation detection instrumentation, and the biological hazards of exposures to radiation. **This training/experience must be relevant to the type of source the user wishes to use** at CSUSB.

Prior to the beginning of each project, applies to the Radiation Safety Committee for Project Authorization. Re-applies for Project Authorization prior to expiration for continuing projects and assure that exposures to and releases of radionuclides are as low as reasonably achievable during the authorized time of use.

Furthermore, the prospective user must establish that his/her facilities, equipment and procedures are adequate to assure safety to all University personnel and property and that they comply with Federal and State regulations as well as with the approved Project Authorization. At the end of each Project Authorization, assures that areas where radioactive materials were used have been properly decontaminated and that wastes have been properly disposed of. In addition, the prospective user must assure that un-used radioactive materials have been properly transferred to the Radiation Safety Officer for storage with corresponding documentation. Request a final inspection from the Radiation Safety Officer of each area included under the Project Authorization for confirmation of proper decontamination.

C. Approval and Renewal of Radiation Use Authorizations

Authorizations are granted for 12 months at which time the Authorized User must submit a revised Application for Project Authorization Form (Appendix C) if there have been any changes in the following:

- Quantities of isotopes being used.
- Chemical/physical forms of isotopes.
- Research procedures.
- Location of research.
- Type and quantity of equipment.
- Facility

If there have been no changes in the above items, the permittee may submit a memo to this effect to the Radiation Safety Officer. If the permittee has received any requests to correct safety violations or any other disciplinary action by the Committee or the Radiation Safety Officer, he/she must indicate, within the memo, what has been done to correct the problem and prevent a reoccurrence

Before any renewal is considered by the Radiation Safety Officer or the Committee, the Radiation Safety Officer will inspect the project area for the following:

1. Ambient radiation levels and removable contamination.

2. Adequate monitoring and safety equipment.
3. That all workers are properly instructed in the following:

a. Protective clothing and equipment.
b. Operating and emergency procedures.
c. Methods of measuring and controlling surface contamination.

4. Adequate maintenance of records of receipt, transfer, use, and disposal.

5. Adequacy of the facility for the radioactive isotopes proposed according to Appendix N of Special Requirements for Broad Scope Research and Development Radioactive Material Licenses Type B and C written by D. A. Pickler.

6. Verification of the information provided by the permittee.

D. Restrictions

1. Pregnancy

Under state and federal law, the dose limit of a pregnant radiation worker remains at 5,000 mrem per year until she specifically declares her pregnancy in a written and signed statement directed to RSO. The declaration is voluntary. Following RSO's receipt of a signed Declaration of Pregnancy form (Appendix D), the dose limit to the worker's embryo/fetus is limited to 50 mrem more than her current dose and shall not exceed 5000 mrem total for the entire gestation period. If the dose equivalent to the embryo/fetus is found to have exceeded 500 mrem (5 mSv), or is within 50 mrem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance if the additional dose equivalent to the embryo/fetus does not exceed 50 mrem (0.5 mSv) during the remainder of the pregnancy, and under no circumstances shall exceed 5000mrems per entire gestation period as stated in 10 CFR 20.1208.

Upon the receipt of a signed Declaration of Pregnancy form, the RSO will monitor potential internal and/or external exposure to the embryo/fetus as appropriate. RSC recommends that a pregnant radiation worker declare her pregnancy so that her occupational radiation exposure potential can be evaluated to ensure that the dose to the unborn child does not exceed 500 mrem over the duration of the pregnancy.

RSC has established a Pregnancy Declaration Program as required by State radiation safety regulations. This program provides information and consultation concerning prenatal radiation exposure as well as dose monitoring of the embryo/fetus at the mother's request.

2. License Exempt Quantities

License exempt quantities as indicated in 17 CCR Section 30235, Schedule A (Appendix A – of this Radiation Safety Program) are also applicable to the above restrictions.

3. Radioactive Iodine (RAI)

a. The amount of iodine will be restricted to not greater than 900 microcuries, such that a bioassay program will not be required.

b. The release of radio iodine or other isotopes must not exceed the limits in Appendix B

of 10 CFR 20 (Annual Limit Intake and Derived Air Concentrations).

c. If ingested, inhaled, or absorbed via the skin, 1.0 uCi of I-125 can deliver a total Thyroid dose of approximately 2.3 REM.

d. In event of a suspected exposure to radioiodine, report the incident to the Radiation Safety Officer (RSO).

3. Basic Operating Procedures for Approved Users

A. Sources of Overexposure

Overexposure to radiation can arise from any of the following sources: external radiation fields, surface contamination, and airborne contamination.

1. External Radiation Fields

The user must maintain radiation fields at a sufficiently low level that no individual will receive more than the MPDE (maximum permissible dose equivalents) as stated below. In keeping with these limits, users will maintain external radiation levels at less than 2 millirems per hour as stated in 10 CFR 20 Subpart C.

a. 5,000 millirems total effective dose equivalent in any one year

b. 50,000 millirems total effective dose equivalent to any individual organ, other than the lens of the eye in any one year.

c. 15,000 millirems dose equivalent to the lens of the eye in any one year

d. 50,000 millirems shallow dose equivalent to the skin or any extremity in any one year.

e. 500 millirems total effective dose equivalent to a declared pregnant worker.

f. Limits for minors are 10% of the above.

2. Removable Surface Contamination

Removable surface contamination, which often results from spills and/or leaks, is a serious safety hazard because it can lead to ingestion or skin absorption of radioactive materials. Therefore, wipe tests must be performed periodically and whenever a spill or leak is suspected. A dry smear using a surface-loading filter (such as a membrane filter) must be taken over an area of 100 cm^2 (4'' x 4''). Smears containing low energy emitters (H-3, C-14) should be analyzed using a liquid scintillation counter; high energy beta emitters (e.g. P-32) can be analyzed with a thin window Geiger counter; a crystal scintillation detector [NaI (Tl)] is the instrument of choice for monitoring most gamma emitters. The maximum permissible removable contamination levels from environmental surfaces are: Alpha emitters: 10^{-6} uCi/cm^2 or 220 disintegrations/min (100 cm^2). Beta or Gamma Emitters: 10^{-5} uCi/cm^2 or 2,200

disintegrations/ (min) (100 cm^2). If these levels are exceeded, then decontamination procedures must be initiated immediately and the source of contamination must be isolated. The Radiation Safety Officer must also be informed so that he/she may evaluate the situation and clear the facility for use.

In an event of a spill, carry out the following procedures:

1) Notify all persons in the room immediately
2) Allow only those persons needed to remain in the room to help deal with the spill.
3) Put on personal protective equipment (PPE) as necessary (i.e. lab coat, gloves, and boots).
4) Confine the spill immediately. Cover with an absorbent paper if possible
5) Clean the area from the outside in. Use a monitor to check that the area is properly decontaminated.
6) Dispose of ALL contaminated waste appropriately, insuring that everything is labelled correctly and clearly.
7) Contact the Radiation Safety Officer (RSO) as soon as possible.

If the spill is large, or you do not feel confident in decontaminating the area properly, immediately call one of the persons listed on Appendix Q or persons on the emergency procedures poster on your laboratory.

In keeping with the ALARA Principal, the Radiation Safety Committee (RSC) has established a limit of four times background for removable contamination. Ask RSC if we want to use two times background?

3. Airborne Contamination

Airborne contamination also poses a serious health hazard because it can be inhaled or absorbed through the skin. The allowed concentration limits of airborne radioactivity are given in Table 2, Column 1 of Appendix B of 10 CFR 20 website located at https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-appb.html . Currently we do not possess the equipment or facilities necessary to work with airborne radioactive materials; therefore an air sampling program will not be required at this time. Details concerning air monitoring may be addressed by the RSO and the RSC at Project Authorization review if necessary.

B. Ordering Procedure

1. When you type a requisition to University Procurement or University Enterprises Corporation (UEC) Accounting the following information must be included:

"Approval by the Radiation Safety Officer, Kathy Pierson. The California Radioactive Materials License Number is: 1874-36 (Expiration Date: 4- 22-2028). After arrival at CSUSB, hold (DO NOT TRANSFER) in the Receiving Department until shipment is inspected. Please contact Kathy Pierson, RSO at extension 73091, mobile 909-208-2258 or Dr. Cynthia Crawford, Professor of Psychology at extension 77416 to make arrangements for inspection of shipment and delivery to Authorized User."

2. All shipments must be delivered to the attention of the Radiation Safety Officer (RSO). This

allows the inspection of all packages for any leaks of radioactive material or excessive radiation levels before release to the Authorized User.

C. Receipt, Use, and Disposal

Upon receipt of radioactive materials at CSUSB, the Receiving Department is instructed to contact the RSO. The RSO shall check radiation levels by surveying the source container and packaging material for evidence of leakage as well as perform wipe tests to check for surface contamination and record the receipt by following the Radioactive Material Shipment Survey and Receipt Report for each shipment and assign an Accession Number for each radioactive source. Upon approval by the RSO, the material will be delivered to the Authorized User. Maximum allowable levels of radiation and removable surface contamination are found in 10 CFR 71.47 and 49 CFR 173.443: Maximum Radiation Level = 200 millirem/hour at Surface and 10 millirem/hour at 3 Feet. Maximum Removable Surface Contamination = 22 disintegrations per minute per square centimeter or 2.2 for alpha emitters.

The Authorized User must also keep a careful record of all receipts, uses and disposals of radioactive materials in microcuries utilizing the Isotope Use Record for daily logs (see Appendix F). Use of the radioactive material must have a log of the amount of radioactivity removed in addition to the amount of dry, liquid, and scintillation waste. Monthly the amount of radioactive material used, decayed, and disposed must be indicated on the Radionuclide Inventory Report (see Appendix J). **This report is due in the Associate Provost's Office at the end of June each year**.

If the inventory report is not received, a Stop User Order may be issued and no further use of radioactive materials may continue in the Authorized User's laboratory.

D. Animal Use Guidelines

All animals used in radioactive studies at the University come under the joint control of the Radiation Safety Program and the Animal Care & Use Program. The University Radiation Safety Office has established the following guidelines for animal research with radioactive isotopes:

1. Radioactive materials shall only be administered to animals owned by the University.

2. Any animals used in radioactive isotope studies are to be kept in the authorized user's laboratory.

3. The authorized user will be responsible for compliance with all appropriate animal care regulations.

4. Animals that have been treated with radioactive isotopes will be turned over to the Radiation Safety Officer upon completion of research unless the user can demonstrate that the animals do not contain radioactive material.

5. All animal cages are to be labeled with the appropriate radiation warning labels including authorized user name, isotope, activity, date of assay, and physical/chemical form.

6. All animals that have been treated with radioactive isotopes shall be managed as radioactive waste. All feces and urine and bedding from animals so treated will be managed as radioactive waste unless the user can demonstrate that the feces and urine do not contain radioactive material.

7. The user is responsible to tag or otherwise keep track of treated animals.

8. All animals are to be placed on an absorbent-lined tray when injected with any radioactive isotope.

9. Adequate ventilation and/or air filters will be used where airborne concentrations may exceed acceptable levels.

10. The user is responsible for the training of his researchers regarding handling of treated animals. This training will cover at least the following items and must be documented:

    a. Use of gloves and any other protective equipment.

    b. Use of ventilation equipment and/or air filters if airborne concentrations exceed acceptable limits.

    c. Use of animal handling equipment.

E. Waste Disposal Procedures

All radioactive waste shall be organized in the following manner prior to submitting it for disposal:

1. Each isotope shall be kept in a separate container and identified by assigned Accession Number, specific isotope, activity, date, physical and chemical form, and Authorized User name. Dry waste must be separated from liquid waste. Liquid scintillation vials must be packaged separately from other liquid wastes. Both dry waste and liquid waste will be kept isolated in the Radiation Storage Room (BI-30E). Some aqueous liquid wastes maybe sewer disposed; check with RSO. The waste can then be removed by a licensed radioactive disposal company.

2. Important: Surface contamination levels and radiation levels must be within acceptable limits to protect the health of personnel handling the waste (see Section III. A.1 and 2).

3. All containers must be sufficiently strong and durable to retain their contents even if they are dropped or otherwise abused.

4. All radioactive waste will be turned over to the RSO for storage and/or disposal as soon as practical, after it is generated. Excessive amounts of waste must never be stored in a laboratory, faculty office, etc.

There are only two types of wastes that must be considered:

    a. Radioactive Waste with half-lives of less than 120 days

This type of waste generally includes ^{32}P (half-life = 14.3 days), ^{35}S (half-life = 87.9 days), and ^{125}I (half-life = 60.2 days). These isotopes will be stored in the Radioactive Materials Storage Room (BI-30E). Waste will be kept for a minimum of 10 half-lives before disposal as regular waste or as hazardous waste depending on the material. Following the retention period, waste will be surveyed prior to the disposal to confirm activity has decayed to a level indistinguishable from background.

b. Radioactive Waste with half-lives of more than 120 days

This type of waste generally includes ^{3}H (half-life = 12.3 years) and ^{14}C (half-life = 5,730 years). These isotopes will be separated as dry, liquid-aqueous, or liquid scintillation cocktail waste.

F. Identification of Radiation Work and Storage Areas

Each area or room in which an isotope is stored or used in an amount exceeding 10 times the quantity specified in Appendix A of this program will be posted with a sign bearing the canonical radiation caution symbol and the words:

CAUTION
RADIOACTIVE MATERIALS

G. Security of Radioactive Material Storage Areas

Every room containing radioactive materials or radiation producing equipment must be locked when the Authorized User is not present. All other personnel who have access to this room (by virtue of possessing a key) must be informed by the Authorized User of the location of all radioactive materials present, and of any risks or hazards involved; this notification must be documented. Students and staff are not allowed to use (nor should they have access to) radioactive materials except under the direct supervision of an Authorized User.

H. Survey Equipment

Authorized Users are responsible for maintaining (calibration and labeling) all survey equipment in their areas. RSO may review compliance of equipment maintenance during periodic lab audits.

1. Radiation detection equipment will include exposure rate, count rate and wipe test instruments.

2. All instruments used for survey purposes will be calibrated annually.

3. Instruments used for demonstration purposes (not survey purposes) do not require

calibration. These instruments must be tagged “Not to be used for Survey Purposes.”

a. Please contact the RSO for polyester chemical resistant label for your instrument; picture below.

4. Table below contains instruments maintained for survey purposes.

Make	Model	Description	Location	Purpose for Which Used	Calibration Frequency
Perkin- Elmer Tricarb	4810 TR	Liquid Scintillation Counter	SBS-011	Research and Wipe Surveys	Annual
WM Johnson	DSM 525	Survey Meter (Exposure / Count Rate)	ES-102	Surveys	Annual

I. Proper Labeling of Containers

All containers of radioactive material must be clearly labeled with the conventional radioactive materials sign and must display the following information: isotope, activity, date, surface radiation level (if > 2 mrem/hr), physical and chemical form, authorized user's name and special handling precautions or hazards. Obtain proper labels from the RSO.

J. Intra-campus Transportation of Radioactive Material

All radioactive material must satisfy the following conditions before it can be transported through the corridors at CSUSB.

1. It must be enclosed in an unbreakable container with a tight fitting lid that will prevent spillage if the container is overturned, dropped or otherwise disrupted. Plastic (not glass) LSC vials with screw- on caps constitute an "unbreakable container" as specified in this paragraph.

2. The container described above shall be transported on a sturdy, four-wheeled cart, with sides capable of containing any liquid spilled.

3. Radiation devices possessed and transported under authority of this license shall be secured in compliance with the following:

a. Transport vehicles must be equipped to provide security of the transport case. The method selected must provide for a fixed and permanent attachment to vehicle frame. When secondary containers are used for the Type A package they shall be attached to the vehicle with the use of tamper resistant fasteners to the frame of the transport vehicle.

b. A minimum of two locks shall be placed between radioactive sources and the public when the device is being transported, in addition to the locks securing the Type A package to the vehicle.

c. Transport vehicles must be equipped with a security device (such as an alarm system) capable of deterring unauthorized entry, access and use of the vehicle.

d. Local law enforcement shall be notified immediately in the event of loss or theft.

4. Training

A. Faculty

Most faculties have been trained in the use of radioactive materials during the course of their education or prior research training. Faculty who have not received training previously and who wish to become Authorized Users will be trained by the RSO in the nature of radioactivity, the measurement of radioactivity, the interaction of radioactivity with matter including biological organisms, and the proper handling, and disposal of radioactive materials. Documentation of training will be provided in the Statement of Training and Experience (Appendix B, RH 2050A).

B. Student Training

It is the Authorized User's responsibility to inform the RSO each time he hires/recruits a new student to work on a project wherein the student will be exposed to radiation and/or radioactive materials. The Authorized User will provide appropriate, documented training to insure the student’s safety and that of others.

C. Lab Personnel

Instructional Laboratory Support Technicians must be instructed in the proper handling and disposal of radioactive materials. These technicians are not involved in the use, instruction or supervision of students or others. Technicians are also not responsible for recordkeeping involving radioactive materials use and quantities remaining. They are not Authorized Users. They must work under the direction of an Authorized User.

5. Personnel Monitoring

Each user of radiation-producing machines and/or radioactive isotopes (except low energy beta

e.g. H- 3 and C-14 users) must wear a dosimetry badge at all times. Users of H-3 and C-14 will monitor themselves and their areas by making frequent wipe tests and analyzing them on the liquid scintillation counter. Wipe tests must be performed at the completion of each experiment and anytime there is reason to believe that contamination (e.g. a spill) exists. Wipe tests must be performed at least once a month during active periods of research. An up-to-date log must be kept to indicate the results of each test (location, date, isotope, level of contamination). Other monitoring devices (such as TLD finger rings and/or wrist bandages) may also be required for specific projects. Students, long term visitors and other non-occupationally exposed personnel will be badged if there exists a significant chance that they may receive more than 2% of the MPDE described in Section III. A. 1 in one year. A permanent record of each user's exposure is kept in the Office of Academic Research pursuant to 10 CFR 20.2106.

The film badge should be worn at the position on the body where the exposure is expected to be greater. If the exposure is uniform, then the badge should be worn on the trunk since the blood-forming organs and gonads are the critical organs. If a lead apron shields the torso, then the thyroid gland and lenses of the eyes become the critical organs. Hence, the badge should be worn on or near the collar.

6. Radiation Laboratory Safety Rules, Radiation Emergency Procedures and Personnel Decontamination

A. Radiation Laboratory Safety Rules

1. Eating, drinking and smoking are prohibited in the laboratory.
2. Use tongs or thumb forceps when handling radioisotopes.
3. First dry run all experiments that use significant amounts of radioactive materials to reduce exposure time.
4. Hands and clothing should be monitored when leaving the laboratory.
5. Always wear a monitoring device such as your dosimetry badge when working in the lab unless exempt under section IV.
6. Evaluate and document your potential exposure before embarking on an experiment.
7. When working with unsealed sources the following precautions must be taken in addition to those described above.
    a. Wear lab coat and impermeable gloves.
    b. Never pipette by mouth
    c. Line working surfaces with absorbent paper having an impermeable base.
    d. Store and transport containers of radioactive materials on trays that will hold the materials if the container breaks.

e. Significant amounts of unsealed sources must be used only in well-designed exhaust-ventilated enclosures. The quantity of radioactive material that constitutes a "significant amount" depends sensitively on the particular isotope used, its physical form (dust, liquid, gas), how readily it is absorbed through the skin, etc. Specific standards have been established in this regard and are available from the RSO.

B. Radiation Emergency Procedures

Every location where radioactive materials or radiation generating machines are used shall post a copy of the Radiation Emergency Poster with Supervisor(s) or Authorized User(s) Office or Phone Number where they can be easily be contacted in case of an emergency IN ANY RADIATION EMERGENCY, IMMEDIATELY NOTIFY:

	Office or Person:	Telephone Number:	Location on Campus:
1.	Your Instructor or Supervisor		
2.	Public Safety (Campus Police Department)		
	Emergency	**Dial 911**	
	Business	909-537-5165	UP-104
3.	Kathy Pierson *Radiation Safety Officer (RSO)* kpierson@csusb.edu	909-208-2258 909-537-3091	ES-108
4.	Teresa Fricke *Environmental Health & Safety Director* teresa.fricke@csusb.edu	909-537-5179 909-453-7763	ES-103
5.	Dr. Cynthia Crawford *Professor of Psychology* ccrawfor@csusb.edu	909-537-7416	SBS-524

In the event of contamination of an individual, area, or work location by radioactive materials or suspected radiation exposure, the following procedures will be immediately initiated:

1. Employ every effort to reduce or restrict spread or dispersion of radioactive materials.

    a. If liquid, apply absorbent material appropriate to the size and type of spill/release.

    b. If gas or airborne powder, stop the release.

2. Restrict access to the contaminated area.

3. If material is a gas or airborne powder,

a. Evacuate the area.

b. Seal and post the location.

c. Shut down ventilation at that location.

4. Identify the precise radioactive contaminant.

5. Assemble in a nearby location with other contaminated individuals.

6. If radioactive material reaches any skin surfaces, wash with soap and warm water (see following section for detailed decontamination procedures).

7. Do not leave scene until instructed.

    a. If exposure is suspected from a radiation generator, medical attention may be necessary. Notify your instructor, supervisor or emergency personnel.

C. Personnel Decontamination Procedures

The following guide is presented through the courtesy of REAC (Radiation Emergency and Assistance Center) in Oak Ridge, TN.

1. EXTERNAL CONTAMINATION WITH RADIOACTIVE MATERIALS

INTACT SKIN: Notify Radiation Emergency Medical Service by dialing 911. If incorporation is suspected: get nose swab, sputum sample. Avoid spread of contamination. Remove clothing from contaminated person. Decontaminate affected area of skin.

Decontaminate: with mild soap, water, and soft brush (2-3min). Repeat at least 3-4 times. Monitor in-between washes. If necessary use mild abrasive (paste of cornmeal and tide, 50/50, in water), repeat 3-4 times. Dry skin, monitor again.

CONTAMINATED HAIR: Shampoo hair with head deflected backwards. Wear gloves! Rinse with 3% citric acid, wash again, rinse, and dry with hair dryer. Monitor.

CONTAMINATED EYES: Spread eyelids, rinse with water from nose to lateral angle of eye.

WHOLE BODY CONTAMINATION: Remove all clothing, shower immediately with water, and brush with mild soap and repeat at least 3-4 times, towel - monitor. Use mild abrasive paste if necessary. If unsuccessful – await physician's orders. Following decontamination take care of skin with skin lotion.

2. CONTAMINATED WOUNDS

Any wound acquired in the presence of open radionuclides has to be considered contaminated until proven otherwise.

FIRST AID: Rinse wound under running water. Delimit contaminated area with waterproof

material. Decontaminate skin around the wound. Remove tape, apply sterile dressing. In case of contamination with highly radiotoxic substances - apply venous tourniquet close to the wound. Notify physician.

MEDICAL TREATMENT: In combined injury primary care is desirable. With associated burns less aggressive treatment is the rule. If wounds are contaminated with short-lived radioisotopes of less toxicity, rinsing the wound with physiological sodium chloride or 3% hydrogen peroxide should be done. Monitor, sterile dressing, tetanus shot.

If the contaminant is highly toxic: maintain venous tourniquet, wash wound, excise wound surgically.
Contact Radiation Emergency Medical Service by dialing 911.

3. **INCORPORATION OF RADIOACTIVE SUBSTANCES**

Intake may occur by ingestion, inhalation, or absorption through intact or injured skin.

INGESTION (swallowing): When smoking eating, drinking, pipetting

INHALATION: Radioactive dusts, aerosols, gases

PENETRATION OF SKIN: Gaseous substances; acne, wounds

COUNTER MEASURES: Determine time of accident, type of uptake, kind of radionuclide, chemical nature and level of activity of contaminant. Notify Radiation Emergency Services immediately by dialing 911. Only in ingestion should mouth be rinsed and vomiting induced.

Decision to treat with chelating agents should be made by experts. Chelation should be started within one hour or less, in order to be effective.

7. Training of Authorized Users

The Radiation Safety Office will periodically schedule a course in radiation properties, policies, and procedures as needed. This course will be designed to meet requirements stated in Title 17, California Code of Regulations Section 30255 and Special Requirements for Broadscope Research and Development Radioactive Material Licenses Type A, as written by the Radiologic Health Branch of the California Department of Health Services. The Radiation Safety Officer will offer periodic retraining as necessary. The periodic retraining shall include information on changes in Regulations, License Conditions, University Policy, Operating Procedures, and Emergency Procedures.

8. Laboratory Inspections/Safety Audits

Laboratory inspection/safety audits are conducted at least once a quarter for every laboratory where radioactive material is used. If the Radiation Safety Officer or the Committee feels that a laboratory requires closer monitoring, audits may be conducted after each use of radioactive material. The audit shall consist of the following:

1. Wipe tests of the laboratory, equipment, and ventilated enclosures to verify containment.

2. Visual inspection of work and storage areas.
3. Monitoring of radiation fields where necessary.
4. Verification that safety procedures and work rules, as listed in the Radiation Safety Program, are being followed.
5. Verification that radioactive material(s) are properly secured during use and storage in the laboratory. Controlled areas must be locked at all times.

Appendix A: 17 CCR Section 30235 Schedule A. Exempt Quantities

Radionuclide	Microcuries		Radionuclide	Microcuries
Antimony-122 (Sb[122])	100		Fluorine-18 (F[18])	1000
Antimony-124 (Sb[124])	10		Gadolinium-153 (Gd[153])	10
Antimony-125 (Sb[125])	10		Gadolinium-159 (Gd[159])	100
Arsenic-73 (As[73])	100		Gallium-67 (Ga[67])	100
Arsenic-74 (As[74])	10		Gallium-72 (Ga[72])	10
Arsenic-76 (As[76])	10		Germanium-71 (Ge[71])	100
Arsenic-77 (As[77])	100		Gold-198 (Au[198])	100
Barium-131 (Ba[131])	10		Gold-199 (Au[199])	100
Barium-133 (Ba[133])	10		Hafnium-181 (Hf[181])	10
Barium-140 (Ba[140])	10		Holmium-166 (Ho[166])	100
Beryllium-7 (Be[7])	100		Hydrogen-3 (H[3])	1000
Bismuth-210 (Bi[210])	1		Indium-113m (In[113m]	100
Bromine-82 (Br[82])	10		Indium-114m (In[114m])	10
Cadmium-109 (Cd[109])	10		Indium-115m (In[115m])	100
Cadmium-115m (Cd[115m])	10		Iodine-123 (I[123])	100
Cadmium-115 Cd[115])	100		Iodine-125 (I[125])	1
Calcium-45 (Ca[45])	10		Iodine-126 (I[126])	1
Calcium-47 (Ca[47])	10		Iodine-129 (I[129])	0.1
Carbon-14 (C[14])	100		Iodine-131 (I[131])	1
Cerium-141 (Ce[141])	100		Iodine-132 (I[132])	10
Cerium-143 (Ce[143])	100		Iodine-133 (I[133])	1
Cerium-144 (Ce[144])	1		Iodine-134 (I[134])	10
Cesium-129 (Cs[129])	100		Iodine-135 (I[135])	10
Cesium-131 (Cs[131])	1000		Iridium-192 (Ir[192])	10
Cesium-134m (Cs[134m])	100		Iridium-194 (Ir[194])	100
Cesium-134 (Cs[134])	1		Iron-52 (Fe[52])	10
Cesium-135 (Cs[135])	10		Iron-55 (Fe[55])	100
Cesium-136 (Cs[136])	10		Iron-59 (Fe[59])	10
Cesium-137 (Cs[137])	10		Krypton-85 (Kr[85])	100
Chlorine-36 (Cl[36])	10		Krypton-87 (Kr[87])	10
Chlorine-38 (Cl[38])	10		Lanthanum-140 (La[140])	10
Chromium-51 (Cr[51])	1000		Lead-210 (Pb[210])	10
Cobalt-57 (Co[57])	100		Lutetium-177 Lu[177])	100
Cobalt-58m (Co[58m])	10		Manganese-52 (Mn[52])	10
Cobalt-58 (Co[58])	10		Manganese-54 (Mn[54])	10
Cobalt-60 (Co[60])	1		Manganese-56 (Mn[56])	10
Copper-64 (Cu[64])	100		Mercury-197m (Hg[197m])	100
Dysprosium-165 (Dy[165])	10		Mercury-197 (Hg[197])	100
Dysprosium-166 (Dy[165])	100		Mercury-203 (Hg[203])	10
Erbium-169 (Er[169])	100		Molybdenum-99 (Mo[99])	100
Erbium-171 (Er[171])	100		Neodymium-147 (Nd[147])	100
Europium-152 9.2 (Eu[152]9.2h)	100		Neodymium-149 (Nd[149])	100
Europium-152 13 yr	1		Nickel-59 (Ni[59])	100

(Eu[152]13 yr)				
Europium-154 (Eu[154])	1		Nickel-63 (Ni[63])	10
Europium-155 (Eu[155])	10		Nickel-65 (Ni[65])	100
Niobium-93m (Nb[93m])	10		Sulphur-35 (S[35])	100
Niobium-95 (Nb[95])	10		Tantalum-182 (Ta[182])	10
Niobium-97 (Nb[97])	10		Technetium-96 (Tc[96])	10
Osmium-191m (Os[191m])	100		Technetium-96 (Tc[96])	10
Osmium-191 (Os[191])	100		Technetium-97m (Tc[97m])	100
Osmium-193 (Os[193])	100		Technetium-97 (Tc[97])	100
Palladium-103 (Pd[103])	100		Technetium-99m (Tc[99m])	100
Palladium-109 (Pd[109])	100		Technetium-99 (Tc[99])	10
Phosphorus-32 (P[32])	10		Tellurium-125m (Te[125m])	10
Platinum-191 (Pt[191])	100		Tellurium-127m (Te[127m])	10
Platinum-193m (Pt[193m])	100		Tellurium-127 (Te[127])	100
Platinum-193 (Pt[193])	100		Tellurium-129m (Te[129m])	10
Platinum-197m (Pt[197m])	100		Tellurium-129 (Te[129])	100
Platinum-197 (Pt[197])	100		Terbium-160 (Tb[160])	10
Polonium-210 (Po[210])	0.1		Thallium-200 (Tl[200])	100
Potassium-42 (K[42])	10		Thallium-201 (Tl[201])	100
Potassium-43 (K[43])	10		Thallium-204 (Tl[204])	10
Praseodymium-142 (Pr[142])	100		Thulium-170 (Tm[170])	10
Praseodymium-143 (Pr[143])	100		Thulium-171 (Tm[171])	10
Promethium-147 (Pm[147])	10		Tin-113 (Sn[113])	10
Promethium-149 (Pm[149])	10		Tin-125 (Sn[125])	10
Rhenium-186 (Re[186])	100		Tungsten-181 (W[181])	10
Rhenium-188 (Re[188])	100		Tungsten-185 (W[185])	10
Rhodium-103m (Rh[103m])	100		Tungsten-187 (W[187])	100
Rhodium-105 (Rh[105])	100		Vanadium-48 (V[48])	10
Rubidium-81 (Rb[81])	10		Xenon-131m (Xe[131m])	1000
Rubidium-86 (Rb[86])	10		Xenon-133 (Xe[133])	100
Rubidium-87 (Rb[87])	10		Xenon-135 (Xe[135])	100
Ruthenium-97 (Ru[97])	10		Ytterbium-175 (Yb[175])	100
Ruthenium-103 (Ru[103])	10		Yttrium-87 (Y[87])	10
Ruthenium-105 (Ru[105])	10		Yttrium-90 (Y[90])	10
Ruthenium-106 (Ru[106])	1		Yttrium-91 (Y[91])	10
Samarium-151 (Sm[151])	10		Yttrium-92 (Y[92])	100
Samarium-153 (Sm[153])	100		Yttrium-93 (Y[93])	100
Scandium-46 (Sc[46])	10		Zinc-65 (Zn[65])	10
Scandium-47 (Sc[47])	100		Zinc-69m (Zn[69m])	100
Scandium-48 (Sc[48])	10		Zinc-69 (Zn[69])	1000
Selenium-75 (Se[75])	10		Zirconium-93 (Zr[93])	10
Silicon-31 (Si[31])	100		Zirconium-95 (Zr[95])	10
Silver-105 (Ag[105])	10		Zirconium-97 (Zr[97])	10

Silver-110m (Ag[110m])	1		Any radionuclide not listed above other than alpha emitting radionuclides	0.1
Silver-111 (Ag[111])	100		**NOTE** **Authority cited: Sections 208 and 25811, Health and Safety Code. Reference: Sections 25801, 25802, 25811, 25815 and 25855, Health and Code.** **HISTORY** **1. New Schedule A filed 7-22-71; effective thirtieth day thereafter (Register 71, No. 30). For history of former section, see Register 62, No. 16.**	
Sodium-22 (Na[22])	1			
Sodium-24 (Na[24]	10			
Strontium-85 (Sr[85])	10			
Strontium-89 (Sr[89])	1			
Strontium-90 (Sr[90])	0.1			
Strontium-91 (Sr[91])	10			
Strontium-92 (Sr[92])	10			

Appendix B: Statement of Training and Experience

State of California-Health and Human Services Agency

California Department of Public Health
Radiologic Health Branch

STATEMENT OF TRAINING AND EXPERIENCE
(Use additional sheets as necessary.)

Instructions: Each individual proposing to use radioactive material is required to submit a Statement of Training and Experience (RH 2050 A) in duplicate to: California Department of Public Health, Radiologic Health Branch, MS 7610, Licensing Section, P.O. Box 997414, Sacramento, CA 95899-7414. Physicians should request form RH 2000 A when applying for human-use authorizations. Radiographers should request form RH 2050 IR. For more information, go to the Radiologic Health Branch website at www.cdph.ca.gov/rhb or phone (916) 327-5106. (4) Medical applicants should request other forms if in-vivo use is involved.

1. Name of proposed user | Position title

Employer address (number, street) | City | State | ZIP code

Radioactive materials license number | Radioactive materials license name

2. Training

a. College or university ☐ Yes ☐ No

Name of college or university

City | State

Years completed | Degree | Course of study

b. Education specifically applicable to use of radioactive material

3. Experience

a. List experience with use of radioactive materials beginning with most recent:

(1) Dates From: | To: | Employer

Title(s) and duties

Radioactive materials license number | Date

Employer address (number, street) | City | State | ZIP code

(2) Dates From: | To: | Employer

Title(s) and duties

Radioactive materials license number | Date

Employer address (number, street) | City | State | ZIP code

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(3) Dates From:	To:	Employer

Title(s) and duties

Radioactive materials license number | Date

Employer address (number, street) | City | State | ZIP code

(4) Dates From:	To:	Employer

Title(s) and duties

Radioactive materials license number | Date

Employer address (number, street) | City | State | ZIP code

b. Indicate the facilities and operations where training was received and refer to Part 3.a. when answering the following:

☐ Laboratories using radiochemicals	☐ (1)	☐ (2)	☐ (3)	☐ (4)
☐ Restricted area laboratories	☐ (1)	☐ (2)	☐ (3)	☐ (4)
☐ Glove boxes	☐ (1)	☐ (2)	☐ (3)	☐ (4)
☐ Field operations	☐ (1)	☐ (2)	☐ (3)	☐ (4)
☐ Environmental applications	☐ (1)	☐ (2)	☐ (3)	☐ (4)
☐ Other (please describe) _____	☐ (1)	☐ (2)	☐ (3)	☐ (4)

c. Radioactive materials previously used. Identify typical radioisotopes in appropriate box and refer to Part 3a. on page 1:

RAM Type	Quantities Handled (a) Microcuries	Quantities Handled (b) Millicuries	Quantities Handled (c) Curies	Quantities Handled (d) Kilocuries
(1) Sealed sources				
(2) Unsealed Alpha emitters				
(3) Unsealed beta-gamma emitters				
(4) Neutron sources				

d. Describe the procedures similar to those proposed in which you have had experience. Indicate months or years for each and refer to Part 3.a. on page 1.

14. Certificate

The information you are asked to provide on this form is requested by the California Department of Public Health, Radiologic Health Branch. This notice is required by Section 1798.17 of the Information Practices Act of 1977 (Code of Civil Procedure, Section 1798œ1798.76) and the Federal Privacy Act to be provided whenever an agency requests personal or confidential information from any individual. It is mandatory that you furnish the information requested on this form. Failure to furnish the requested information may result in an inaccurate determination of statements and/or disapproval of your application.

I hereby certify that all information contained in this statement is true and correct.

Signature of proposed user _____ Date

Appendix C: Project Application

Each person responsible for a project must be an Authorized User. This person must complete the Statement of Training and Experience Form (Form RH-2050-A, Appendix B above) which is submitted to the Radiation Safety Committee. For each project utilizing radioactive materials, including classroom use, a Project Authorization must be approved by the Radiation Safety Committee. The Project Authorization is valid for a period of **one year only**. At the end of each year, the Authorized User may reapply.

PROJECT AUTHORIZATION FORM

1. Individual(s) responsible for this project: _____

   _____

2. Beginning and ending dates for this project: _____

3. Licensee authorizing project:

   Office of Academic Research
   California State University at San Bernardino
   Under license number 1874-36

4. Radionuclides used in project:

Source	Quantity	Form	Sealed / Unsealed	Possession Limit of License

5. University or other facilities to be used: _____

6. Will experimental animals be used? ☐Yes ☐No

   If yes, what kind of animals? What is the activity per carcass? What is the method of disposal? Date of Institutional Animal Care and Use Committee (IACUC) approval

7. Will an airborne radioactive gas, vapor or aerosol be generated? ☐Yes ☐No

If yes, what will become airborne? What is the quantity that will become airborne? How will it be contained? What is the method of disposal?
How will it be monitored?

8. Description of the project, including the hazardous operations

9. Description of methods and equipment used to reduce risks to humans and the environment to “as-low-as-practicable” levels. Include training of students and other lab personnel. How will exposure to personnel be monitored?

10. Will students be involved in this project? ☐Yes ☐No

If so, please attach or forward the names of all students involved in this project either currently or in the future. Include written description of the students involved in this project training in radioisotope use which the students have received.

11. Special requirements from Radiation Safety Officer (RSO) and Radiation Safety Committee (RSC).
    a. Include the following wording on purchase order for every purchase of a radionuclide:

    "Approval by the Radiation Safety Officer:_____, Kathy Pierson. The California Radioactive Materials License Number is: 1874-36 (Expiration Date: 4-22-2005) and a copy of the "Timely Renewal Letter". After arrival at CSUSB, hold in the Receiving Department until shipment is inspected. Please contact Kathy Pierson, RSO at extension 73091, mobile 909- 208-2258 or Cynthia Crawford, Professor of Psychology at extension 77416 to make arrangements for inspection of shipment and delivery to Authorized User."

    b. Contact the RSO for disposal of radionuclides.

    c. At the end of the project, contact the RSO for pick-up of remaining radionuclides and for inspection/survey of the facilities used.

    d. **Attach a drawing of the room in which the radioisotope will be used**. Use this drawing to indicate where surveys or swipe tests have been done at either the end of each laboratory exercise (for classroom), the end of each experiment, or at a minimum of monthly intervals.

    e. Waste disposal: All liquid waste containing radionuclides will be collected and transferred to the RSO after labeling with identity and quantity of radioisotope. All dry waste, including gloves, vials, dishes, pipettes, paper towels, and bench paper, will be collected and transferred to the RSO after labeling with identity and quantity of radioisotope.

Printed Name of Applicant:

Signature of Applicant: _____ Date: _____

Approved Signature By:

Radiation Safety Officer _____ Date:_____

Radiation Safety Committee _____ Date: _____

Original: Office of Academic Research
Copies: Applicant, Chair, Radiation Safety Committee, Radiation Safety Officer

Appendix D: Declaration of Pregnancy for Radiation Workers

This form is provided for your convenience and is voluntary. To make your written declaration of pregnancy, you may fill in the blanks provided. This form will be reviewed by the Radiation Safety Officer (RSO) or the Radiation Safety Representative. A copy of the reviewed declaration will be returned to you in a confidential envelope and another copy will be delivered to your employer. If you do not receive a confirmation of receipt with seven days of submission, please contact our office at 909-537-5179.

If you are currently occupationally exposed to sources of radiation at a place of work other than California State University, San Bernardino, please provide the name and address on the bottom of this form.

To: _____

(Name of your supervisor or employer representative)

I am declaring that I am pregnant. I believe I became pregnant in_____,_____.

(Month, Year)

I understand that my occupational radiation dose to my embryo/fetus will not be allowed to exceed 0.5 rem (500 mrem) during my entire pregnancy for a DECLARED pregnant women (unless that dose has already been exceeded between the time of conception and submitting this letter). The RSO will investigate any report of a dose in excess of 0.05 rem (50 mrem) to a declared pregnant worker within 7 working days of receiving knowledge of a dose. I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

_____ _____

(Your Signature) (Date)

_____ _____

(Your Printed Name) (Coyote ID)

Other Sources of Radiation Exposure

Facility Name: _____

Facility Address:

_____

****

Date Received: _____

Reviewed By:

_____ _____

(RSO or Radiation Safety Representative) (Date)

CALIFORNIA STATE UNIVERSITY, SAN BERNARDINO

Appendix E: Material Order Approval Form

Vendors will require the items listed below before sale of radioactive materials (RAM) to purchaser. Notify Radiation Safety Officer via email (kpierson@csusb.edu) of your intent to purchase RAM and obtain approval signature, copy of license and timely renewal letter, which will be required by vendor.

"Approval by the Radiation Safety Officer, Kathy Pierson

_____,
(RSO Signature)

The California Radioactive Materials License is: 1874-36 (expiration date: 4-22-2028).

After arrival at CSUSB, **HOLD** (do not transfer) in the Receiving Department until the shipment is inspected.
Please contact **Kathy Pierson**, RSO at extension x73091, mobile 909-208-2258 *or*

Dr. **Cynthia Crawford**, Professor of Psychology, at extension x77416 to make arrangements for inspection of shipment and delivery to "Authorized User."

Type of Isotope purchased: _____

Amount purchase: _____

Activity of Isotope purchased: _____

Appendix F: Isotope Usage Record

Isotope:	
Amount Received:	
Date Received:	
Concentration:	

Date:	Amount Removed:	Dry Waste:	Liquid Waste:

Appendix G: Radiation Wipe Tests

Date:_____Location:_____/_____
Building Room Number

Specific area of Wipe (100 cm^2):

1) _____ 6) _____

2)_____ 7) _____

3)_____ 8) _____

4)_____ 9) _____

5)_____ 10) _____

Results: List by above numbers.

CPM

6% Gain				60% Gain			
1)_____	6)_____			1)_____	6)_____		
2)_____	7)_____			2)_____	7)_____		
3)_____	8)_____			3)_____	8)_____		
4)_____	9)_____			4)_____	9)_____		
5)_____	10)_____			5)_____	10)_____		

14C (6) % Eff:_____ 3H (60) % Eff: _____

0.005 uCi. = 11 x 10^3 dpm

Comments:

_____
(Signature)

Appendix H: Contamination Survey Tests

Date:_____Location:_____/_____
Building Room Number

Meter Information: _____

Manufacturer:_____Type of Meter: _____

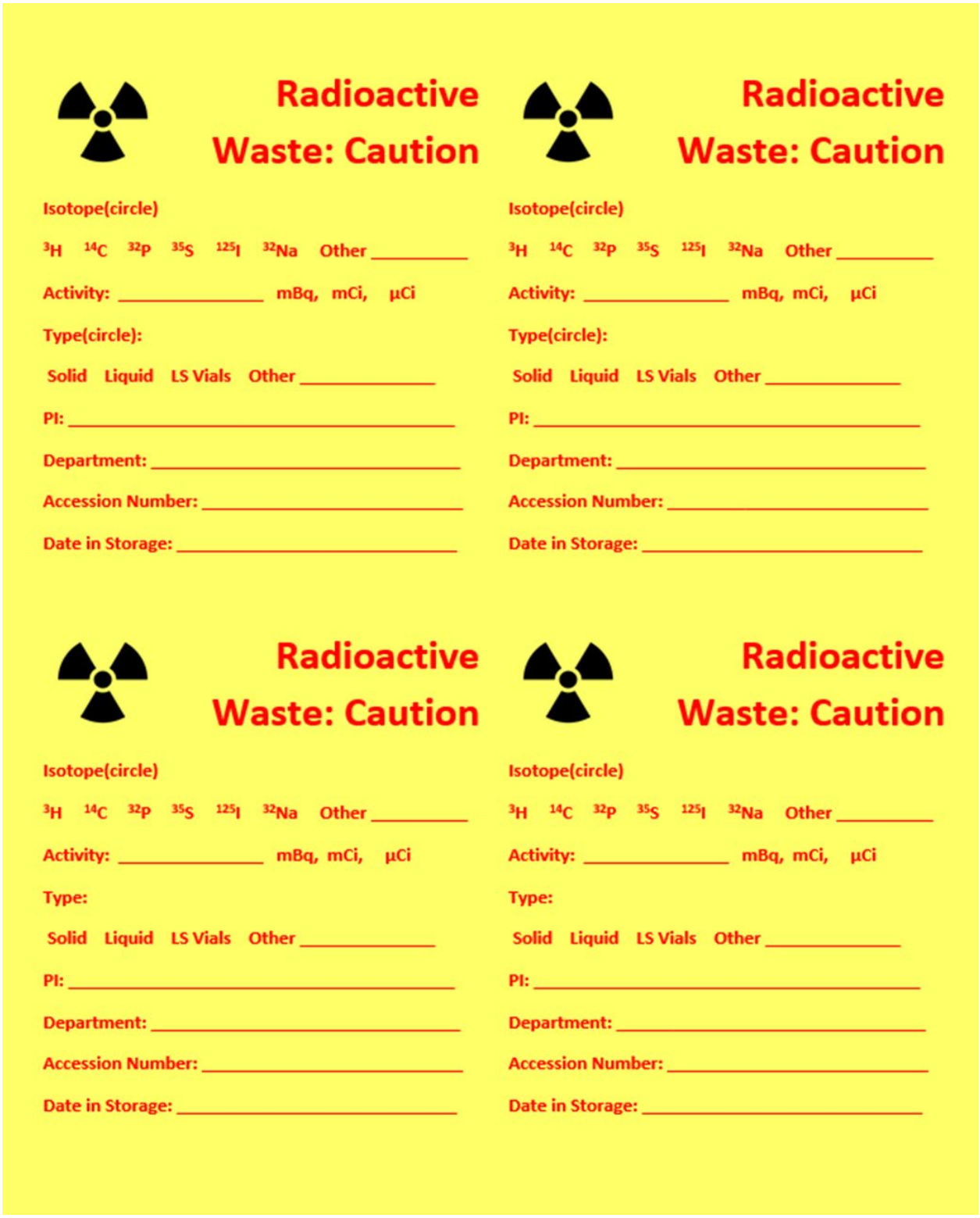
Model No:____Serial No:____CPK No: _____

Area Surveyed (Description)	Reading (cpm)	Reading (mrem/hr)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		

Comments:

_____
(Signature)

Appendix I: Labels for Disposal/Decay in Storage



Appendix J: Radionuclide Inventory Report

Authorized User:	
Beginning and Ending Dates of Project Authorization:	
Radionuclide: Amount and Form:	
Half-Life:	
Accession Number:	

Inventory:

Month	Date	Initial Amount	Used	Decayed	Disposed	Stored	Ending Amount
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							

Name:_____Signature:_____

Title:_____Date:_____

Appendix K: Procedure for Sanitary Sewer Disposal of Aqueous Radioactive Material

(Reference: 10 CFR 20.2003)

1. Only Radioactive Material that is soluble or dispersible in water will be considered for sanitary sewer disposal.

2. The total and specific activity of the radioactive material will be determined utilizing a Liquid Scintillation Spectrometer or other appropriate instrumentation.

3. The total activity discharge to sanitary sewers shall not exceed five curies of H-3, one curie of C-14, or one curie of other isotopes combined per year for the entire University.

4. The diluted specific activity of the radioisotope at the point of discharge shall not exceed the levels specified in table 3 of Appendix B 10 CFR 20.

5. If the material to be discharged contains more than one isotope, the sum of the diluted specific activities divided by the levels in Appendix A must be calculated. This sum shall be less than unity.

6. The faucet in the sink to be used for discharge shall be turned on. The rate of water entering the drain shall be calculated and the radioactive material added at a rate which will achieve the required dilution specified above.

7. The Authorized User shall be responsible for documenting the diluted specific activity and the total amount of activity discharged.

8. All records of sanitary sewer disposal of radioactive materials shall be provided to the Radiation Safety Office upon request.

9. The Radiation Safety Officer shall ensure that the activity discharge limits are not exceeded. Calculation based on daily through put amounts from sewer meter records.

10. Due to the complex nature of the above procedures, the Radiation Safety Office must be contacted prior to the initial discharge of any isotopes to the sanitary sewer. A disposal plan will be created specific to each isotope.

Appendix L: Procedures for the Disposal of Exempt Liquid Scintillation Media

1. All users are required by the Radiation Safety Program to store all waste isotopes in separate containers.

2. All waste containers are to be labeled with the identity of the isotope, the approximate activity, date, user name, and physical/chemical form.

3. When waste is received by the Radiation Safety Officer, he (she) will separate any liquid scintillation media which is labeled as having an activity below 0.05 microcurie/ml.

4. One milliliter of the supposedly exempt media will be counted on a liquid scintillation counter and the activity determined versus a known standard of C-14 or H-3. Minimum detectable activities for our liquid scintillation counter are at least 5.82 x 10-6 microcurie for C-14 and H-3 (from item 3 above).

5. If the calculated specific activity is below 0.05 microcurie/ml of either C-14 or H-3, all radiation labels will be removed and the waste turned over to the Hazardous Materials Program for management as a hazardous waste.

6. These procedures apply to liquid scintillation media only. Animal carcasses will always be managed as radioactive waste.

Appendix M: Radioactive Material Decay and Disposal Procedure

1. Only radioisotopes with half-lives at/or below 120 days will normally be held for decay.

2. All radioactive material received for decay will be labeled with the identity of the radioisotope, waste type activity of the isotope, laboratory where generated and the date.

3. Radioactive material being held for disposal will be stored in the University Radiation Storage Facility (BI-30E), unless permission is granted by the Radiation Safety Officer (RSO) to store the material in another location.

4. No radioactive material will be disposed of to public solid waste or the sanitary sewage system until the following criteria is met.

    a. The radioactive material has gone thru ten half-lives.

    b. The ambient radiation levels at the surface of the package shall not exceed twice background.

    c. The specific activity of the radioactive material shall not exceed 0.002 microcurie/gram for solids or the guidelines specified in Title 10, Code of Federal Regulations, and section 20.2003 for liquids.

    d. All radioactive labels and/or markings have been removed.

    e. All liquids that meet the above criteria shall be discharged to the sewer as per the University's Procedure for Sanitary Sewer Discharge of Aqueous Radioactive Waste.

    f. All solids that meet the above criteria shall bedisposed of at a public landfill.

5. The Radiation Safety Officer will maintain records of all radioactive material held for decay.

Appendix N: Special Requirements for Broad Scope Research and Development

RADIOACTIVE MATERIAL LICENSES

State of California Department of Health Services
Radiologic Health Branch
744 P. Street
Sacramento, California 95814

RH 2083 (3/82)

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INTRODUCTION

The State Department of Health Services ("the Department") has the responsibility imposed by the State Radiation Control Law and Regulations for evaluating and approving or disapproving each proposed use of radioactive materials subject to its specific license. Normally, a separate license application is submitted for each proposed use, although several related uses may be included in a single application. Each application is evaluated in detail by the Department to insure that adequate provisions are made for compliance with law and regulations and for protection of life, health, and property.

The Department has established the Types B and C Broad Scope Radioactive Material Licenses for the administrative convenience of both the organization and Department. The broad scope format permits a degree of flexibility not possible under the ordinary specific license in use of a wide range of radionuclides in small quantities for research and development and in instructional programs. The Department delegates through the broad scope license authority and responsibility to the organization with respect to "licensing" individual uses of radioactive material. This delegation involves most particularly those matters covered by Section 30194 of the California Radiation Control Regulations. This section requires that findings be made for each proposed use of radioactive material, that the applicant is qualified by reason of training and experience to use the material in the quantity and for the purpose requested, and that equipment, facilities, and procedures are adequate to protect health and minimize danger to life and property.

Responsibility under the Type C delegation is carried out by the Radiation Safety Officer, who is qualified as a user of radioactive material as discussed below. Responsibility under the Type B delegation is discharged by the Radiation Safety Officer and the Radiation Safety Committee. For an organization to qualify for either the Type B or C license, it must institute a comprehensive radiation safety program which includes acceptable details for evaluating proposed specific uses of sources of radiation and for maintaining surveillance over approved uses. An organization must establish a program, whereby technical review of individual uses, their procedures, and facilities will be assured before any project is started.

This pre-review program (equivalent to the licensing procedure of the Department) must be coupled with an internal inspection program, which will insure that all health and safety requirements are being met. The "licensing' and inspection functions must be tied together into a "feed-back" loop through a radiation safety officer. Finally, these operations must be recorded in such a way that compatibility with the Department's statewide program can be demonstrated.

An acceptable program for the administration of the Type B and Type C licenses is outlined below. Except where alternative programs are developed in the application and accepted by the Department, all uses of sources of radiation must be conducted in accordance with requirements developed in this guide.

Administrative Procedures

a. Project Authorization Procedures

(1) Typically, the Radiation Safety Officer will handle requests from potential

users and aid in the preparation of applications. It will also be necessary for the Radiation Safety Officer to document his analysis of the proposed project. This analysis, when combined with the application, must establish that the applicant is qualified by prior training and experience to use radioactive material in the quantity and for the purpose requested and that equipment, facilities, and procedures are adequate to assure safety. In short, the analysis and application must make the showings required by Section 30194 of the California Radiation Control Regulations.

The Radiation Safety Officer may grant authorization for individual uses of radioactive material to those quantities listed for single nuclides under Type C in Part 3c of the Application Form, RH 2082. Proposals where requested possession exceeds this limit must be reviewed by the Radiation Safety Committee as an authorization under a Type B license A critical aspect of the review involves the adequacy of engineering controls for the use proposed. Criteria to be used for guidance in making these decisions are specified and discussed in Appendix A.

(2) Individuals who are proposed as independent users or who will supervise use of sources of radiation by others, must have minimum qualifications as follows:

a) A college degree or an equivalent in the physical or biological sciences or engineering.

b) At least 20 hours of training or practical experience in the characteristics of ionizing radiation, and its radiation dose quantities, radiation detection instrumentation, and biological hazards of exposures to radiation appropriate to the types and forms of radiation sources to be used.

(3) Beyond the minimum requirements, it is necessary for the approval authority to include in a safety review of the proposed use, the qualifications of the user. The Department's form, RH 2050-A: Statement of Training and Experience and the instructions for its completion may be useful in devising a format or form for eliciting this information from prospective users within the organization. Where committee action is required, the application and safety analysis are normally presented to the Committee by the Radiation Safety Officer along with his recommendations.

b. Project Changes and Renewals

(1) Authorizations should expire on the anniversary of issue. Renewals and other changes should be requested in writing. A visit by the Radiation Safety Officer must be made in all cases to confirm that no changes are needed at renewal, or that changes requested do not require amendment of the authorization.

c. Selection of the Radiation Safety Officer and Radiation Safety Committee

(1) The Radiation Safety Officer and chairman of the Radiation Safety Committee will be specified by license condition. Beyond these two positions, staffing of the radiation safety function is a management prerogative not requiring prior approval of the Department.

(2) The Committee should be composed of at least five members consisting of the Radiation Safety Officer and representation from operating groups and administration. Except for administration, all members must be qualified as users.

d. Operations of the Radiation Safety Officer

(1) In addition to review of applications already discussed, the Radiation Safety Officer must assume responsibility for such matters as:

Inspection of ongoing programs, acceptance of new installations, investigations of incidents, enforcement of policies and special requirements, waste disposal, environmental monitoring, preservation of records, facility design, and emergency action.

e. Internal Inspection and Review

(1) Periodic audits of authorizations granted by the approval authority must be made by the Radiation Safety Officer to establish compliance with regulations, authorizations, and good radiation protection practice. The Radiation Safety Officer must establish a frequency for these audits based on potential hazards, provide for recording, and feed-back to management and the Committee.

f. Operations of the Radiation Safety Committee

(Note: A Radiation Safety Committee is required for all Type B licenses and is recommended, but optional, for Type C licenses. The Radiation Safety Officer assumes responsibility for development of organization policy for radiological matters where the Type C licensee elects not to form a Radiation Safety Committee.)

(1) The Committee should hold regularly scheduled meetings on a quarterly basis. Meetings can be called by the Chairman or Radiation Safety Officer at other times to consider applications or special problems which cannot await consideration at the next regular meeting. A quorum for the purpose of conducting committee business should consist of at least a simple majority of the membership, and must include the Radiation Safety Officer or his designated alternate.

g. Program Records

(Note: it is largely through the records of an organization that its effectiveness may be established. While performance is the ultimate standard, in any realistic time scale, only records can provide insight into performance.)

(1) Centralized records of project authorizations must be maintained for all individual projects. These records must include information as follows:

- The location of use.
- The names of all independent users in addition to the name of the principal investigator.

- A resume of each independent user's training and experience, with respect to use of radioactive materials, if such resume is not already on file.

- A description of the nature and purpose of the proposed use.

- A specification of isotopes, forms, activity per procedure and possession limits adequate to cover the proposed use.

- A description of the major steps in the processing and handling of the isotope, including disposal.

- A description of facilities and equipment to be used in processing or storing the isotopes.

- A copy of the authorization from the approval authority to the user which permits the use in question, and contains conditions under which the use may be conducted which have been established by the approval authority following safety review.

(2) The Department's Form RH 2000-F: Application for Non-Human Authorization may be useful in devising a format or form for use of prospective users within the organization.

Records of receipt, transfer and disposal should be kept by the Radiation Safety Officer in a manner such that it is possible from his central files to determine the quantity of material on hand within any individual project. A note card file provides a simple means for satisfying this requirement. The Radiation Safety Officer enters receipts by project. Individual users maintain records of receipt, transfer and disposal for their project, submitting monthly summaries to the Radiation Safety Officer. From these summaries, the Radiation Safety Officer is able to enter transfers and disposals reported as debits for the project. Inventories should be conducted at the time of project authorization renewal as a control on accuracy of inventory records. A radioactive waste disposal log must also be maintained by the Radiation Safety Officer to show nuclides, quantity, date and disposition of all significant quantities of radioactive materials wasted by the organization.

(3) The Radiation Safety Officer must make periodic audits of authorizations for use of sources of radiation granted. A quarterly interval would appear to be an appropriate lower limit on the frequency of these audits. Audits should include reviews of activities to establish compliance with authorizations and good radiation protection practice. In addition, measurements of radiation fields and checks for surface contamination should be included where appropriate. A brief record of observations made by the Radiation Safety Officer during these audits should be maintained to comply with Section 30293(a) (1) of the California Radiation Control Regulations.

(4) If exhaust-ventilated enclosures are required, the user must monitor for surface contamination outside of enclosures to provide indication of loss of control. Applications for uses which require enclosures should include provisions for self-monitoring in radiation safety and operating procedures and descriptions of instrumentation to be employed for this purpose. Results must be recorded for review by the Radiation Safety Officer.

(5) Instruments used for determining levels of radiation or concentrations of radioactive materials in effluents must be calibrated at regular intervals (usually every three months). Records of these calibrations must be maintained.

Radiation Protection Procedures

a. Basic Radiation Safety Principles and Work Rules

(1) Basic radiation safety principles and work rules are discussed and specified in Appendix B to facilitate reference and ease of duplication. An annotated bibliography is also included for rapid identification of resources for additional information.

(2) Beyond material contained in Appendix B. users within the organization will need information, perhaps in the form of radiation safety memoranda, on such matters as:

- Personnel monitoring requirements (film badges, dosimeters, bioassay, etc.)
- Radiation level limits, dose limits (external radiation, surface contamination, airborne contamination, etc.)
- Requirements for survey instruments.
- Posting and labeling rules. Waste disposal methods and limits.
- Required reports and records.
- Procedure for applying for use of sources of radiation.
- Emergency procedures.

b. Personnel Monitoring

(1) California Radiation Control Regulations require that personnel be supplied with and use film badges or other approved personnel monitoring devices, if they enter a radiation controlled area under such circumstances that they are likely to receive more than 10 percent of the appropriate maximum permissible dose equivalents (Reference:10 CFR 20.1201(a)). For persons 18 years of age or older, 10 percent of the MPDE for the whole body is: 500 millirems total effective dose equivalent, 5,000 millirems total effective dose equivalent to any individual organ (Excludes the lens of the eye), 1,500 mrem lens dose equivalent, or 5,000 mrem shallow dose equivalent to the skin or to the extremities per year. For persons under 18 dosimetry is required if they are likely to exceed: 100 mrem deep dose equivalent, 150 mrem lens dose equivalent, or 500 mrem shallow dose equivalent to the skin or to the extremities per year.

(2) Film badge dosimeters should be changed at quarterly intervals where radiation exposure is likely to be nominal. This is normally the situation for students in course work involving radioactive materials, if badging is required at all.

(3) Bioassays and internal dose assessment should be undertaken in all cases where it is known or suspected that an individual has received a significant internal exposure to radioactive material. For purposes of this discussion, an internal exposure should be deemed significant if an intake exceeds 1.6×10^8 times the limit in microcuries specified in: (1) Section 30355, Appendix A, Table I, if the individual is 18 years of age or over; or (2) Section 30355, Appendix A, Table II, if the individual is under 18 years of age. This intake by inhalation will result in 25 percent of the quarterly MPD being delivered to the critical organ in the 50-year period following the intake.

c. Limits of Radiation in Uncontrolled Areas

(1) Maximum permitted levels of radiation fields and concentrations in uncontrolled areas are proscribed by Title 10 Code of Federal Regulation 20.1003 and 20.1402. All releases of facilities and equipment must be based on survey results at background levels. If survey readings are above background, facilities and equipment must be re-cleaned and re-tested until background levels are achieved.

Instruction of Personnel

California Radiation Control Regulations, Section 30255, requires that a licensee instruct his personnel regarding health and safety rules and Stems attendant to the use of sources of radiation. A program for instructing users in matters of radiation physics and biology, policy, and procedures should include material contained in Appendix B. in Radiation Safety Memos issued by the organization, and a lecture program divided into two Phases.

NCRP Report #30, Safe Handling of Radioactive Materials, Section 5.6c (NCRP Publications, Washington, D. C., 1964.)

a. Formal Training of New Users

(1) Responsibility for instruction of new users falls jointly to the Radiation Safety Officer and the individuals' supervisors. The Radiation Safety Officer may conduct general introductory lectures for a group of new users. Instruction in matters specific to projects is most often presented by the supervisor. This training should not be of less than 20 hours in duration and should include instruction in:

b. Periodic Retraining

(1) This may be presented by supervisors and would include instruction in:

- Changes in regulations, state license conditions, and/or local authorizations and their consequences to the individual's operations.
- Changes in operating procedures.
- Emergency procedures.

Technical Capabilities

Existing technical capabilities must be documented in the application. This documentation must include discussions of the following matters:

a. General purpose use

The program for use of radioactive material proposed by the organization should be described in a general way in Part 4b of the application. Indication should be made of the type of research to be carried out by the various departments expected to be working with radioactive materials. Typical uses in instructional programs should be discussed in applications submitted by educational institutions.

b. Organizational Structure

An organizational chart should be submitted as part of the application. This chart should clearly establish management's responsibility for health and safety.

c. Technical Personnel

Brief resumes of training and experience relative to use of sources of radiation must be submitted on Form RH 2050-A: Statement of Training and Experience, for the Radiation Safety Officer and all other members of the Radiation Safety Committee.

d. Instrumentation

Applications must include, in Part 6, descriptions of instruments to be used in the radiation safety program. These descriptions should indicate purpose, functional name, and number available.
Methods, frequency, and standard sources used in calibrating instruments listed should be discussed in Part 7. In general, fixed counting instruments should be calibrated before each use. Portable survey instruments should be calibrated at quarterly intervals.

e. Facilities

Review of specific facilities for compatibility with selection criteria specified in Appendix A of this guide will be delegated to the organization. The application must, however, contain a demonstration in Part 9, that presently existing facilities are adequate to permit use of the quantities of radioactive material requested. This demonstration may include description of:

Hoods. (Face velocity with sash full open)

Glove boxes. (Pressure differential, alarms, fire resistance)

Waste Disposal

(1) The collection, storage, and disposal procedures for radioactive waste should be described. The organization to whom waste is transferred for final disposal should be identified.

(2) Items of particular interest include:

- Description of containers used for dry and liquid waste collection.
- Limits on the time of residence of these containers at the user's location, and storage of the central collection point, if applicable.
- Description of the central collecting point for waste, the security of this storage site against authorized entry and fire.
- Specifications of methods employed to insure that effluent limits in California Radiation Control Regulations are not exceeded if any liquid waste is disposed via the sanitary sewer.
- Description of any waste processing done by the organization. If waste processing such as incineration, evaporation, compaction, etc., are done, detailed written procedures including personnel safety requirements, effluent monitoring and engineering controls must be supplied.

(Appendix within Appendix N)

WORKPLACES FOR UNSEALED RADIONUCLIDES

BY D. A. Pickler

A search was made for existing guidelines as to the maximum amount of unsealed radioactive material which can be safely used: (1) outside hoods or glove boxes, and (2) in hoods. Of the guidelines examined (References B. C, D, E and H.), only References E and H are definite in this respect. The latter part of this paper proposes a new guideline that, it is believed, has advantages over those of the referenced publications.

Reference A discusses the toxicity of radionuclides which may become incorporated in the human body. Of special interest is the conclusion that, in working with radionuclides, inhalation, rather than ingestion, is the most significant mode of entry in the body because ingestion is usually more readily controlled or avoided by taking simple precautions. Accordingly, in that document radionuclides are classified as to toxicity based on two factors, the MPI (annual inhalation maximum permissible intake) in microcuries and the MPI in milligrams. The MPI in microcuries is the only factor used for radionuclides of higher specific activity. With radionuclides of lower specific activity both factors are used, the MPI in micrograms being used to "downgrade" the toxicity because of the smaller probability of breathing significantly harmful amounts of radioactive material with lower specific activity. All radionuclides with an MPI of over 10 milligrams are classified as "low" toxicity. All radionuclides with an MPI of between 0.1 and 10 milligrams which would be classified as "high" toxicity based solely on MPI in microcuries are classified as "upper medium" toxicity. Thus, for example, strontium—90 is classified as "high" toxicity and natural uranium and natural thorium are classified as "low" toxicity although the MPI in microcuries is greater for strontium—90 than for natural uranium or natural thorium.

References B and C are very similar to each other. Apparently Reference C was based directly or indirectly on Reference B. Both contain the following table:

Type of laboratory or working place required

Relative radiotoxicity of isotopes	Minimum significant quantity	Type C Good chemical laboratory	Type B Radioisotope laboratory	Type A High level laboratory
Very High	0.1 uC	10 uC or less	10 uC – 10 mC	10 mC or more
High	1.0 uC	100 uC or less	100 uC–100mC	100 mC or more
Moderate	10 uC	1 mC or less	1 mC - 10 C	1 C or more
Slight	100 uC	10 mC or less	10 mC – 10 C	10 C or more

References B and C also contain a statement as follows on modifying factors to be used with the above table:

Procedure of operation	Modifying factor
Storage	X 100
Very simple wet operations	X 10
Normal chemical operations	X 1
Complex wet operations with risk of spills	X 0.1
Simple dry operations	X 0.1
Dry and dusty operations and those where isotopes are evolved as gases	X 0.01

Each of the more generally used radionuclides is listed under one of the four radiotoxicity classifications in the first column of the table. The method of classification is not specified except in a very general manner.

In Reference B the equipment required for type A, B. and C laboratories or working places is described only in a very general manner. No statement is made as to whether type B and C facilities should include hoods or glove boxes or both. The statement is made that "in general, type A laboratories will use glove boxes or other completely enclosed systems".

Reference C describes in considerable detail guidelines for design of a type B laboratory, including guidelines for design of hoods and glove boxes. Although References B and C provide guidelines for the amount of material which can be safely used in type A, B. and C facilities, neither provides guidelines for the amount of material which may be safely used in hoods nor for the amount of material which may be safely used in facilities with neither hoods nor glove boxes.

Reference D divides the more commonly used radionuclides into four groups, "very high hazard", "high hazard", "medium hazard", and "low hazard" for the soluble forms. It contains no classification for the insoluble forms. For "normal chemical operations" a given amount of a radionuclide is a "low level" amount, a "medium lever' amount, or a "high level" amount (with borderline areas extending for a factor of 10), depending upon the group to which it belongs, as shown in Table 2 of that document. Factors for use other than "normal chemical operations" are the same as for References B and C. To illustrate differences in grouping of radionuclides in References B and C on one hand, and Reference D on the other, strontium—89 is listed as "high" in References B and C, but as "medium" in Reference D, while sodium—22 is listed as "moderate" in References B and C, but as "high" in Reference D.

Reference D states that for low-level work an ordinary fume hood such as is used in chemical laboratories may be used; it also states that for highly toxic or high level radioactive material, the velocity through hood openings must be 125 to 200 fpm. No amount of radioactive material is specified as small enough for use outside a hood, or as too large for use in a properly designed and operating hood.

Reference E also divides the more commonly used radionuclides into four groups: "very high", "high", "moderate", and "low". It lists some radionuclides not mentioned in References B and C, and does not include some radionuclides listed in those documents. Uranium—233 is classified as "very high" in References B and C, and as "high" in Reference E. Natural uranium is classified as "high" in References B and C, and as "low" in Reference E.

Reference E includes the following equation to obtain a guide to the type of workplace required: H = QTU, where

H = Hazard guide value
Q = Quantity of radionuclide (in uc)
T = Relative toxicity factor U = Use factor

Relative toxicity factor (T) is 100 for radionuclides classified as "very high", 10 for those classified as "high", 1 for those classified as "moderate", and 0.1 for those classified as "low". The use factor is as follows:

Type of Operation	Use Factor (U)
Storage	0.01
Very Simples, wet	0.1
Normal	1
Simple, dry	10
Complex, wet	10
Dry and dusty	100

The workplace required is a function of the hazard guide value (H) as follows:

Hazard Guide Value (H)	Workplace Required
Less than 100	Type I
100- 1000	Type II
More than 1000	Type III

Type I is described in some detail and is essentially a good laboratory, but with no hood or glove box required. Type II is also described in some detail, including a minimum requirement that operations be carried out in hoods. Type III is also described in some detail, including a minimum requirement that operations be carried out in gloved boxes.

Reference H provides a guideline based on eight toxicity groups, but with no allowance for variations according to procedures and operations. The eight groups are chosen to correspond to the eight orders of magnitude over which the estimated maximum doses per curie range for the various nuclides when they are delivered in a single intake by inhalation.

The following disadvantages are listed for the above-described methods of establishing guidelines for workplaces for radionuclides:

1. References B. C, and D do not establish guidelines for operations requiring hoods and glove boxes.

2. Reference E does not assign a use factor for gases and volatile materials. Reference H does not assign and use factors.

3. Radionuclides are classified into groups, with each group assigned a relative toxicity factor of 10 greater than that of the less toxic group adjacent to it, resulting in the following conditions:

    a. Many radionuclides are not listed in any of the groups.

    b. The classification does not take into account the chemical form of the radionuclide. For example, each guide either considers soluble material only, or there is no distinction between soluble and insoluble forms, although the MPC in air may be quite different for soluble and insoluble material; for radium—226 the MPC in air for soluble and insoluble material is different by a factor of about 6,000. However, care should be exercised in classing a highly toxic material as "insoluble". For example, radium sulfate might be thought of as "insoluble" as its solubility is listed (Reference F) as 2x10—8 gm/cc at 25 degrees centigrade and 5x10—8 gm/cc at 45 degrees centigrade. If one assumes that the solubility is 4x10—8 gm/cc at body temperature and that the amount dissolved in the gastrointestinal tract from a single large ingestion of radium—226 is equal to the amount which can be dissolved in one liter of water (a purely arbitrary assumption), by using the data in Reference G it is men that, under these conditions, 1.1 microcuries of radium—226 (11 times the maximum permissible body burden) could be expected to be deposited in bone from this one ingestion of "insoluble" material.

    c. Relative toxicity between the most toxic and the least toxic of the 4 groups of References B. C, D, and E is assigned a value of 103. However, the MPC in air for hydrogen—3 (soluble) is greater than that for plutonium—239 (soluble) by a factor of about 107.

To eliminate the above listed disadvantages, it is suggested that a new guide for workplaces for unsealed radionuclides be set up. This guide would, like those discussed above, be for protection against internal exposure only, and would not consider external radiation. The guide would be based on MPC's for air as stated in Handbook 69, except that the criteria for radioactive material of very low specific activity would be different from that for other radioactive material. Handbook 69 is suggested as a basis for the guide because it is widely distributed and contains information on all commonly used radionuclides for both soluble and insoluble forms. The exact formulas would have to be arbitrary to some degree, as are all such formulas. The criteria and formulas below are suggested as such a guide; recommendations are welcomed for modifications of either the criteria or formulas or both. Of course exceptions to the guide would be made whenever it is reasonable to do so.

I. Based on experience, natural thorium, thorium—232, natural uranium, uranium—235, and uranium— 238 need not be handled in a hood or glove box provided the material is in a form which is neither volatile nor apparently contains respirable size particles.

II. For radioactive material not meeting all the provisions of I above, guides are based on the following more or less arbitrary assumptions:

    1. Inhalation is the most significant mode of entry into the body.

2. Each person breathes 107 ml. of air per day while working with radioactive material. (Reference G)

3. The maximum fractional part of radioactive material present which is inhaled per day by any person is as follows:

Procedure or operation	Outside hood or glove box	In hood
Operation involving gases or volatile liquids	10^{-1}	3×10^{-3}
Dry operations with respirable size particles	10^{-2}	3×10^{-4}
Dry operations with apparently no respirable size particles	10^{-3}	3×10^{-5}
Complex wet operations with risk of spills	10^{-3}	3×10^{-5}
Normal chemical operations	10^{-4}	3×10^{-6}
Very simple wet operations	10^{-5}	3×10^{-7}
Storage of gases and volatile liquids	*	*
Storage of solids and non-volatile liquids	**	**

*Storage requirements to be based on leakage rate and on maximum credible accident. **Storage requirements to be based on maximum credible accident.

Using the above assumptions, one arrives at the following guides (MPC means MPC in uc/ml in air for a 40 hour week):

Procedure or operation	Maximum amount to be handled outside hood or glove box (uc)	Maximum amount to be handled in hood (uc)
Operations involving gases of volatile liquids	MPC x 10^{8}	MPC x 3 x 10^{9}
Dry operations with respirable size particles	MPC x 10^{9}	MPC x 3 x 10^{10}
Dry operations with apparently no respirable size particles	MPC x 10^{10}	MPC x 3 x 10^{11}
Complex wet operations with risk of spills	MPC x 10^{10}	MPC x 3 x 10^{11}
Normal chemical operations	MPC x 10^{11}	MPC x 3 x 10^{12}
Very simple wet operations	MPC x 10^{12}	MPC x 3 x 10^{13}
Storage of gases and volatile liquids	*	*
Storage of solids and non-volatile liquids	**	**

*Storage requirements to be based on leakage rate and on maximum credible accident.
**Storage requirements to be based on maximum audible accident.

III. When radioactive material is handled outside hoods or glove boxes, Reference E requirements for "Type I workplaces" (paragraph D.1. of Reference E) will apply. When radioactive material is handled in hoods, Reference E requirements for "Type II workplaces" (paragraph D.2. of Reference E) will alpha. When radioactive material is handled in facilities designed for containment superior to that of hoots, Reference E requirements for "Type III workplaces" (paragraph D.3. of Reference E) will apply.

References:

A. A Basic Toxicity Classification of Radionuclides, IAEA Technical Reports Series No. 15, 1963.

B. Safe Handling of Radioisotopes, IAEA Safety Series No. 1, 1958.

C. Design Guide for a Radioisotope Laboratory (Type B.), American Standards Association, Incorporated, sponsored by American Institute of Chemical Engineers 1964.

D. National Bureau of Standards Handbook 92.

E. Workplaces for Radionuclides, Lawrence Radiation Laboratory (Livermore) Health Chemistry Manual, Part I, Procedure 701, 1963.

F. Handbook of Chemistry and Physics, 45th edition, The Chemical Rubber co.

G. Health Physics, June 1960.

H. Brodsky, Industrial Hygiene Journal, May—June, 1965, p. 294.

Radionuclide and Use	Guide From Ref. B And C		Guide From Ref. E		Proposed Guides	
	Max. Amt. In Good Chemical Lab.	Max. Amt. In Type B Lab.	Max. Amt. Outside Hood or Glove Box	Max. Amt. In Hood	Max. Amt. Outside Hood or Glove Box	Max. Amt. In Hood
^{3} gas, storage H-3 as H_2	1 c	1000 c	Use not listed		*	*
^{3} gas H-3 as H_2 Chemical operations	100 uc	100 mc	Use not listed		200 mc	6 c
^{3}O, chemical operation (H-3 as H_2 considered volatile)	100 uc	100 mc	Use not listed		2 mc	60 mc
C-14, normal chemical operations	10 mc	10 c	1 mc	10 mc	400 mc	12 c
C-14, chemical operations involving volatile C-14 compounds	100 uc	100 mc	Use not listed		400 uc	12 mc
P-32 (Sol), normal chemical operations	1 mc	1 c	100 uc	1 mc	7 mc	210 mc
P-32 (Insol), dry operations with apparently no respirable size particles	** 100 uc	** 100 mc	** 10 uc	** 100 uc	800 uc	24 mc
S-35 (Sol), normal chemical operations	1 mc	1 c	100 uc	1 mc	30 mc	900 mc
S-35 (Insol), dry operations with apparently no respirable size	** 100 uc	** 100 mc	** 10 uc	** 100 uc	3 mc	90mc

particles						
S-35 (Sol), chemical operations involving volatile S-35 compounds	10 uc	10 mc	Use not listed		30 uc	900 uc
Cr-51 (Sol), very simple wet operations	100 mc	100 c	10 mc	100 mc	10 c	300 c
Fe-59 (Sol), very simple wet operations	1 mc	1 c	100 uc	1 mc	100 mc	3 c
Co-57 (Sol), very simple wet operations	Nuclide not listed		Nuclide nor listed		3 c	90 c
Co-60 (Insol), dry operations with apparently no respirable size particles	** 100 uc	** 100 mc	** 10 uc	** 100 uc	90 uc	2.7 mc
Sr-89 (Sol), normal chemical operations	100 uc	100 mc	10 uc	100 uc	3 mc	90 mc
Sr-89 (Insol), dry operations with apparently no respirable size particles	** 10 uc	** 10 uc	** 1 uc	** 10 uc	400 uc	12 mc
Sr-90 (Sol), normal chemical operations	10 uc	10 mc	1 uc	10 uc	30 uc	900 uc
Sr-90 (Insol), dry operations with apparently no respirable size particles	** 1 uc	** 1 mc	** 0.1 uc	** 1 uc	50 uc	1.5 mc
Mo-99 (Insol), very simple wet operations	10 mc	10 c	1 mc	10 mc	200 mc	6 c
Tc-99 (Sol), very simple wet operations	Nuclide not listed		Nuclide not listed		40 c	1,200 c
I-131 (Sol), very simple wet operations	1 mc	1 c	100 uc	1 mc	9 mc	270 mc
I-131 (Sol), normal chemical operations	100 uc	100 mc	10 uc	100 uc	900 uc	27 mc
I-131 (Sol), chemical operations involving volatile I	1 uc	1 mc	Use not listed		0.9 uc	27 uc
Au-198 (Insol), very simple wet operations	10 mc	10 c	1 mc	10 mc	200 mc	6 c
Hg-203 (Sol), very simple wet operations	Nuclide not listed		Nuclide not listed		70 mc	2.1 c
Ra-226 (Sol), dry operations with apparently no respirable size particles	** 1 uc	** 1 mc	** 0.1 uc	** 1 uc	0.3 uc	9 uc
Ra-226 (Insol), dry operations with apparently no respirable size particles	** 1 uc	** 1 mc	** 0.1 uc	** 1 uc	2 mc	60 mc
Th natural (Insol), dry operations with apparently no respirable size particles	Material not listed		** 100 uc (900 g)	** 1 mc (9 kg)	No limit	
Th natural (Insol), dry operations with respirable size particles	Material not listed		+ 10 uc (90 g)	+ 100 uc (900 g)	0.004 uc (0.036 gm)	0.12 uc (1.1 gm)
U natural (Insol), dry operations with apparently no respirable size particles	** 10 uc (30 gm)	** 10 mc (30 kg)	** 100 uc (300 gm)	** 1 mc (3 kg)	No limit	
U natural (Insol), dry operations with respirable size particles	+ 1 uc (3 gm)	+ 1 mc (3kg)	+ 10 uc (30 gm)	+ 100 uc (300 gm)	0.06 uc (0.18 gm)	1.8 uc (5.4 gm)
Plutoniu-239 (Sol), dry operations with apparently no respirable size particles	** 1 uc	** 1 uc	** 0.1 uc	** 1 uc	0.02 uc	0.6 uc

Americium-241 (Sol), dry operations with apparently no respirable size particles	** 1 uc	** 1 mc	** 0.1 uc	** 1 uc	0.06 uc	1.8 uc

*Storage requirement to be based on leakage rate and on maximum credible accident.
**Amount for “simple dry operations”.
+ Amount for “dry and dusty operations”.

APPENDIX N-1: Basic Radiation Safety Principles and Work Rules

Radiation sources can be divided into two groups when discussing physical principles for preventing or minimizing exposure to ionizing radiation. These groups contain those sources, which are external to the body, and those sources, which are internally deposited within the body.

1. Control of External Exposure

External radiation exposure Tom a given radioactive source is controlled by the distance from the source, the exposure time, and shielding.

Increasing the distance from the source is frequently the most effective and economical means to reduce radiation exposure from gamma rays and other highly penetrating radiations. The radiation field varies inversely with the square of the distance. For this reason, tongs or other long-handled tools should always be used for manipulating radionuclide preparations emitting significant levels of radiation. Radioactive materials should never be picked up with the fingers. Low-level sources can be handled with short forceps that provide a large reduction in exposure when compared with direct skin contact.

Increasing the time of exposure decreases the radiation dose proportionately. It is important to include "dry runs" with non-radioactive material for critical steps in preplanning of all work which may involve substantial radiation exposure.

Shielding the source of radiation will be necessary when the maximum distance and minimum time do not insure a significantly exposure to operating personnel. Shielding for gamma radiation is accomplished by interposing materials, preferably of high atomic number and high density, between the source of radiation and the area to be shielded.

An estimate of radiation dose is a fundamental aspect in preplanning for work with radioactive material.

External radiation from beta rays is rather simply controlled. A few millimeters of solid material is sufficient to totally absorb most commonly encountered beta radiations. Where radioactive material emits both beta and gamma radiations, shipping considerations will be controlled by the gamma radiation. One must also recall that beta rays produce a penetrating x-ray called Bremsstrahlung. The intensity of Bremsstrahlung varies directly with the square of the energy of the beta radiation and the average atomic number of the shielding material. Low atomic number materials such as Lucite or glass should therefore, be used for shielding of beta radiation whenever possibly When working with energetic beta emitters, care must be taken to avoid exposing hands above opened containers where the dose rate can be on the order of rads per minute for commonly used quantities of beta emitters such as phosphorus—32.

2. Control of Internal Exposure

Distance, time and shielding are obviously not available for protection when the source of radiation is internally incorporated into the body. Incorporation of radioactive material into the body is most easily controlled by preventing exposure to unsealed sources of

radioactive material. All significant quantities of unsealed radioactive material must be used inside properly designed exhaust-ventilated enclosures.

In a well-designed low or moderate level laboratory, protective clothing consisting of laboratory coats and rubber or plastic gloves should be worn when working with radioactive material.

A second reason for preventing radioactive contamination is based on interference with technical considerations, avoiding contamination of radiation measuring instruments and gross-contamination of experiments. If this technical contamination is controlled, internal exposure of laboratory personnel will usually not be a serious problem.

3. Work Rules

The following rules of good radiation protection practice should be scrupulously observed by all radiation workers to prevent unnecessary radiation exposure and minimize contamination.

a) **Do** wear lab coats and impermeable gloves when working with radioactive material.

b) **Do** work with radioactive material in an exhaust-ventilated enclosure.

e) **Do** store and transport containers of radioactive solutions on trays that will hold the contents of the primary container in the event of breakage.

d) **Do** line trays and working surfaces with absorbent paper. Absorbent paper with an impermeable base is commonly available.

e) **Do** keep radioactive solutions in scaled containers.

f) **Do** clearly label all containers of radioactive material and post all radiation and storage areas with the standard radiation warning symbol. Labels on containers should bear the legend, "Caution—Radioactive Materials", an indication of the nuclide and quantity of radioactive material and the date of assay. Placards for posting of radiation and storage areas should bear the legend, "Caution—Radiation Area" or "Caution—Radioactive Materials", respectively.

g) **Do** conduct work with radioactive material in accordance with written radiation safety and operating procedures.

h) **Do** carry out new procedures in a "dry run" with inactive materials before using radioactive material.

l) **Do** monitor around work areas after each procedure where there is any possibility of contamination and otherwise on a regular periodic basis. Keep records of such surveys.

j) **Do** clean up spills promptly.

k) **Do not** eat, drink, smoke or apply cosmetics in areas where unsealed radioactive materials are used.

L) **Do not** pipette by mouth.

Appendix O: Radiation Emergency Procedures

Evaluate situation; remain calm, cool, collected

Maximize security; request assistance

Employ procedures to prevent further radiation dispersion

Remain in vicinity to aid and assist

Give essential information to authorities

Enforce radiation safety regulations

Never delay report

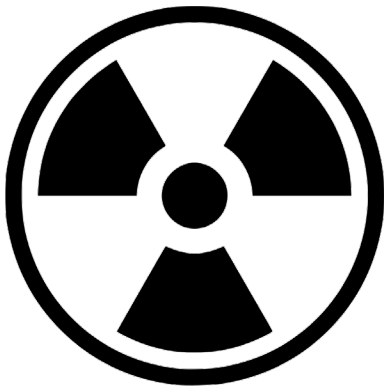
Clarify situation, by phone-radioactive spill, explosion, fire, injuries etc.

You will receive immediate assistance

- PHONE-

RADIATION SAFETY OFFICE
in the
ENVIRONMENTAL HEALTH & SAFETY DEPARTMENT
(Ext. 75179) OR RADIATION SAFETY OFFICER AT (909) 208 - 2258

After 5:00 P.M. and Weekends – Phone University Police Department
(DIAL 911)



<u>Authorized User(s)</u>

Name:
Office Extension:
Home Phone: ( )

Name:
Office Extension:
Home Phone: ( )

Appendix P: Sealed Source Leak Test Procedure

1. Minimum Detectable Activity Calculations

   Liquid scintillation count is a very good method for counting alpha and beta particles. The sealed sources to be leak tested by the University are either alpha or beta emitters as listed below.

- Alpha Emitting Sources (Energy Range 4.7 to 6.12 MeV Probability of Alpha Emission during Decomposition >95%)
- Am-241 (present in Am/Be sources)
- Cf-252
- Cm-244
- Ra-226

- Beta Emitting Sources (Energy Range 0.067 to 1.48 MeV Probability of Beta Emission during Decomposition >95%)
- Co-60
- Cs-137
- Ni-63
- Tl-204

   For our instrumentation the ideal calculated efficiency for tritium, a low energy beta emitter, is 35%. Of the isotopes present in the sealed sources to be leak tested, the lowest energy beta emitter is 0.067 MeV which is greater than the corresponding energy for the tritium beta. Therefore, the efficiency for counting these beta emitters will be higher than 35%. Efficiency for counting alpha emitters is greater than that for beta emitters. Therefore, the efficiency for counting the alpha emitters should also be greater than 35%.
   But to be conservative, the University will assume a conservative value of 10% efficiency for both alpha and beta emitters. The leak test samples are counted for 2 minutes and the background is 31 cpm. The following calculations for the minimum detectable count rate are as follows:

   MDCR = 1.64 (CRb/Tb + CRb/Ts) 1/2

   = 1.64 (3 1/2 + 3 1/2) 1/2

   = 9.13 counts per minute

   MDA = MDCR/Efficiency

   = 9.13/0.10

   = 91.3 dpm or 4.11 x 10-5 microcurie

   This value for the minimum detectable activity is well below 0.005 microcurie.

2. Leak Tests will be performed by trained staff members in Environmental Health & Safety.

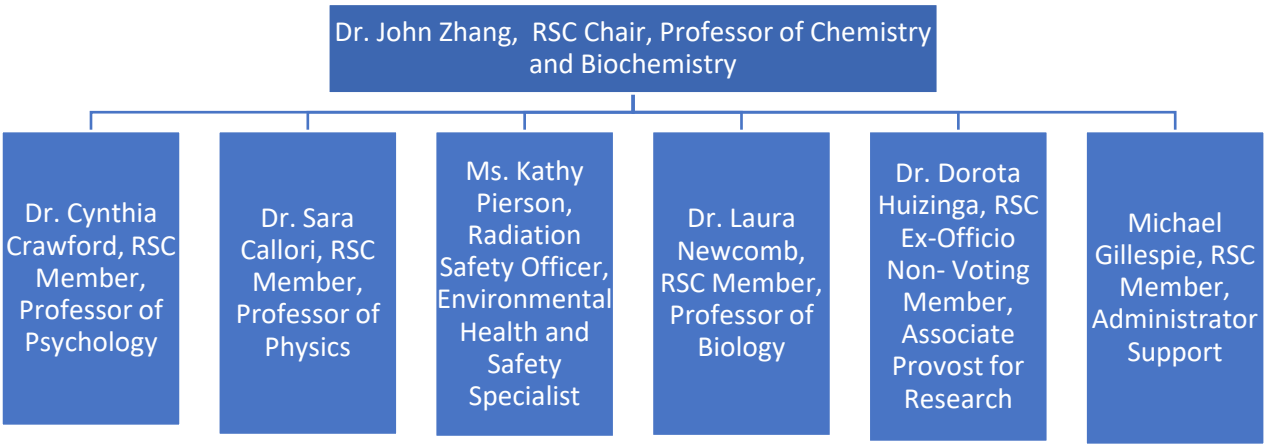
3. The training will be the same training required for authorized users as specified in Section VI of the Radiation Safety Program.

4. Sources to be leak tested will be wiped with a one inch filter paper circle, or equivalent,

which has been moisten with isopropyl alcohol.

5. The exposed wipes will be placed in a large counting vial with 10 milliliters of liquid scintillation cocktail and counted in a liquid scintillation counter.

Appendix Q: Radiation Safety Committee Members



Appendix R: Radiation Safety Manual

Introduction

Purpose of use of radioactive materials

Radioactive materials (also referred to as isotopes or radionuclides) can be used for research and development as defined by Section 31175(j) of the California Code of Regulations Title 17 and for instructional programs. Radioactive materials will be utilized for research projects by University faculty and their students. In addition, radioactive materials will be used in student teaching laboratories to teach students the nature, hazards, safe use and detection of radioactive materials. The majority of the projects will use less than 1 mCi of material.

Safety Issues

The purpose of the campus procedures and regulations are to reach personal exposures to ionizing radiation which are As Low As Reasonably Achievable (ALARA). The purchase and use of radioactive materials is only allowed by authorized individuals for specific approved projects. Each user is additionally responsible for meeting these regulations and handling the materials in the safest possible (and practical) manner.

Regulations

The campus use of radioactive materials is regulated by the Federal government standards described in 10 CFR Part 20 and by the California Code of Regulations Title 17. The campus is licensed to possess and use specific radioactive materials by the California Radiologic Health Branch of the Department of Health Services under license number 1874-36 which expires on April 22, 2005. Timely renewal dated March 25, 2005 received and available for review. We are currently under amendment number 17 of the license. All users of radioactive materials must follow these published regulations. Copies of the regulations are available in the Academic Research Office, FB-108 or from the RSO, ES-105.

Administrative Structure Facilities and Equipment

The Schools of Natural Sciences and Social and Behavioral Sciences have student teaching laboratories and research laboratories in which radionuclides will be used. Storage of radioactive materials is limited to Controlled Areas, Authorized User research labs, or a designated Radiation Safety Lab and Storage Room (BI- 30E). Each of these rooms is kept locked at all times and access is limited to authorized personnel or their assistants. Radioactive material is utilized in student laboratories (only exempted sealed sources) for selected experiments and all radioactive materials, including waste, are removed at the end of the lab session.

Make	Model	Description	Location	Purpose for Which Used	Calibration Frequency
Perkin-Elmer Tricarb	4810 TR	Liquid Scintillation Counter	SBS-011	Research and Wipe Surveys	Annual
WM Johnson	DSM 525	Survey Meter (Exposure / Count Rate)	ES-102	Surveys	Annual

Additional equipment for use with radionuclides includes lead storage containers, lead lined gloves, a 2-foot remote tongs, Plexiglas shields and storage cabinets.

Program Administration and Responsibilities

A. Associate Provost for Research

1. The responsible administrator for the radioactive material program under California Material License number 1874-36.

2. Requires a policy of complying with all required codes, standards and regulations and also requires that exposures to and releases of, radionuclides shall be as low as practicable.

3. Administrates the overall program as it affects each academic department.

4. Appoints the Radiation Safety Officer, the Administrative Representative, and the members of the Radiation Safety Committee

5. Has right of entry into each area where a radionuclide or source material administered under the license is ordered, stored, used or disposed of.

6. Has the authority to issue Stop Use Orders.

7. Delegates responsibility and authority to each of the following.

B. Radiation Safety Officer (RSO)

1. Responsible for assuring radionuclides are received, stored, used, surveyed and disposed of in a safe and healthful manner and that possession limits are not exceeded.

2. Acts as liaison with representatives from other governmental agencies on matters concerning health and safety, licensure, inspections, shipping and receiving.

3. Has right of entry into each area where a radionuclide or source material administered under the License is stored, used, or disposed of and in areas included under a Project Authorization.

4. Has authority to issue and remove Stop Use Orders.

5. Inspects, monitors, surveys and inventories and prepares related records and reports.

6. Has authority to restrict entry, place and remove radiation warning ribbons, place and remove "Tag Out" signs.

7. Has authority to monitor and receive shipments of radionuclides and prepares related records and reports.

8. Has the authority to dispose of radionuclides and prepares related records and reports.

9. Determines the need for preparing new and up-dating existing documents and procedures that relate to the radiation health and safety program.

10. Is a member but not the Chair, of the Radiation Safety Committee.

11. Provides consultative services to faculty, staff or students who are preparing applications to become Independent Users (Form RH-2050-A) or are preparing an application for Project Authorization.

12. Inspects the central record system to assure that records are complete.

13. Provides services for training Independent Users when requested.

14. Provides services for training University personnel that are associated with the radiation health and safety program.

15. Assures that necessary supplies and equipment are purchased.

16. Assures the availability to Radiation Safety Officer, the Institutional Official., The Radiation Safety Committee and each Authorized User under a Project Authorization, of required and necessary codes, standards and regulations.

17. Prepares and sends an annual report in June, to the State of California, Department of Health Services. The report will include a summary of the June meeting of the Radiation Safety Committee plus an up-dating of the status radiation health and safety program.

18. Is responsible for having survey meters and other safety monitoring equipment calibrated annually.

C. Administrative Representative

1. Appointed by the Institutional Official.

2. Represents the Institutional Official on the Radiation Safety Committee.

3. Is a member of the Radiation Safety Committee.

4. Prepares the minutes of the Radiation Safety Committee Meetings.

5. Maintains the central record system for all matters required under or pertaining to, California Material License number 1874-36.

6. Tracks due dates for fees, renewals, correspondence, monitoring, disposal and calibrations of instruments.

7. Assures that required renewals, forms, correspondence, file records, monitoring, purchases and calibrations are completed in a timely manner (RSO duty?).

D. Radiation Safety Committee

1. Subscribes to a policy
    a. of complying with pertinent codes, standards and regulations; and
    b. that exposures to and releases of radionuclides shall be as low as practicable.
2. Each member with the exception of the Administrative Representative must be an Independent (Authorized) User.

3. Each member is a voting member.

4. A quorum is required in order to do business or take official action related to or required by the conditions required under California Radioactive Material License number 1874-36.

5. A quorum shall be one-half of the members at any meeting called by the Chair. In order for the Committee to take official action, a majority vote (i.e., more than half) of the members present is required.

6. Elects a Chair for the next fiscal year at the annual June Meeting.

7. Requires Project Authorization for all projects involving the use of radionuclides or sources of radiation. Project Authorization is required even when the quantity of radionuclide or source possessed is exempt from California Code of Regulations, Title 17, Health, California Radiation Control Regulations. The only exceptions are for sealed exempt sources and naturally-occurring sources in geological specimens.

8. Approves, disapproves or suspends each application for Project Authorization.

9. Each Project Authorization automatically expires 12 calendar months after the approval date. In special cases (e.g., approving for more than 12 calendar

months or approving an effective date beginning in a later fiscal year) an exception can be made. Each exception shall be documented in writing and the documentation shall be forwarded by the Radiation Safety Officer to the Radiological Health Branch within 30 days of the approval date. If there is an objection from the Radiological Health Branch, the Project Authorization will be amended or cancelled and the Radiological Health Branch shall be notified of this action by the RSO within 30 days.

10. Prepares and approves new or up-dated documents and procedures that are required or needed in order to administer the radiation health and safety program.

11. Surveys the use of radionuclides and source materials and provides assurance to the Radiation Safety Officer and the Institutional Official that health and safety is adequately protected and that codes, standards and regulations are complied with.

E. Chair, Radiation Safety Committee

1. Is member of the Radiation Safety Committee, but cannot be the Institutional Official, Administrative Representative or the Radiation Safety Officer.

2. Has right of entry into areas under the jurisdiction of the Radiation Safety Committee.

3. Calls meetings of the Radiation Safety Committee. An annual meeting is required each June. Additional meetings may be called as necessary throughout the fiscal year.

4. Presides over Radiation Safety Committee Meetings.

5. Signs for actions taken by the Radiation Safety Committee.

F. Independent (Authorized) User under a Project Authorization

1. Assures that than up to date State of Training and Experience Form (Form RH-2050-A) is submitted to the Radiation Safety Committee

2. Prior to the beginning of each project, applies to the Radiation Safety Committee for Project Authorization. Re-applies for Project Authorization prior to expiration for continuing projects.

3. Assures that radionuclides and sources are purchased, received, stored, used, surveyed and disposed of in a manner required by California Code of Regulations, Title 17, Health, California Radiation Control Regulations; California Radioactive Material License number 1874-36 and the approved Project Authorization.

4. Assures that exposures to and releases of radionuclides are as low as reasonably achievable.

5. At the end of each Project Authorization, assures that areas where radioactive materials have been used have been properly decontaminated and that wastes have been properly disposed of. Assures that un-used radioactive materials have been properly transferred to the Radiation Safety Officer for storage. Requests that the Radiation Safety Officer do a final inspection of each area included under the Project Authorization.

G. Radiation Safety Committee Members Information

	Member	Department	Office	Telephone
1.	Dr. Cynthia Crawford, Professor of Psychology ccrawfor@csusb.edu	Psychology	SB-524	909-537-7416
2.	Ms. Kathy Pierson, Radiation Safety Officer kpierson@csusb.edu	Environmental Health & Safety	ES-108	909-537-3091
3.	Dr. Sara Callori, Physics Professor scallori@csusb.edu	Physics	PS-114	909-537-5317
4.	Dr. Laura Newcomb, Biology Professor dcoffey@csusb.edu	Biology	BI-310	909-537-5542
5.	Mr. Michael Gillespie, Research Compliance Officer mgillesp@csusb.edu	Office of Academic Research	AD-160	909-537-7588
6.	Dr. Dorota Huizinga, Associate Provost for Research shull@csusb.edu	Office of Academic Research	AR-111A	909-537-3064
7.	Renwu 'John'Zhang, Chemistry Professor rzhang@csusb.edu	Chemistry	CS-307	909-537-5446

H. Emergency Procedures

In the event of a spill, carry out the following procedures:

1. Notify all persons in the room immediately.
2. Allow only those persons to remain in the room necessary to deal with the spill.
3. Put on protective equipment as necessary (lab coat, gloves, and boots).
4. Confine the spill immediately. Cover with absorbent paper.
5. Clean the area from the outside in. Use a monitor to check that the area is properly decontaminated.
6. Dispose of all contaminated waste appropriately.
7. Contact the Radiation Safety Officer.

If the spill is large, or you do not feel confident in decontaminating the area, immediately call one of the persons in the list on the following page.

1. Personnel to Contact in Case of an Emergency

In case of emergency involving radioactive materials, contact only the appropriate people from the following ranked order list:

Office or Person:		Telephone Number:	Location on Campus:
1.	Your Instructor or Supervisor		
2.	Public Safety (Campus Police Department)		
	Emergency	**Dial 911**	
	Business	909-537-5165	UP-104
3.	Kathy Pierson *Radiation Safety Officer (RSO)* kpierson@csusb.edu	909-208-2258 909-537-3091	ES-108
4.	Teresa Fricke *Environmental Health & Safety Director* teresa.fricke@csusb.edu	909-537-5179 909-453-7763	ES-103
5.	Dr. Cynthia Crawford *Professor of Psychology* ccrawfor@csusb.edu	909-537-7416	SBS-524

I. Radioactive Material Use

Type and limits allowed by license

a. Nuclide	b. Chemical and/or Physical Form	c. Possession Limit
A. ^{3}H	Any	10 millicuries
B. Any listed in Section 30356, Appendix B with atomic numbers 3 - 83	Any	Not to exceed 100X the quantity listed in Appendix B for any one source. Total not to exceed 20 millicuries.
C. Any listed in Section 30356, Appendix B with atomic numbers 3 – 83 millicuries.	Sealed sources	Not to exceed 1 millicurie per source. Total not to exceed 5
D. Any listed in Section 30356, Appendix B with atomic numbers 84 - 105 except source and SNM.	Any	Not to exceed 100X the quantity listed in Appendix B for any one source. Total not to exceed 10 microcuries.
E. Any listed in Section 30356, Appendix B with atomic numbers 84 - 105 except source and SNM.	Sealed sources	Not to exceed 1 millicurie per source. Total not to exceed 5 millicuries.
F. Source material	Any	2.29 mCi
G. Iodine 125	Any	Not to exceed 10mCi
H. Phosphorous 32	Any	Not to exceed 1mCi

J. Personal Exposure Limits

In general, radiation exposure shall be As Low As Reasonably Achievable (ALARA), but in no case shall the exposure exceed the limits specified below, as per 10 CFR 20 Subpart C. (Note: the limits include combined exposures at CSUSB and other locations.)

Dose (in mrem)				
Organ	**Year**	**Quarter**	**Month**	**Week**
Whole Body	5,000	1,250	400	100
Forearms, hands, feet	50,000	12,500	4,100	960
Skin of whole body	50,000	12,500	4,100	960
Lens of eye	15,000	3,750	1,250	280
Minors (under 18)	500	125	40	10
Pregnant women	500	125	40	10

K. Training

1. Faculty

Most faculties have been trained in the use of radioactive materials during the course of their education or prior research training. Those faculties who have not received training previously and who wish to become Authorized Users will be trained by the Radiation Safety Officer in the nature of radioactivity, the measurement of radioactivity, the interaction of radioactivity with matter including biological organisms, and the proper handling and disposal of radioactive materials. Documentation of training will be provided in the Statement of Training and Experience (RH 2050A).

2. Students

Students use radionuclides either as a part of a class activity or as part of a research project. Specific instruction and supervision is provided by the class instructor or by the research supervisor. The instructor or research supervisor must be Authorized Users and must have a current Project Authorization.

3. Lab Personnel

Instructional Lab Support Technicians have been instructed in the proper handling and disposal of radioactive materials. These technicians are not involved in the use, instruction or supervision of students or others.

4. Others (housekeeping, security, etc.)

This group does not use, instructor supervise the use of radioactive materials. Custodians and Campus Police personnel are instructed not to disturb the equipment and facilities where radioactive materials are utilized and are instructed not to dispose of waste labeled as radioactive.

5. Training and Continuing Education

a. Basic Training

All persons using ionizing radiation, or working in areas where ionizing radiation is used, shall receive basic training from the RSO. These persons include all Users, faculty, staff, students and ancillary personnel. Basic training shall include but is not be limited to the following:

- Annual dose limits
- Identification of use areas
- Potential hazards
- Pregnancy policy
- Current regulations
- License conditions
- Duty to report unsafe condition

The RSO or designated representative schedules Radiation Safety orientation training for all Users and Ancillary Personnel prior to use and before working in the vicinity of Radioactive Materials. XUR Principal Investigators are to notify potential new users or ancillary personnel of the required radiation safety training and to have them contact the RSO at x73091.

b. Additional Training for Users

- The RSO will explain particular aspects of the University's license as it applies to the User's work. The approved XUR will be reviewed in detail and all applicable forms will be disseminated.

c. Refresher Training

- Refresher training shall be provided at least annually to all persons working with ionizing radiation. The RSO or designated representative schedules annual Radiation Safetyrefresher trainings for Users and Ancillary personnel.

d. Visiting Researcher Training

- Visiting researchers who will be working with radioactive material must receive Basic Training from the RSO. Visitors must be listed on the XUR's approved personnel list.

e. Training Documentation

- CSU San Bernardino will maintain training documentation for inspections.

L. Project Application

Each person responsible for a project must be an Authorized User. This person must complete the Statement of Training and Experience Form (Form RH-2050-A, Appendix B above) which is submitted to the Radiation Safety Committee. For each project utilizing radioactive materials, including classroom use, a Project Authorization must be approved by the Radiation Safety Committee. The Project Authorization is valid for a period of **one year only**. At the end of each year, the Authorized User may reapply.

PROJECT AUTHORIZATION FORM

1. Individual(s) responsible for this project: _____

   _____

2. Beginning and ending dates for this project: _____

3. Licensee authorizing project: Office of Academic Research
   California State University at San Bernardino
   Under license number 1874-36

4. Radionuclides used in project:

Source	Quantity	Form	Sealed / Unsealed	Possession Limit of License

5. University or other facilities to be used:

   _____

6. Will experimental animals be used? _____
   If yes, what kind of animals? What is the activity per carcass? What is the method of disposal? Date of Institutional Animal Care and Use Committee (IACUC) approval:

7. Will an airborne radioactive gas, vapor or aerosol be generated? _____

If yes, what will become airborne? What is the quantity that will become airborne? How will it be contained? What is the method of disposal?
How will it be monitored?

8. Description of the project, including the hazardous operations.

9. Description of methods and equipment used to reduce risks to humans and the environment to "as-low-as-practicable" levels. Include training of students and other lab personnel. How will exposure to personnel be monitored?

10. Will students be involved in this project?_____. If so, please attach or forward the names of all students involved in this project either currently or in the future. Include a written description of the training in radioisotope use which the students have received.

11. Special requirements from Radiation Safety Officer (RSO) and Radiation Safety Committee (RSC).

    a. Include the following wording on purchase order for every purchase of a radionuclide:

    "Approval by the Radiation Safety Officer:_____, Kathy Pierson. The California Radioactive Materials License Number is: 1874-36 (Expiration Date: 4-22-2028). After arrival at CSUSB, hold in the Receiving Department until shipment is inspected. Please contact Kathy Pierson, RSO at extension 73091, mobile 909- 208-2258 or Cynthia Crawford, Professor of Psychology at extension 77416 to make arrangements for inspection of shipment and delivery to Authorized User."

    b. Contact the RSO for disposal of radionuclides.

    c. At the end of the project, contact the RSO for pick-up of remaining radionuclides and for inspection/survey of the facilities used.

    d. **Attach a drawing of the room in which the radioisotope will be used**. Use this drawing to indicate where surveys or swipe tests have been done at either the end of each laboratory exercise (for classroom), the end of each experiment, or at a minimum of monthly intervals.

    e. Waste disposal: All liquid waste containing radionuclides will be collected and transferred to the RSO after labeling with identity and quantity of radioisotope. All dry waste, including gloves, vials, dishes, pipettes, paper towels, and bench paper, will be collected and transferred to the RSO after labeling with identity and quantity of radioisotope.

Printed Name of Applicant:

Signature of Applicant: _____ Date: _____

Approved Signature By:

Radiation Safety Officer _____ Date:_____

Radiation Safety Committee _____ Date: _____

Original: Office of Academic Research
Copies: Applicant, Chair, Radiation Safety Committee, Radiation Safety Officer

M. Procedures for Ordering Radioactive Materials

Radioactive materials may be ordered from commercial sources only after approval of the specific project by an Authorized User. The purchase order form must have the following information included:

"Approval by the Radiation Safety Officer:_____, Kathy Pierson. The California Radioactive Materials License Number is: 1874-36 (expiration date: 4-22-05) and a copy of the "Timely Renewal Letter". After arrival at CSUSB, hold in the Receiving Department until shipment is inspected. Contact Kathy Pierson, RSO at extension 73091, mobile 909 208-2258 or Cynthia Crawford, Professor of Psychology at extension 77416 to make arrangements for inspection of shipment and delivery to authorized user."

1. Receipt of radioactive materials

Upon receipt of radioactive materials at the University, the Receiving Department is instructed to contact the RSO. The RSO will then inspect the shipment for accuracy of items and survey the source container and the packaging material for evidence of leakage. The following Radioactive Material Shipment Survey and Receipt Report will be completed for each shipment and an Accession No. will be assigned for each radioactive source. Upon approval by the RSO, the material will be delivered to the Authorized User.

N. Inventory

During each use of the radioactive material, the Authorized User must keep a log of the amount of radioactivity removed. In addition, the amount of dry, liquid and scintillation waste must be determined and written in the log. Monthly, the amount of radioactive material used, decayed and disposed must be indicated on the Radionuclide Inventory Report (as follows). Use the Isotope Use Record (following page) for daily logs. The Radionuclide Inventory Report is due in the Associate Provost's Office at the end of June of each year.

If the inventory report is not received, a Stop User Order may be issued and no further use of radioactive materials may continue in the Users laboratory.

Radionuclide Inventory Report

Authorized User:	
Beginning and Ending Dates of Project Authorization:	
Radionuclide: Authorized Amount and Form:	
Half-Life:	

Inventory:

Month	Date	Initial Amount	Used	Decayed	Disposed	Stored	Ending Amount
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							

Isotope Usage Record

Isotope:	
Amount Received:	
Date Received:	
Concentration:	

Date:	Amount Removed:	Dry Waste:	Liquid Waste:

O. Survey

Each user must survey the laboratory or classroom on a periodic basis. Appropriate times to survey would be
a) monthly, b) at the end of each project, or c) at the end of classroom use (ideally the students should do the survey to determine their appropriate handling and detection of the materials), whichever comes first. Records of the survey must be kept and filed in the Office of Academic Research annually or at the end of the authorized project. **If the survey reports are not received, a Stop User Order may be issued and no further use of radioactive materials may continue in the Users laboratory.** Survey records must show the room, the location of the survey and the readings of the radioactive detector. Use a copy of the drawing included with the Project Application Form to indicate the location of each reading. Any reading of greater than
100 DPM at a single location requires that that location be decontaminated and resurveyed. Survey instruments will be determined by the type of radioactive particle released: low energy beta (^{3}H and ^{14}C) should be detected by counting filter paper swipes of an area of at least 100 cm^2 in the liquid scintillation counter; higher energy beta or gamma particles can be detected with a Geiger counter or with a swipe counted in the gamma counter. CPM values should be converted to DPM values to determine the level of contamination.

P. Waste

Two types of waste must be considered: a) radioactive waste with half-lives of less than 90 days and b) radioactive waste with half-lives of more than 90 days.

a) Radioactive waste with half-lives of less than 90 days will typically include ^{32}P (half-life 14.3 days), ^{35}S (half- life 87.9 days) and ^{125}I (half-life 60.2 days). These materials will be stored in the Radioactive Materials Storage Room (BI-30E). The waste will be labeled as to the type and amount of radioactivity and dated. Waste will be kept for a minimum of 10 half-lives before disposal as regular waste or as hazardous waste depending on the material. Following the retention period, waste will be surveyed prior to the disposal to confirm activity has decayed to a level indistinguishable from background.

b) Radioactive waste with half-lives of more than 90 days will typically include ^{3}H (half-life 12.3 years) and ^{14}C (half-life 5,730 years). These materials will be separated as dry waste, liquid waste and liquid scintillation cocktail waste. Dry waste will be kept isolated in the Radiation Storage Room (BI-30E) and labeled with type of radioactive material and approximate amount. The dry waste will be collected for removal from the campus by a licensed radioactive disposal company. Liquid waste will be labeled as to type of radioactive material and amount and kept isolated in the Radiation Storage Room (BI-30E) until disposal by a licensed radioactive disposal company.

Liquid waste from ^{3}H which is in aqueous form can be disposed in the sanitary sewers only by the Radiation Safety Officer or his/her designee under the following conditions. Liquid waste containing ^{3}H will be diluted to a concentration of 10 µCi or less per liter as determined by counting in a beta scintillation counter. The ^{3}H solution will be disposed in the sanitary sewer and tap water will flush the drain for 30 minutes. Samples of tap water give a background reading of approximately 80 DPM per milliliter. Thus, one gallon containing 40 µCi needs to be diluted by 150 gallons to reach background. The daily

average of water effluent from the campus is 94,000 gallons. Therefore, these amounts assure that the radioactive ^{3}H will be diluted well below background levels. The total quantity released per year will be less than five curies of ^{3}H.

If the liquid scintillation cocktail waste containing ^{3}H or ^{14}C is less than 0.05 micro curies per gram (110,000 DPM per gram as determined by scintillation counting) it will be disposed of as nonradioactive hazardous chemical waste.

Q. Personnel Monitoring

Projects which use ^{32}P, ^{22}Na or ^{125}I will require personnel monitoring. Requirements for monitoring during use of all other radioisotopes will be assessed on a case-by-case basis. Ordering and mailing of film badges in a timely manner is the responsibility of the Authorized User. The RSO will assist the Authorized User in determining the appropriate dosimetry for each type of radiation. The monitoring devices will be read at monthly or quarterly intervals as appropriate.

1. ALARA Program

a. The RSC will encourage all users to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

b. The RSC will perform a quarterly review of occupational radiation exposure with particular attention to instances in which the investigational levels in Table 1 are exceeded. The principal purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when investigational levels are exceeded (see below for a discussion of investigational levels).

c. The RSC will evaluate the institution's overall efforts for maintaining doses ALARA on an annual basis. This review will include the efforts of the RSO, authorized users, and workers as well as those of management.

2. Establishment of Investigational Levels in Order to Monitor Individual Occupational Radiation Doses (External and Internal)

This institution hereby establishes investigational levels for occupational radiation doses which, when exceeded, will initiate review or investigation by the RSC and/or the RSO. The investigational levels that we have adopted are listed in Table 1. These levels apply to the exposure of individual workers. The following actions will be taken at the investigational levels stated in Table 1.

a. Personnel Dose Less Than Investigational Level I

Except when deemed appropriate by the RSO, no further action will be taken in those cases where an individual dose is less than Table 1 values for the Investigational Level I.

b. Personnel Dose Equal to or Greater Than Investigational Level I but Less Than Investigational Level II

The RSO will review the dose of each individual whose quarterly dose exceeds

Investigational Level I and will report the results of the reviews at the first RSC meeting following the quarter when the dose was recorded.
If the dose does not equal or exceeds Investigational Level II, no specific action related to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, review each such dose in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

c. Personnel Dose Equal to and Greater Than Investigational Level II

The RSO will investigate in a timely manner the causes of all personnel doses equaling or exceeding Investigational Level II and, if warranted, will take action. A report of the investigation and any actions taken will be presented to the RSC at its first meeting following completion of the investigation. The details of these reports will be included in the RSC minutes.

d. Reestablishment of Investigational Levels to Levels above Those Listed in Table 1

In cases where a worker's or a group of worker's doses need to exceed an investigational level, a new, higher investigational level may be established for that individual or group on the basis that it is consistent with good ALARA practices. Justification for new investigational levels will be documented. The RSC will review the justification for and must approve or disapprove all revisions of investigational levels.

Table 1

Investigational Levels*

	Investigational Levels (mrems per calendar quarter)	
	Level I	**Level II**
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads.	125	375
2. Hands and forearms; feet and ankles	1,875	5,625
3. Skin of whole body	750	2,250
4. Thyroid uptake	0.1 microcurie	0.3 microcurie

* Note that investigational levels in this program are not new dose limits but serve as checkpoints above which the results are considered sufficiently important to justify investigations.

3. Useful Information

Half-Life Values of Selected Nuclides

Nuclide	Half-Life	10 Half-lives
^{32}P	14.3 days	143 days (0.4 years)
^{125}I	60.2 days	602 days (1.7 years)

^{35}S	87.9 days	879 days (2.5 years)
^{3}H	12.26 years	122 years
^{14}C	5,730 years	
^{22}Na	2.6 years	26 years

Note: Our current license authorizes us to hold nuclides with half-lives of less than 120 days for decay-in- storage until a minimum of 10 half-lives expire. Disposal can then occur with regular waste.

Appendix S: X-Ray Producing Equipment Safety Manual

1. Organization and Responsibilities

A. License

California State University San Bernardino (CSUSB) has a specific Radioactive Materials License issued by the State of California Radiological Health Branch. The license contains the specific terms and conditions of radioactive material use at CSUSB, including types, forms, quantities, uses, locations and specific procedures that will be followed. The licensing branch may also impose special licensing conditions for radiation producing machines. The license requires a full-time Radiation Safety Officer (RSO) and an active Radiation Safety Committee (RSC).

B. Radiation Safety Program

The purpose of the Radiation Safety Program is to ensure that work with radiation producing machines is conducted in such a manner as to protect health and keep radiation exposure As Low As Reasonably Achievable (ALARA). Responsibility for enforcement of this policy is vested in the RSC and should be consistent with the goals of the University, while allowing the user freedom in work that is safe and legal.

C. X-Ray Safety Manual

The X-Ray Safety Manual is a formal statement of policy, operating procedures and standards of conduct for CSUSB set forth by the RSC and the RSO. The purpose of the manual is to establish policy and provide guidance for individuals using or having responsibility for the use of radiation producing machines to comply with university policy, university license conditions, the Code of Federal Regulations 10 CFR 20, and the California Code of Regulations Title 17.
Each Principal Investigator (PI) who is authorized to use a radiation producing machine is issued an X-Ray Safety Manual and is responsible for complying with its policies. The PI must keep a current copy of the X-Ray Safety Manual in the laboratory.

D. Radiation Safety Officer (RSO)

RSO is responsible for maintaining the Radiation Safety Program and administering the policies set forth by the University and the RSC. The RSO is responsible for assuring that use of ionizing radiation meets all applicable government regulations and is responsible for the safety of the students, faculty, staff, and general public regarding radiation exposure. The RSO has the authority to immediately terminate any procedure involving radiation producing machines which is judged to be a hazard to the health and safety of the worker or general public. Specifically, the RSO is directly responsible for:

1. Reviewing and evaluating projects;

2. Providing any necessary dosimetry;

3. Providing training materials;

4. Perform radiation surveys.

E. Principal Investigator (PI)

The PI is personally responsible for compliance with University and governmental regulations as they pertain to their authorized use of radiation producing machines. The PI's specific responsibilities include, but are not limited to:

1. Adhering to all requirements contained within the X-Ray Safety Manual and the X-ray Equipment Use Registration (XUR).

2. Ensuring that procedures involving radiation producing machines are performed only by personnel who have read and understand this document and have been properly instructed on the operation of the machine.

3. Notifying the RSO (x75179) promptly of changes in personnel, locations, procedures and proposed XUR changes.

4. Notifying EH&S immediately in cases of suspected occupational radiation exposure, accidents or unusual events.

F. Individual Users

Each user of radiation producing machines has a responsibility to:

1. Log each use of the machine in the required log for each machine to include date, operating parameters, and duration of use.

2. Ensure that the machine and all its components are in a secure/locked area, where only authorized personnel have access.

3. Contact PI or RSO with any questions regarding radiation safety or radiological concern.

4. Wear external dosimeters, if assigned, while using the machine.

2. Dose Limits and ALARA

On January 1, 1994, the revised Code of Federal Regulations, 10 CFR 20, "Standards for Protection Against Radiation," became law. The State of California has also adopted the revised regulation and implementation date. A summary of the entire revision is not presented here. Concepts which may affect radiation safety at CSUSB are given below. If there are any questions regarding the revised 10 CFR 20, please contact the RSO.

A. External Dose Terms and Annual Limits (Adult Occupational)

Deep Dose Equivalent - (DDE) - Whole body dose from penetrating radiation. Penetration depth 1 cm (1000 mg/cm2). Limit is 5 rem/yr

Lens Dose Equivalent - (LDE) - Dose to the lens of the eye from penetrating radiation. Penetration depth = 0.3 cm (300 mg/cm2). Limit is 15 rem/yr

Shallow Dose Equivalent, Whole Body - (SDE(WB)) - Dose to the skin of the whole body from non- penetrating radiation. Penetration depth = 0.007 cm (7 mg/cm2). Limit is 50 rem/yr

Shallow Dose Equivalent, Max Extremity - (SDE(ME)) - Dose to the maximally exposed extremity. Limit is 50 rem/yr

B. ALARA (As defined in Part 10 CFR 20)

"Acronym for **A**s **L**ow **A**s **R**easonably **A**chievable, means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the license activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and license materials in the public interest."

C. Means of Controlling Exposure

Three principles that can be used to reduce external exposure are:

1. Time.
2. Distance.
3. Shielding.

D. Biological Effects Common to Analytical X-Ray Exposure

The majority of radiation exposures from analytical x-ray equipment are localized to specific parts of the body, usually the hands and fingers, rather than to the whole body. Such exposures are usually delivered acutely and during a one-time exposure. Therefore, the biological effects of concern are primarily prompt, somatic effects to the skin.

For x-rays at energies of about 5 - 30 keV, irradiation of the fingers or hands does not result in significant damage to blood-forming tissue. However, at high exposures, some general somatic effects to the skin can occur.

3. Authorization to Use X-Ray Producing Equipment

A. Procedures for Purchase, Use, and Transfer

A department or a Primary Investigator (PI) wishing to procure x-ray producing equipment must obtain prior approval from the Radiation Safety Officer (RSO) before the acquisition or fabrication of a machine is carried out. The RSO needs to be notified with the following:

1. Description of equipment (type of machine, manufacturer, model, year of manufacture,

maximum operating parameters, energy and beam current).

2. Standard Operating Procedures (SOPs), protocol and typical operating parameters.

3. Engineering controls such as, shielding, interlocks, and access control.

4. Once the machine is obtained, any modification in use, design or location of a radiation producing machine, or if sold, traded, transferred or discarded must be approved by the RSC.

5. Notification can be done via the X-ray Producing Equipment Registration (XUR) Form. Call EHS at X75179 to obtain this form.

B. Personnel Dosimetry

Only after the appropriate training on operating procedures and safety protocols have been covered, will dosimetry be provided. All personnel that has been issued dosimetry must wear their personal dosimeters while working with or near the machine when it is producing ionizing radiation. The PI responsible for the machine must ensure that the appropriate dosimeters are worn and returned to PI for assessment.

Personnel dosimeters must not be used to measure beam output nor deliberately placed in the beam.

1. External Radiation Monitoring

   Under the revised 10 CFR 20, personnel dosimetry is required for those workers who are likely to receive 10% of the regulatory dose limit for external sources. Even though the occupational workers at CSUSB rarely approach 10%, dosimetry is used on a case by case basis. The dosimeters should be worn only by the worker to whom they were assigned, and only at CSUSB, as the exposure data becomes part of the worker's permanent exposure history record.

   Dosimeters should remain on campus and be stored in a designated location in the workers primary laboratory. New dosimeters will be issued in the beginning of each calendar month/quarter by the PI or RSO. It is important to keep dosimeters in the proper location in order to expedite the exchange process.

- The external monitoring program uses body dosimeters for determining deep dose, lens dose, and shallow dose and finger rings for determining extremity dose.

- Dosimeters measure x-ray and gamma radiation.

C. Safety Devices

1. Specific safety devices are required by state and federal agencies for each x-ray producing equipment. Example of controls are: warning lights, beam enclosures, interlocks, shielding, and radiation survey meters. All safety devices shall be maintained in good working order, and must not be replaced, or modified without the

RSO approval. No safety device is absolutely fail-safe or foolproof. If a safety device becomes non-operational, the radiation producing machine shall not be operated. The RSO must be notified immediately. The unit will remain non-operational until the device is repaired and inspected by the RSO.

2. A safety device must never be purposely defeated. If the design of a device makes a certain desired operation inconvenient or impossible, another device providing the same degree of protection must be substituted and approved by the RSO. Serious injuries can occur when safety devices are bypassed.

D. Posting and Labeling

Posting and labeling of x-ray producing equipment shall be according to 10 CFR 20.1902. Rooms that are used for medical diagnosis should have a warning light that indicates X-Ray On to alert personnel who may inadvertently enter a room during operation of the machine. The machine operating protocol should be posted near the equipment.

Posting should include a precautionary statement in relation to the dose amount.

1. *Caution X-Rays*: access to a room or area where x-rays are being generated.

2. *Radiation Area*: area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in one hour at 30 cm.

3. *High Radiation Area*: area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in one hour at 30 cm.

4. *Very High Radiation Area*: area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 500 rem in one hour at 1 meter.

E. Machine Location

A room devoted solely to the x-ray producing equipment is preferred. The equipment should be placed in an area that is not in the main traffic pattern of the laboratory or near other continuously occupied work areas. The equipment must be situated so that scatter or stray beams will be directed toward an unoccupied area. Any change in the location of x-ray producing equipment must be approved by the RSO.

F. Surveys

The RSO shall inspect the radiation producing machine installation, whether newly procured, relocated, modified or repaired to ensure proper operation of the unit. The RSO shall survey each machine annually. Users shall perform safety checks on the machine if required by the Radioisotope Use Authorization (XUR).

G. Specific Precautions are required for Analytical X-Ray Machines

1. Know the location and/or presence of the primary and diffracted beams at all

times.

2. Do not intercept the primary or diffracted beams with any portion of the body.

3. Provide and periodically inspect the shielding of the unit.

4. Never disassemble shielding, uncover or remove the x-ray tube, or otherwise perform maintenance without first determining that the tube is not energized.

5. Perform checks of any safety devices at least yearly.

H. X-Ray Diffraction/ Fluorescence Units

Open beam x-ray diffraction units can be very hazardous because of the very high primary beam exposure rates (several 100,000 R/minute) at the x-ray tube ports. Serious damage can result to an individual's eyes and skin, even if exposed to this intense radiation level for a very short period of time. Extreme caution must be exercised in the use of x-ray diffraction equipment. The following are requirements for safe use of x-ray diffraction units:

1. The PI is responsible for ensuring that the x-ray diffraction machine is kept in good working condition, equipment meets specifications, and safety systems are functioning.
2. Personnel working or supervising the x-ray diffraction machine are responsible for notifying co-workers and the RSO of any unsafe operating conditions or machine failures.

3. Appropriate radiation shielding must be installed on each x-ray diffraction unit. These shields should be interlocked to prevent radiation exposure to personnel in the event the shield is removed or opened.

4. All beam shutter mechanisms must be interlocked to prevent operation if the shutter is not properly closed.

5. The authorized user of x-ray diffraction equipment is responsible for ensuring that all personnel operating the equipment understand the radiation exposure potential and are properly trained in operating procedures required for radiation protection. The EH&S Department will provide general radiation safety training and the PI shall provide training for the machines operations and laboratory procedures. This training shall be documented and operating procedures approved by the RSO.

6. All x-ray diffraction units and use areas must be labeled with appropriate radiation caution signs, along with the required operational radiation warning lights.