Radiation Safety Manual
Texas Christian University

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Licenses: L01096 and R00109
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1) DEFINITIONS

a) As low as reasonably achievable (ALARA)-Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the 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 ionizing radiation and licensed sources of radiation in the public interest.

b) Dose-A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent.

c) Dose equivalent-The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the sievert (Sv) and rem.

d) External dose-That portion of the dose equivalent received from any source of radiation outside the body.

e) Internal dose-That portion of the dose equivalent received from radioactive material taken into the body.

f) Lens dose equivalent (LDE)-The external dose equivalent to the lens of the eye at a tissue depth of 0.3 cm (300 mg/cm\(^2\))

g) Radiation area-Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 cm from the source of radiation or from any surface that the radiation penetrates.

h) Radiation safety officer (RSO)-An individual who has a knowledge of and the authority and responsibility to apply appropriate radiation protection rules, standards, and practices, who must be specifically authorized on a radioactive material license, and who is the primary contact with the DSHS.

i) Rem-The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert (Sv)).

j) Restricted area-An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to sources of radiation. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

k) Sealed source-Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material.

l) Shallow dose equivalent (SDE)-Applies to the external exposure of the skin of the whole body or the skin of an extremity. It is the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm\(^2\)).

m) TAC-Texas Administrative Code
n) DSHS-Texas Department of Health Services, Bureau of Radiation Control.

o) Total effective dose equivalent (TEDE)—The sum of the effective dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

2) RADIATION SAFETY PROGRAM MANAGEMENT

a) Appointments

i) The Radiation Safety Officer (RSO) for the university is Scott Dunkle. Scott Dunkle is also the Hazardous Materials Safety Coordinator for the College of Science and Engineering.

ii) The Radiation Safety Committee (RSC) will consist of the RSO, a licensed user faculty member representative from each science department in which radioactive materials or radiation-producing machines are used, and a representative from the administration. These members will be appointed by the RSO. If not the RSO, the Safety Director of the University will be the assistant RSO. The current RSC consists of Scott Dunkle, Safety Coordinator and RSO, Randy Cobb, Safety Director, Joel Mitchell, Kinesiology, C. A. Quarles, Physics, Kayla Green, Chemistry, Chris Hall, Athletics, and Phil Hartman, Dean of the College of Science and Engineering.

b) Responsibilities of the Radiation Safety Officer (RSO)

i) The RSO monitors, updates and determines compliance with established regulations, policies and practices for the licensing, purchasing, shipment, use, monitoring, disposal, and transfer of radioisotopes or sources of ionizing radiation at Texas Christian University. The RSO provides the Radiation Safety Committee (RSC) with a comprehensive briefing on the status of the Radiation Safety Program.

ii) The responsibilities of the RSO include those specified in DSHS §289.252(f)(3), §289.226(t)(2), and those specific to the TCU license. The RSO responsibilities are to:

1. Establish and oversee operating, safety, emergency, and as low as reasonably achievable (ALARA) procedures, and to review them at least annually to ensure that the procedures are current and conform with the latest rules;

2. Oversee and approve all phases of the training program for operations and/or personnel so that appropriate and effective radiation protection practices are taught;

3. Ensure that required radiation surveys and leak tests are performed and documented in accordance with the regulations and these procedures, including any corrective measures when levels of radiation exceed established limits;

4. Ensure that individual monitoring devices are used properly by occupationally-exposed personnel, that records are kept of the monitoring results, and that timely notifications are made in accordance with §289.203;

5. Investigate and cause a report to be submitted to the agency for each known or suspected case of radiation exposure to an individual or radiation level detected in excess of limits established by this chapter and each theft or loss of source(s) of radiation, to determine the cause(s), and to take steps to prevent a recurrence;
Investigate and cause a report to be submitted to the agency for each known or suspected case of release of radioactive material to the environment in excess of limits established by the regulations;

Have a thorough knowledge of TCU management policies and administrative procedures;

Assume control and have the authority to institute corrective actions, including shutdown of operations when necessary in emergency situations or unsafe conditions;

Ensure that records are maintained as required;

Ensure the proper storing, labeling, transport, use and disposal of sources of radiation, storage, and/or transport containers;

Ensure that inventories are performed in accordance with the licensed activities;

To perform a physical inventory of the radioactive sealed sources authorized for use on the license every six months and make and maintain records of the inventory of the radioactive sealed sources authorized for use on the license every six months, to include, but not be limited to the following: (i) isotope(s); (ii) quantity(ies); (iii) activity(ies); (iv) date inventory is performed; (v) location; (vi) unique identifying number or serial number; and (vii) signature of person performing the inventory;

Ensure that personnel are complying with these procedures and regulations, the conditions of the license, and the operating, safety, and emergency procedures of the licensee;

Serve as the primary contact with DSHS;

To have knowledge of and ensure compliance with federal and state security measures for radioactive material;

Terminate any operation the RSO finds to be in continued violation after notification of the corrective actions that should be taken to bring the operation into compliance;

Perform periodic inspections of areas where sources of radiation are stored or used;

See that required records of radiation surveys, inventories of radioisotopes and waste disposal are maintained as appropriate by authorized users;

Administer the rules and procedures developed to control procurement and use of radioactive materials on campus and to approve all radioisotope purchases;

Ensure that annual calibration of survey instruments is performed by a company licensed by the state;

Maintain a comprehensive file on receipt, use, storage, and disposal of radioisotopes, and on all matters pertinent to the Radiation Safety Program;

Ensure that sealed sources have a leak test performed as required by DSHS regulations and to maintain records of these tests;
(23) Review and evaluate safety precautions and procedures for each prospective user of radioactive materials and radiation-producing equipment prior to their using such items;

(24) Maintain and update TCU’s license and radiation-producing equipment registration with the DSHS;

(25) Oversee the disposal of radioactive waste to ensure compliance with the appropriate regulations;

(26) Investigate and provide a written briefing to the RSC, the Safety Director, and university management (as needed) of accidents and serious incidents involving radiation activities, including personnel overexposures, facility contamination, violations of regulations, and deficiencies warranting management concern;

(27) Provide information to the local fire and law enforcement agencies in the event of a theft, fire, explosion, tornado, or vandalism involving radioactive materials on campus;

(28) Call meetings of the RSC at least three times per year to review the progress of the Radiation Safety Program and for any other business that needs to come before the RSC;

(29) Call on any member of the RSC to assist in the implementation of the Radiation Safety Program;

(30) Temporarily transfer the duties of RSO to the Assistant RSO if the RSO is gone from TCU for more than one (1) month; if the Assistant RSO is gone, the RSO duties will be temporarily transferred to another member of the RSC;

(31) Send a letter to users found to be in violation of DSHS and/or university regulations that outlines the corrective action needed to be taken to maintain compliance; failure to follow the corrective action will result in the suspension of the use of radioactive materials or equipment;

(32) Conduct, with the assistance of the RSC, the annual audit of regulations as required by DSHS;

(33) Monitor records of the R values of the inventory to insure that a combination of the unsealed radionuclides requested or authorized on the license, with a half-life greater than 120 days, results in the R of the radionuclides divided by 10^5 being greater than 1 (unity rule), where R is defined as the sum of the ratios of the quantity of each radionuclide to the applicable value in subsection (ii)(2) of section §289.252. This insures that TCU complies with the financial assurance level set by the license and by the DSHS section 289.252(gg)(1)(B) and is not required to file a decommissioning plan. The current structure of TCU’s license is set to ensure compliance and not require a decommissioning plan;

(34) Ensure that any source or radioactive material in the inventory considered obsolete be removed from inventory and properly disposed of;

c) Responsibilities of the Radiation Safety Committee (RSC)
i) The Radiation Safety Committee (RSC) will consist of the RSO, a licensed user faculty member representative from each science department in which radioactive materials or radiation producing machines are used, and a representative from the administration. These members will be appointed by the RSO. If not the RSO, the Safety Director of the university will be the assistant RSO.

ii) A quorum shall be three members. The committee shall meet at least three times per year, and at other times as needed or as otherwise requested by the RSO.

iii) The responsibilities of the RSC include those specified in TAC 289.252(g) and those specific to the TCU license. The responsibilities of the RSC are to:

1. Meet as often as necessary to conduct business but no less than three times a year; the RSO will maintain records of the minutes of the RSC meetings;
2. Review summaries of the following information presented by the RSO:
   (a) Over-exposures;
   (b) Significant incidents, including spills, contamination, or medical events; and
   (c) Items of non-compliance following an inspection;
3. Review the program for maintaining doses ALARA, and providing any necessary recommendations to ensure doses are ALARA;
4. Review the overall compliance status for authorized users;
5. Share responsibility with the RSO to conduct periodic audits of the radiation safety program;
6. Review the annual audit of the radiation safety program and to act upon the findings;
7. Develop criteria to evaluate training and experience of new authorized user applicants;
8. Evaluate and approve authorized user applicants who request authorization to use radioactive material at TCU;
9. Evaluate new uses of radioactive material;
10. Review and approve permitted program and procedural changes prior to implementation;
11. Have knowledge of and ensure compliance with federal and state security measures for radioactive material
12. Assist the RSO in implementing the Radiation Safety Program;
13. Review the policies and practices regarding the licensing, purchase, shipment, use, monitoring, disposal, and transfer to radioisotopes or sources of high-energy radiation;
14. Provide technical support and information to the RSO and/or the Safety Director;
15. Make recommendations to insure that regulations, standards, and policies are followed;
3) RADIATION FACILITIES AND EQUIPMENT

a) General Requirements
   i) The use of all radioisotopes and sources of radiation (exclusive of special nuclear materials) is authorized by the Texas Department of State Health Services Radioactive Materials License number L01096 issued to Texas Christian University. A copy of this license is available for inspection from the RSO.

b) Use of Animals and Animal Carcasses
   i) When animals or animal carcasses are used in research involving radioactive materials, the user will provide the RSO with a description of animal housing facilities; instructions provided to animal handlers on the handling of animals and animal carcasses; the procedures for cleaning and decontaminating cages; and, procedures for securing animal rooms from unauthorized users.

c) Radiation Machines
   i) All X-ray machines and other radiation-producing equipment are required to be registered in accordance with TAC §289.226.
   ii) University personnel procuring radiation-producing equipment must contact the RSO.

4) RADIATION SAFETY PROCEDURES

a) General
   i) Each person authorized to use radioisotopes or sources of radiation are responsible for the safe use of such materials and/or devices. The user must carry out the required administrative and safety procedures; select those laboratory practices that are applicable to the work and consistent with ALARA procedures; train and supervise those assisting and acquaint them with proper radiation safety practices; maintain the required records on inventory, surveys and waste disposal, and ensure that the laboratory is posted with the proper warning signs.

b) Radioactive Materials
   i) Every user of radioactive sources or shall become familiar with the appropriate regulations of this manual and of the DSHS. Copies of all state regulations [25 TAC (Texas Administrative Code)] are available for download from the DSHS web site at www.DSHS.state.tx.us/radiation. Relevant to the radioactive materials safety program at TCU are the rules §289.201, §289.202, §289.203, §289.204, §289.205, §289.251, §289.252, and §289.257.
   ii) General Laboratory Safety Guidelines
      (1) Keep the laboratory clean and orderly at all times.
      (2) Ensure non-essential personnel are not in laboratories when radioactive material is used.
      (3) Label radioactive material containers with the radiation trefoil and pertinent information according to section 5(h)(ii)(3) of this manual.
      (4) Store all radioactive material in a locked room or cabinet.
(5) All unsealed sources or radioactive liquids will be stored in non-breakable, leak-proof containers.

(6) Exercise deliberate care in handling radioactive material and store/transport it in shielded containers, when necessary, to protect against external radiation exposure.

(7) Wear lab coats, rubber gloves, closed-toed shoes, shoe covers, eye protection, and respirators where appropriate. No protective clothing will then be worn when leaving labs.

(8) Cover work surfaces with absorbent paper when unsealed radioactive material is used.

(9) Work with radioactive material should be done rapidly but carefully. Plan work and, if possible, perform practice runs to test procedures.

(10) Never pipette by mouth.

(11) Do not eat, drink, smoke, apply lip balm or cosmetics, or store food and personal effects.

(12) Dispose of radioactive waste only in specially labeled and properly shielded receptacles. Waste management and record keeping should be accomplished according to section (8) of this manual.

(13) Monitor hands, clothing, notebooks, and writing instruments for contamination before leaving an area.

(14) Survey areas where radioactive material in uncontained form is used after each procedure and/or at the end of the day. Decontaminate immediately if necessary.

(15) Check survey meters routinely with a source of radiation to see if they are responding properly. A battery check should be performed before each use.

(16) Wear radiation badges, if assigned, while in areas where radioactive material is stored or used. If assigned, finger badges must be worn when handling radioactive material. Personal monitoring should be performed according to section (6)(d) of this manual.

(17) Use unsealed radioisotopes only in approved laboratories that possess non-porous flooring and work sources, for purposes of easy decontamination.

(18) Only designated sinks will be used for washing contaminated glassware. Sinks will be labeled as such.

(19) Only designated storage boxes, freezers, and refrigerators will be used for the storage of radioisotopes. The storage areas will be labeled as such.

(20) Do not open sealed sources.

(21) Any work with a radionuclide susceptible to atmospheric distribution (e.g. vaporizing, aerosol producing, spillage, dusting, effervescence of solution or other releases of radioactive gas) shall be confined to a designated hood.
(22) Chemical hoods in which radioactive materials are used should be operating according to their specifications. Any hood not working properly should be reported to the RSO, which in turn will contact the Physical Plant for repair. The hood should not be used until it is certified as meeting specifications.

(23) Report radiation accidents involving radioactive material resulting in suspected or known overexposure or cross-contamination of a worker to the RSO as soon as practical.

(24) Signs or labels shall be posted wherever radioactive materials are present. This includes sinks and equipment. Postings shall be according to section (5)(h) of this manual.

(25) The user shall maintain record files on the receipt, use, transfer, storage and disposal of radioisotopes according to section (7) of this manual.

(26) The RSO will be notified before radioisotopes are transferred from one Research Director or authorized user to another. No transfers will be made to unauthorized users.

(27) Control of access into restricted areas is the responsibility of the research director in charge of the project. Security measures should be in place according to §289.202(y).

iii) Specific Laboratory Guidelines

(1) Radiation detection and monitoring instruments will be as specified in appendix A of this manual.

(2) Radioisotopes producing a radiation dose level in excess of 1 mRem/hr at a distance of one (1) foot from the source shall be stored in shielded containers of sufficient thickness to reduce the dose rate to less than 1 mRem/hr at a distance of 1 foot from the surface of the container.

(3) Radioactive materials shall not be used in or on human beings without prior approval of the RSC, who in turn will seek approval from the DSHS.

(4) The use of safety glasses, or similar eye protection, is required when an individual is handling or is in the general vicinity of any hard beta-emitting (P, I\textsuperscript{125}) radioisotopes.

(5) If I-125 is to be used in amounts greater than 10 mCi for each experiment, the Radiation Safety Officer should be notified so that procedures for performing bioassays and keeping records can be developed and approved by DSHS.

(6) Any proposed changes in a user’s current authorization will be submitted in writing to the RSC for approval.

c) Radiation Machines

   i) Every user of x-ray machines shall become familiar with the appropriate regulations of this manual and of the DSHS. Copies of all state regulations [25 TAC (Texas Administrative Code)] are available for download from the DSHS web site at www.DSHS.state.tx.us/radiation. Relevant to the x-ray safety program at TCU are
the rules §289.203, §289.204, §289.205, §289.226, §289.227, §289.228, and §289.231.

ii) General Safety Guidelines

(1) Only the appropriate research directors and authorized users will be allowed to operate x-ray units. A list of authorized users will be maintained by the research director of each laboratory and by the RSO.

(2) A personal monitoring device will be worn by the operator of an x-ray unit in accordance with section (6)(d) of this document, and a suitable survey meter will be used to monitor the general area of the x-ray unit to ensure that excessive radiation levels are not present to endanger the operator or other personnel.

(3) As a safety feature in the use of uncollimated x-ray beams, micro-switches will be located on the doors to the exposure cell that will deactivate the x-ray generator should the door be opened while the generator is in operation. For well-collimated, narrow beam geometries, physical restriction of access to the x-ray beam is required.

(4) Any variance in these requirements must be approved by the DSHS.

(5) The specific manufacturer’s instructions shall be followed when operating x-ray generators or electron microscopes. Records should be kept of each operation of the x-ray machine or electron microscope. The records should indicate the date of operation, time voltage, filter, shield or shutter arrangement, and should be initialed by the operator using the instrument.

(6) The RSO will be notified whenever the shielding or the location of x-ray generators is changed.

(7) No person shall bypass a safety device unless that person has obtained the approval of the RSO. When a safety device has been bypassed, a visible sign bearing the words “SAFETY DEVICE NOT WORKING,” shall be placed on the radiation source housing.

(8) Safety and operating procedures must be present for each radiation-producing machine.

iii) X-ray Diffraction Units

(1) This section provides special requirements for the analytical x-ray equipment. These requirements are in addition to and not in lieu of requirements in other parts of this manual.

(2) A safety device that prevents the entry of any portion of an individual’s body into a primary x-ray beam path or that causes the beam path to be shut off upon entry into its path will be provided on all open-beam configurations. A user may apply to the RSC for an exemption from the requirement of a safety device. This exemption must be approved by the DSHS. Such application will include:

(a) A description of the various safety devices that have been evaluated;

(b) The reason that each of these devices cannot be used;
(c) A description of the alternative methods that will be used to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.

(3) The RSO will forward this application to the DSHS for its approval.

(4) Open-beam configurations will be provided with a readily discernible warning device that will reveal the X-ray tube status (on-off) and shutter status (open-closed). Warning devices shall be labeled so that their purpose is easily identified and shall have fail-safe characteristics. Unused ports will be secured in the closed position in a manner that will prevent casual opening.

(5) Each port of any radiation device with open-beam configuration will be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.

(6) Areas or rooms housing an x-ray diffractometer shall have postings in accordance with section (6)(h) of this manual.

(7) An easily visible warning light labeled with the words, “X-RAY ON,” will be located near any switch that energizes the X-ray tube and will be illuminated only when the tube is energized. Warning lights will have fail-safe characteristics on new equipment installations.

(8) Sufficient radiation surveys will be conducted on all analytical x-ray equipment to show compliance with this manual and the DSHS regulations. A radiation survey will be made after any change in operating configurations.

(9) No person will bypass a safety device without obtaining the approval of the RSO. When a safety device has been negated, an appropriate warning sign will be placed on the radiation source housing.

(10) Finger dosimetric devices will be worn by users of x-ray equipment as appropriate in accordance with section (6)(d) of this document.

iv) Radiation Machines in the Healing Arts

(1) Radiation machines in the healing arts are subject to §289.227 and all operators of such machines shall be familiar with this section of the TAC. General operating requirements can be found in §289.227(i).

(2) Individuals who supervise the use of radiation machines for human use shall meet the appropriate credentialing requirements of rules issued in accordance with the Medical Radiologic Technologist Certification Act, Texas Occupations Code, Chapter 601. Copies of the credentialing document shall be maintained at the location(s) where the individual is working.

(a) A licensed practitioner shall supervise operation of radiation machines for human use.

(b) Individuals that do not meet the established credentialing requirements shall not operate a radiation machine for human use unless there is oversight by a licensed practitioner.
(3) Equipment performance evaluations shall be performed by a licensed medical physicist according to the time intervals described in §289.227(o).

(a) Fluoroscopic machines shall be evaluated annually.

(b) All other radiographic machines shall be evaluated once every two years.

(c) Bone densitometers are exempt from performance evaluations; however, one initial performance evaluation shall be performed on all new densitometers upon start-up.

(4) The licensed practitioner directing operation shall maintain records of equipment performance evaluations. A copy should also be provided to the RSO.

(5) Each directing practitioner shall have and implement written operating and safety procedures. These procedures shall include, but are not limited to the items in §289.227(t). The procedures shall be made available to each individual operating a radiation machine, including any restrictions of the operating technique required for the safe operation of the particular x-ray system. The directing practitioner shall document that each individual operating a radiation machine has read the operating and safety procedures and shall maintain this documentation for inspection by the DSHS. The documentation shall include the following:

(a) Name and signature of individual

(b) Date individual read the operating and safety procedures

(c) Initials of the RSO

(6) Protective devices, including aprons, gloves, and shields shall be checked by the directing practitioner annually for defects such as holes, cracks, and tears. If a defect is found, protective devices shall be replaced or removed from service until repaired. A record of this test shall be made and maintained for inspection by the DSHS.

5) RADIATION-RADIOISOTOPE ACCOUNTABILITY

a) General

i) No employee or student is authorized to purchase, receive, or transfer radiation-producing materials, equipment, or irradiation services except as authorized by the RSC or RSO. All purchase and transfer requests will be routed to the RSO for approval annotation and signature. The following forms found in appendix C shall be used as appropriate to report the desire for radiation machine and materials acquisition, transfer, or discard:

(1) Radioisotope Daily Use Log

(2) Notice of Radiation Machine Acquisition

(3) Notice of Radiation Machine Discard/Transfer

ii) All radioactive materials, survey meters and radiation-producing equipment must be reported to the RSO regardless of how it is procured.

b) Student and Research Associate Users
i) Before authorization for students or research associates to use any new radiation-producing equipment, neutron-irradiated materials, or radioisotopes is issued, the Research Director will make application to the RSO to have the student or research associate added to the list of approved users. The prospective user will contact the RSO to schedule the training and test, or submit evidence of prior training, and will complete form BRC on prior exposure. Appropriate personnel monitoring will be ordered by the RSO.

c) New Full-Time Faculty Users
   i) New full-time faculty users who request to be added to the license will submit an application. The application can be found in appendix C of this document. Once the application is submitted to the RSO, the RSC will review the user’s plan for radiation safety and will authorize use or return the application for additional information.

d) Purchasing
   i) To purchase any radioactive materials, the user will complete the top portion of a Radioisotope Daily Use Log (see appendix C) and obtain approval from the RSO for the purchase. Instructions for completing and distributing the Radioisotope Daily Use Log can be found on the form in appendix C.

   ii) Prior to purchasing any radiation machine, the user must complete the Notice of Radiation Machine Acquisition form found in appendix C and submit to the RSO.

e) Shipping
   i) All shipments of radioactive materials from or by the University to outside agencies shall comply with the requirements of the appropriate regulating agencies.

f) Receiving
   i) Authority for use of radioisotopes will automatically be transferred to the Texas Christian University Radioactive Material License No. L01096 when the shipment is received.

   ii) All radioactive materials shipped to TCU will be received by the RSO or his designate. The RSO or his designate will inspect the package.

   iii) The RSO or his designate will monitor the package as soon as practicable after receipt, but no later than 3 hours during normal working hours, or 18 hours if received after normal working hours, if

      1) There is any visual sign of degradation of the package such as crushed, wet or damaged,

      2) The package is labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in DOT regulations 49 CFR §§172.403 and 172.436-440, for radiation levels and the package contains quantities of radioactive material that are greater than or equal to the Type A quantity, as defined in §289.201(b) and specified in §289.257(s)(1).

   iv) If the package is contaminated, the RSO or his designate shall immediately notify the user and the shipping firm.
v) If the package is undamaged or the quantity of material is below the level in paragraph iii)(2) above, the RSO or his designate will contact the user.

vi) The user will pick up the package, leak test the package as required and open the package in accordance with §289.202(ee).

vii) The date of receipt, the type of package and the results of the leak test shall be noted on the Radioisotope Daily Use Log (appendix C).

viii) Rubber gloves shall be used when opening packages. The package should be opened under a hood if the isotopes are in a volatile chemical form.

ix) If the package is contaminated, the user shall immediately notify the shipping firm and then the RSO.

g) Security and Control

i) Users shall secure radioactive material and radiation machines from unauthorized removal or access.

ii) Users shall maintain constant surveillance, using devices and/or administrative procedures to prevent unauthorized use of radioactive material and radiation machines.

h) Posting and Labeling Requirements

i) General

(1) Signs shall identify each area as a restricted area in which a dose rate above 2.0 mRem/hr exists.

(2) Each radiation area shall have a conspicuous sign or signs bearing the radiation symbol (appendix B) and the words “CAUTION, RADIATION AREA.” This sign will be posted on the outside door(s).

(3) Each room where radioactive material or equipment is used or stored will post a RC 203-I “Notice to Employees” form or a sign with the same wording on the inside door(s).

(4) Each room where radioactive material or equipment is used or stored will post a list of emergency phone numbers on the inside door(s).

(5) Exemptions to posting requirements can be found in §289.202(bb) and §289.231(y).

ii) Radioactive Materials

(1) Each area in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in §289.202(ggg)(3) shall have a conspicuous sign or signs bearing the radiation symbol and the words “CAUTION, RADIOACTIVE MATERIAL(S).” This sign will be posted on the outside door(s).

(2) Each container of radioactive material, including refrigerators and cabinets, will have a durable, clearly visible label bearing the radiation symbol and the words, “CAUTION, RADIOACTIVE MATERIAL.” The label shall also provide
information such as the radionuclides present, and estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

(3) Each user shall, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

(4) Exemptions to requirements of labeling of individual containers are given in 289.202(dd).

iii) Radiation Machines

(1) All analytical X-ray equipment will be labeled with a readily discernible sign bearing the radiation symbol and the words, “CAUTION – HIGH INTENSITY X-RAY BEAM,” or words having a similar intent, placed on the source housing.

(2) All analytical x-ray equipment will be labeled with a readily discernible sign bearing the radiation symbol and the words, “CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED,” or words having similar intent, placed near any switch that energizes the X-ray tube.

(3) Each area or room will be posted with a sign bearing the radiation symbol and the words, “CAUTION X-RAY EQUIPMENT,” or words having similar intent.

6) RADIATION MONITORING

a) General

i) Various survey instruments available to the users, and the RSO are listed in Appendix A.

ii) The RSO shall be notified about any other survey meter that is or will be actively used. Such meters must be calibrated as indicated below.

b) Instrument Calibration

i) All radiation survey instruments will be calibrated to read within +/- 20% of full scale on linear meters and at the point of the reading for long readout meters. A DSHS-approved company will perform this calibration every 12 months. The RSO will arrange for calibration of this equipment and will review and maintain calibration records. Calibration is currently carried out by MPM Products, Inc., Texas License # L-00967.

c) Occupational Dose Limits

i) The following limits correspond to the amount of radiation dose received by adult users in one year:

(1) Total Effective Dose Equivalent: 5 rems (0.05 Sv)

(2) Lens Dose Equivalent: 15 rems (0.15 Sv)
(3) Shallow Dose Equivalent: 50 rems (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

ii) The annual dose limits for minors and pregnant women are as stated in §289.231(m)(1)(C) and (D).

iii) Dose limits for members of the public are as follows:

(1) The total effective dose equivalent from exposure to radiation from radiation sources does not exceed 500 mRem in a year, exclusive of the dose contribution from background radiation, exposure of patients to radiation for the purpose of medical diagnosis or therapy, or to voluntary participation in medical research programs.

(2) The dose in any unrestricted area from registered external sources cannot exceed 2 mRem/hr.

(3) Compliance with dose limits for individual members of the public shall be according to §289.202(n) and §289.231(p).

d) Personnel Monitoring

i) Personnel monitoring by film badge is required in accordance with §289.202(q) and §289.231(n). Users shall monitor exposures from radiation sources at levels sufficient to demonstrate compliance with the occupational dose limits of this section. Individual monitoring devices are required for:

(1) Adults likely to receive, in one year from sources external to the body, a dose in excess of 10% of the limits established in this section.

(2) Minors likely to receive, in one year from sources of radiation external to the body, a deep dose equivalent in excess of 0.1 rem (mSv), a lens dose equivalent in excess of 0.15 rem (1.5 mSv), or a shallow dose equivalent to the skin or to the extremities in excess of 0.5 rem (5 mSv).

(3) Declared pregnant women likely to receive during the entire pregnancy, from sources of radiation external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv).

(4) Either a whole body film badge or ring badges are available as appropriate. The current monitoring time between exchanges of badges is two months. This time interval has been determined to be appropriate for the typical level of exposure that all users can be expected to receive during the monitoring period.

ii) Landauer, Inc. provides the film badge service. They provide bimonthly exposure records and annual cumulative records of exposure on each monitored user. These records are kept by the RSO.

iii) Requests for film badges can be made by submitting the form in appendix C to the RSO.

7) REQUIRED TESTS AND RECORDS

a) General
i) The DSHS requires that certain tests and records be maintained. The requirements for tests, surveys, personnel monitoring, waste management, record keeping and reports of incidents are covered under TEXAS ADMINISTRATIVE CODE. Specific rules especially relevant to these areas discussed in this section are the following:

(1) §289.201(g) - Tests for leakage of sealed sources

(2) §289.202(o)-(r) and §289.231(cc)-(dd) – General surveys and monitoring; Requirements for surveys; Compliance with dose limits for individual members of the public; Requirements for personnel monitoring with film badges and/or pocket dosimeters

(3) §289.202 (ff)-(kk) – Management and disposal of radioactive wastes

(4) §289.202 (ll)-(vv) – Required Records

ii) Every Research Director will become familiar with these requirements and will see that the personnel under their supervision follow them. Copies of all state regulations [25 TAC (Texas Administrative Code)] are available for download from DSHS website at www.dshs.state.tx.us/radiation.

b) Leak Tests

i) Sealed sources and plated alpha-emitting sources will be tested by the users for leakage as described below:

(1) The leak test sample shall be taken from the surface of the source or from the surface of the device in which the source is stored or mounted.

(2) The test shall be capable of detecting the presence of 0.005 micro Ci of radioactivity. The results shall be recorded in units of micro Ci.

(3) Each source shall be tested at intervals not to exceed six (6) months. Exception: Alpha-emitting sources shall be tested at intervals not to exceed three (3) months.

(4) If a test reveals leakage, the user will immediately withdraw the source from use. The user will then notify the RSO. The RSO will begin procedures for decontamination of the source and notify the DSHS in a written report within 30 days.

(5) The user shall maintain records of these tests for five (5) years from the date of testing.

ii) Exemptions

(1) These sealed sources do not need to be leak tested:

(a) Sealed sources that are stored and not in use. These sources shall be tested for leakage prior to any use or transfer to another user, unless the source has been tested within six (6) months of transfer or use.

(b) Hydrogen-3 sources.

(c) Sources with a half-life of 30 days or less.

(d) Sources of beta and/or gamma emitting radioactive material with an activity of 100 micro Curies or less.
(e) Sources of alpha emitting radioactive material with an activity of 10 micro Curies or less.

(f) Nickel-63 foil sources of 100 micro Curies or less.

(g) Plated alpha sources (other than Californium-252) with an activity of 0.1 micro Curie or less.

c) **Surveys**

i) All laboratories and facilities where radioactive materials or radiation machines are used or stored will be surveyed periodically in order to detect any changes in radiation levels and to prevent the spread of radioactive materials. Results from these surveys should be documented on a current facility map indicating where measurements were taken and the radiation levels at each point. These shall be conducted at minimum of once every three months for all analytical x-ray machines and areas with radioactive materials. Surveys will be kept by the research director and the RSO in a survey log.

ii) The user shall monitor work areas in which unsealed radioactive materials are used after each use of radioisotopes to determine radiation levels and presence of contamination, if any.

iii) Areas with radiation machines shall be surveyed:

   1. Upon installation of the equipment
   2. Following any change in the initial arrangement, number, or type of local components in the system
   3. Following any maintenance requiring the disassembly or removal of a local component in the system
   4. During the performance of maintenance and alignment procedures if the procedures require the presence of a primary x-ray beam when any local component in the system is disassembled or removed
   5. Any time a visual inspection of the local components in the system reveal an abnormal condition
   6. Whenever individual monitoring devices show a significant increase of the previous monitoring period or the readings are approaching the radiation dose limits.

d) **Inventories**

i) Each user will keep a detailed continual inventory of all radioisotopes in their use or stored under their supervision. A Daily Use Log, Appendix C, must be completed for each isotope received. This form can be used for the inventory of each isotope until it is disposed of either by use or by disposal to waste. When the isotope has been completely disposed of or used up a copy of the Daily Use Log is forwarded to the RSO for his records. In addition to the Daily Use Log, all waste disposals must be recorded on a separate log and the information also is attached to the waste disposal container or bag as discussed below in section E and in VII.
ii) Inventories of all radioisotopes purchased, used, stored, and disposed of will be made quarterly by each licensed user of such materials. User inventories will be forwarded to the RSO either using the Quarterly Inventory form in Appendix C or the equivalent information by email.

iii) Each quarterly inventory will include the following information:

1. Name of each sealed source or radioisotope with serial or other appropriate identification number;
2. Date of the last leak test of sealed sources (if applicable);
3. Amount of material at the beginning of the quarter;
4. Amount of material received during the quarter;
5. Amount of material disposed of during the quarter;
6. Amount of material at the end of the quarter.

iv) Small concentrations of radioisotopes may be purchased as exempt quantities according to §289.251(e) and listed in tables §289.251(q)(1) and §289.251(q)(2). Exempt quantities do not need to be included in the inventory. However, according to §289.251(e)(2)(B) quantities of material originally purchases as non-exempt do not become exempt by decaying below the exempt concentrations. For H-3 the exempt concentration is 3x10^{-2} mCi/mL for liquids or 3x10^{-2} mCi/g for solids. For C-14, the exempt concentration is 8x10^{-3} mCi/mL for liquids or mCi/g for solids. It may be useful to purchase low-level radioactive sources as exempt sources if their level is below that listed in table §289.251(q)(2).

v) An annual inventory will be taken of all radiation machines. The inventory must include the manufacturer, model number, serial number, standard operating conditions, location, and the user responsible for the instrument.

e) **Waste Disposal**

i) Each licensed user will keep records of all waste disposals. The waste disposal form in appendix C or the equivalent should be used. The waste disposal record is separate from inventory records or Daily Use Logs. It should include the following information:

1. Radioactive isotope
2. Activity in milli Curies
3. Chemical carrier form
4. Date of disposal

ii) At the end of each quarter of the calendar year, the disposal of each particular radioisotope will be itemized and reported to the RSO on the Quarterly Inventory.

f) **Usage Records**
i) All users shall keep a record of daily use of radioisotopes. Usage records will be kept on the “Daily Use Log” found in appendix C for each isotope.

ii) Usage records shall be kept for all analytical x-ray machines. This includes a log indicating the name of the user, the date of usage, time of usage, and operating conditions.

**g) Other Records**

i) The RSO and each research director or licensed user will maintain a list of authorized users for their research group.

ii) Documentation of lab-specific training for each user shall be available from each research director.

**h) Inspections**

i) The RSO will make periodic inspections of required records that are to be maintained by each licensed user. At least 50% of the laboratories using radioactive materials or equipment will be inspected in each academic spring and fall semester.

**8) WASTE MANAGEMENT**

a) **General Procedures**

i) The waste management program seeks to reduce the liquid and solid waste that has to be stored in the waste storage room as much as possible.

ii) In waste disposal, separation of isotopes in the waste is required. That is, appropriately labeled separate bags should be used for H-3, C-14, etc. waste.

b) **Disposal of Liquid Waste**

i) In so far as possible, low-level liquid waste, especially H-3 and C-14, should be disposed of in the sanitary sewer in accordance with §289.202(fff) and §289.202(gg) and the limits in Table §289.202.33(ggg)(2)(F).

ii) In disposal down the drain of low level wastes, DSHS Bureau of Radiation Control rules have precedence over any local ordinances.

iii) Liquid disposal permitted down the drain: 0.05 micro Ci or less of H-3, C-14, I-125 per gram of medium used for liquid scintillators. Individual limits are based on the average water flow from the TCU campus per year.

iv) For purposes of estimating limits on disposal, contact the Associate Vice Chancellor for Facilities to obtain the average monthly water flow for TCU.

v) The maximum permitted disposal is up to 5 Ci/yr of H-3, 1 Ci/yr of C-14 and 1 Ci/yr of all other isotopes.

vi) The permitted monthly average release limit to sewer for several isotopes of interest is:

   (1) H-3: 1x10^{-2} mCi/ml.
   (2) C-14: 3x10^{-4} mCi/ml (compounds)
   (3) Any other is available from the Table §289.202.33(ggg)(2)(F).
vii) The Research Director and the RSO should determine whether there are any hazardous chemical considerations that should apply to disposal of liquid waste. If disposal to the sanitary sewer is used, the Research director should:

1) Designate a drain for waste disposal in each lab.

2) Keep a record of each waste disposal and send this information to the RSO quarterly. The record should include the date, the isotope, the estimated activity in micro Ci and the initial of the person disposing of the waste.

3) See that scintillation vials are emptied, rinsed to ensure that any contamination of the vials is below the level permitted for disposal in normal trash.

viii) In some cases it may be more convenient to collect the liquid waste in a container as described below and dispose of the liquid in the container in one disposal. This is permitted as long as the single disposal is below the permitted level for disposal in one month.

c) Short Lived Isotopes

i) Short-lived isotopes, such as Cr-51, P-32, and S-35 should be packaged as described below, placed in a designated laboratory area, and allowed to decay away. There is never any reason to dispose of short-lived isotopes in the waste storage drums. Isotopes should not be mixed and should be packaged separately. A waste disposal log should be kept of each addition to the waste storage container or bag indicating the date of disposal, the estimated activity and the initial of the person making the disposal. After the last date of a disposal, the bag should be kept for 10 half lives. Before discarding the bag or container, it should be surveyed and the record of the survey should be noted on the waste disposal log.

d) Packaging of Waste

i) The following procedures should be followed for the storage and packaging of radioactive wastes:

ii) All solid waste should be packaged in plastic bags in as compact a manner as possible.

iii) Scintillation vials, where it is necessary to dispose of them as radioactive waste, should be bagged separately from other solid waste.

iv) Bags should be yellow and imprinted with the standard radiation caution symbol and the words “Caution – Radioactive Material” or “Caution – Radioactive Waste”.

1) The preferred size of the bags is 24” X 36”, or less, and 3 or 4 mils thickness. Larger sizes tend to rip due to weight or when being placed in waste drums.

v) Liquid waste containers should be non-breakable. Each container should be labeled with the standard radiation caution symbol and the words “Caution- Radioactive Material” or “Caution- Radioactive Waste.” Tops should be of the screw-on type and compatible with the liquid stored to prevent corrosion or destruction of the lid itself.
e) **Laboratory Storage of Wastes**

   i) Each laboratory generating radioactive waste will need to:

   (1) Designate a location for the collection of radioactive wastes generated by their research. This area should be noted on the quarterly survey form and surveyed at least quarterly.

   (2) Place bags in a container strong enough to support the weight of the waste placed in them. Bags should overlap the sides of the container sufficiently to prevent their collapsing into the container. Each container should be labeled with the standard radiation caution symbol and the words “Caution- Radioactive Material” or “Caution- Radioactive Waste”.

   (3) Keep a log on each container or bag listing the isotope, activity, chemical form, date of disposal and initial of the person making the disposal and the cumulative activity in the bag or container.

f) **Transfer of Waste to the Waste Storage Room**

   i) To transfer waste from the laboratory to the consolidation area, the user will need to:

   (1) Request that the RSO have the waste transferred to the Waste Storage Room.

   (2) Prepare the waste as described above. Containers of liquid waste that cannot be disposed of down the drain as described above should be double-checked to ensure that lids are tight and will not leak during transfer.

   (3) Ensure that a log or label is attached to each container or bag and lists the isotope, the cumulative activity and the final disposal date.

   (4) Update the log on the drum when material is placed in the drum. This information should be the same as the log kept on each waste container.

9) **TRAINING**

   a) To help ensure that radioactive materials and equipment are used safely, all student users must have adequate training. Students are not authorized to use radioactive materials and equipment until the following has been accomplished:

   i) Student users will successfully complete courses in general laboratory and radiation safety. Topics will include those mentioned in §289.252(jj)(1).

   ii) Student users must receive lab-specific training offered by their research director. Lab-specific training should cover the safe handling of radioactive materials or operation of radiation machines specific to the lab they will be working in.

   iii) Documentation of all training shall be available upon request.

10) **EMERGENCY PROCEDURES**

   a) **General**

   i) In case of suspected or known overexposure to an individual, the RSO will be contacted immediately. The individual and research director overseeing the project will make a written report in each case of overexposure. Additional investigation by the RSO and Safety Director may be needed prior to turning this information over to
the RSC for action. If it is determined or suspected that an overexposure has occurred, the RSO will send a report to the DSHS in accordance with §289.202(yy).

ii) In the event of an emergency involving the possibility of radiation contamination, special precautions must be taken to protect personnel. Prompt notification of the RSO, the acting RSO, and/or the Safety Director is important.

iii) A current notification list shall be posted in each area where radioactive-producing equipment or radioactive material is used.

iv) Records of the radiation exposure of all personnel using radiation sources at the university will be kept by the RSO. A personal report of exposure history is provided annually by the RSO and by request at other times and upon termination, and when requested by the RSO at another institution authorized by the person in question.

b) **Radioisotope Accident/Incident**

i) If a person is both injured and contaminated, a quick decision will have to be made as to the best possible course to follow. In making this decision, the following possibilities should be considered:

1. Notify the TCU Campus Police Department, request medical assistance, and render preliminary treatment at the scene. Notify the RSO and/or Safety Director.

2. When the ambulance arrives, inform the attendants of the possibility of contamination and the radioactive material involved.

3. In determining the severity of the injury contamination, the following factors must be considered:

   a) External contamination is not immediately harmful to the patient unless his/her skin is badly punctured or wet.

   b) The contamination of the individual may be harmful to other people if it is spread to the ambulance and the emergency room.

   c) All cuts offer a point of easy access to the body for radioactive materials. Radioisotopes should not be allowed to contact a cut. Any cut by a contaminated article should receive immediate treatment. It should first be cleansed very thoroughly with soap and water. Free bleeding should then be checked for contamination if a high-energy beta or gamma emitter is involved. Soft beta and gamma emitters cannot be easily detected in a cut, particularly in the presence of water. All cuts involving contamination should be reported to the RSO.

4. Anyone who suspects that radioactive material has been ingested should induce vomiting. Notify the RSO immediately. The vomit materials should be retained for examination.

5. If possible, contaminated clothing should be removed. Disposable coveralls can be used as temporary replacement clothing.
c) X-ray Machine Accident/Incident

i) In the event that any person is suspected of being exposed to radiation involving x-ray machines or electron microscopes, the following steps should be taken:

1) Turn off the machine immediately.

2) **Do not alter** the voltage or current controls or the position of the tube head so that the conditions of irradiation may be duplicated to determine the extent of the radiation exposure.

3) Notify the RSO immediately of the incident.

4) Record the conditions under which the exposure occurred so that the RSO can determine the extent of the exposure.

d) Emergency Equipment

i) Protective items that can be used in an emergency include: disposable coveralls, disposable gloves, disposable shoe covers, respirators, decontamination wash powder, dosimeters, survey instruments, radiation signs, tags, labels, tongs, and properly labeled plastic bags.

e) Facility Decontamination

i) It will be the responsibility of the research director involved to decontaminate any laboratory or facility that becomes contaminated. If contamination occurs, the RSO should be notified of decontamination procedures before they occur.

ii) Upon discovery of the contamination of equipment or facilities by the user or during a quarterly inspection, the following procedures can be used as a guide for decontamination:

1) Laboratory Spills

   a) For small spills, the usual is to absorb all liquid with absorbent paper. Larger spills may require the use of pillows or dikes of absorbent material. This contaminated material should then be double-bagged in plastic and a label attached, estimating the maximum activity, the radionuclide, and the date.

   b) The area should then be washed with warm soapy water. Iodine-based disinfectants or solutions are quite effective in cleaning radioactive iodine contamination. The wash water should be collected, by absorption or other means, for disposal based on the RSO’s recommendations. After the area has dried, wipe tests or surveys with an appropriate detector should be conducted. Some areas may require several washings to reduce the contamination to an acceptable level of 1-1.5 times the background counting rate.

   c) Protective clothing such as lab coats, disposable coveralls, gloves, and booties should be worn during decontamination.

2) Glassware/Equipment

   a) Soap and water washing are usually sufficient to decontaminate glassware or equipment, but special cleaning products are available commercially. Similar procedures given above for the collection and disposal of the cleaning product
should be followed. Precautions in cleaning around electrical components should be taken. Protective clothing appropriate for the task should be worn.

(3) Hands/Body

(a) After the completion of work or when contamination is suspected, a person should wash the contaminated body part(s) with mild soap and water and then monitor them with a survey meter. If contamination persists, a second or third washing may be required, using a heavy lather and a soft brush. Stiff brushes or implements that abrade the skin should be avoided; instead, numerous light washings are recommended.

(b) Contaminated clothing should be double-bagged in plastic and labeled. Disposable coveralls/booties can be used as temporary clothing.

iii) The user will provide the RSO with radiation survey results and/or wipe tests for review before the facility can be used.

iv) Upon vacating all premises where radioactive materials have been used, the research director will ensure that all residual radioactivity is properly removed and disposed of in accordance with this manual. The RSO will survey the premises prior to subsequent use.

f) Emergency Notification

i) Emergency and other important phone numbers are as follows:

(1) Scott Dunkle, RSO, Hazardous Materials Safety Coordinator
   (a) Office: x5395
   (b) Cell: 817-874-5349

(2) Randy Cobb, Safety Director
   (a) Office: x6363
   (b) Cell: 817-312-1089

(3) Campus Police: x7777

(4) Fort Worth Fire Dept.: 911

(5) Ambulance: 911

(6) Work Order Desk, Physical Plant: x7956
APPENDIX A: Monitoring Equipment

1. Eberline Model E-120 Meter, Serial Number 8637; Scott Dunkle, RSO’s Office
   a. HP-260 “Pancake” Probe (GM).

2. Eberline Model E-120 Meter, Serial Number 12364; Scott Dunkle, RSO’s
   a. LEG-1 Low Energy Gamma Probe, used for detecting low-energy gamma and X-rays (SCIN).
   b. HP-190A End Window Handprobe (GM).

3. Eberline Model ASP-1 Meter, Serial Number 1939; Randy Cobb, Safety Director’s Office
   a. HP-270 Handprobe, general purpose GM probe measuring up to 200 mR/hr. (GM).
   b. HP-260 “Pancake” Probe, used for contamination surveys of tabletops, personnel, floors, etc. (GM).

4. Eberline Model E-120 Meter, Serial Number 7065; Dr. Mitchell
   a. HP-270 Handprobe (GM)

5. Ludlum M-3 Meter, Serial Number 194713; Dr. Quarles, used in Modern Physics Laboratory.
   a. Model 44-38 ser.# PR202473 Handprobe (GM)

6. Eberline Model ASP-1 Meter, Serial Number 3214; Dr. Quarles
   a. HP-270 Handprobe, (GM).
   b. HP-260 “Pancake” Probe, (GM).
   c. LEG-1 Low Energy Gamma Probe, (SCIN).

7. ISO Data 100 Series Gamma Counter, Serial Number 8811065; Dr. Mitchell

8. Film badges for neutron, beta-gamma, and x-ray exposure are provided by Landauer Inc., 2 Science Rd., Glenwood, Illinois 60425-1586.
APPENDIX B: Radiation Caution Sign

1. The cross-hatched area of the symbol is to be magenta, or purple, or black.
2. The background of the symbol is to be yellow.
APPENDIX C: Forms and Records

1. Radioisotope Daily Use Log
   a. Prior to purchasing any radioisotope, the top portion of the form should be completed, as much as possible, and submitted to the RSO for approval.
   b. Upon receipt of the material, the top portion should be completed except for “Date of Final Disposal”. A photocopy or email should be sent to the RSO.
   c. Upon final disposition of the material, a copy of the log should be sent to the RSO.
   d. This form will help meet the recordkeeping requirements for maintaining a log of use and storage of radioisotopes. In some cases, it may be necessary to use more than one form, particularly on sealed sources, when space may run out. There should be at least one log per radioisotope.

2. Quarterly Inventory of Unsealed Isotopes & Quarterly Inventory of Sealed Sources
   a. This form or the equivalent should be completed by April 1, July 1, October 1, and January 1 of each year. It should be completed before any holidays or before leaving for the end of semester.
   b. Use additional forms as needed. The Research Director should keep one copy. One copy should be sent or emailed to the RSO.

3. Radioactive Waste Log- Laboratory & Drum Storage
   a. There should be at least one waste log form for each container of waste. The “Chemical Name” is the chemical in which an isotope may be combined. Isotopes should be separated in different waste containers.
   b. These logs should be maintained in the general area of the disposal site. Once a laboratory container is full and the laboratory log is complete, then this information should all be transferred to the drum storage log. The user should maintain the original of this log.
   c. The drum storage log will be taped to the top of the lid of each waste drum.
   d. These forms will provide the RSO with information to track the amount of radioactive waste, from the laboratory to final disposition, generated by the University.

4. Application to Use Radioactive Material
   a. This application shall be completed and submitted to the RSO by all faculty that wish to begin using radioactive materials.
   b. This application will be reviewed by the Radiation Safety Committee and a collective decision made regarding the approval of the research project.
   c. A copy of the application will be kept by the research director and the RSO for documentation purposes.
5. **Notice of Radiation Machine Acquisition**
   a. This form is to be completed and submitted to the RSO prior to any acquisition of radiation machines.
   b. This allows time for evaluation of the current x-ray registration and submission of amendments if required. Also serves as documentation of machine acquisition.
   c. Ensures research director is familiar with the applicable regulations for the machine to be acquired.

6. **Notice of Radiation Machine Discard/Transfer**
   a. This form is to be completed upon discard or transfer of a radiation machine.
   b. This serves as documentation of radiation machine discard or transfer.

7. **Request for Radiation Dosimeter**
   a. This form should be filled out to obtain a dosimetry badge and grants authorization for TCU to obtain monitoring records from previous employers.
   b. Form should be submitted to RSO prior to beginning radiation work if monitoring is required.
Radioisotope Daily Use Log

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**Ordering Information:**
- **Date of Order:**
- **PO # (if available):**
- **Supplier:**

**Date Received:**
- Send copy of this form to RSO upon material arrival

**Package survey readings using Geiger counter or wipe tests as appropriate:**
- **Package Type:**
- **Surface (<200mRem/hr):**
- **3’ Distance (<10 mRem/hr):**
- **Wipe Test Results:**

**Inventory Information:**
- **Serial or Lot #:**
- **TCU Chemical Inventory #:**
- **Location of Use:**

**Disposal:**
- **Date of Final Disposal:**
- Send photocopy or email copy of this form to RSO on disposal

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</tbody>
</table>

Use additional sheets as necessary

**Note:**
- Obtain approval by the Radiation Safety Officer before ordering.
- Upon receipt and disposal of material, send a photocopy or email copy to RSO.
- Maintain this document throughout possession and usage of this material. Every radioactive material should have one or more of these forms.

Scott Dunkle, RSO, TCU Box 298860, Office: SWR 475, phone 817-257-5395, s.s.dunkle@tcu.edu
# Quarterly Inventory of Unsealed Radioactive Isotopes

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Amount at start of quarter (mCi)</th>
<th>Amount received during quarter (mCi)</th>
<th>Amount disposed of during quarter (mCi)</th>
<th>Amount at end of quarter (mCi)</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>
# Quarterly Inventory of Sealed Radioactive Isotopes

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Manufacturer/Serial #</th>
<th>Amount (mCi)</th>
<th>Date of last wipe test</th>
<th>Storage location</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
### Radioisotope Waste Log

This form for record of disposal in: **Sanitary Sewer**  **Waste Storage Room**

<table>
<thead>
<tr>
<th>Date</th>
<th>Isotope</th>
<th>Chemical Name</th>
<th>Solid (S) or Liquid (L)</th>
<th>Amount disposed (mCi)</th>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
Application to Use Radioactive Material

This form shall be completed and returned to the Radiation Safety Officer (RSO). (It is suggested that an electronic draft be submitted to the RSO for review and comment prior to obtaining the required signatures.) Only upon notification of approval shall use of radioactive material be permitted.

Scott Dunkle, RSO, TCU Box 298860, SWR 475, Ph: (817) 257-5395, s.s.dunkle@tcu.edu

<table>
<thead>
<tr>
<th>Name:</th>
<th>Department:</th>
<th>TCU ID#:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCU Box #:</td>
<td>Office Location:</td>
<td>Phone #:</td>
</tr>
<tr>
<td>Email:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Address of laboratory or place of use and storage:

<table>
<thead>
<tr>
<th>Street Address:</th>
<th>City, State</th>
<th>Zip:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Worth, TX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building:</th>
<th>Room # (s):</th>
</tr>
</thead>
</table>

Two laboratory contacts:

<table>
<thead>
<tr>
<th>Name:</th>
<th>TCU ID#:</th>
<th>Office Location:</th>
<th>Phone #:</th>
</tr>
</thead>
</table>

Applicant’s previous permits, authorizations, or equivalent obtained under a NRC or Agreement State license or registration:

Radioactive material for which authorization is desired (attach additional sheets if necessary):

<table>
<thead>
<tr>
<th>Element and Mass #:</th>
<th>Sealed Source?</th>
<th>Chemical or Physical Form:</th>
<th>Maximum Activity Requested:</th>
<th>Use of Each Form:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes ☐ No ☐</td>
<td></td>
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<tr>
<td>Yes ☐ No ☐</td>
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<tr>
<td>Yes ☐ No ☐</td>
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<tr>
<td>Yes ☐ No ☐</td>
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<tr>
<td>Yes ☐ No ☐</td>
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</tr>
</tbody>
</table>

Describe, in detail, proposed uses for radionuclide(s) identified above and the period of time radioactive material use is requested (attach additional sheets if necessary):

---

Rev. 02/2013
Describe procedures which will ensure radiation doses to faculty, staff, and students are As Low as Reasonably Achievable (ALARA):

Describe the types of radioactive waste to be generated and radioactive waste collection and handling procedures (e.g., chemical and physical form of the waste, radioactive materials in each waste stream, other hazardous or potentially infectious materials present, total activity or concentration of radioactive material).

Describe personnel training and experience. Include, at a minimum, individual(s) identified as laboratory contacts above:

Type and number of radiation detection instruments available for surface contamination and area surveys:

Proposed personnel monitoring devices:

Clearly identify location(s) of use and describe facilities to be used (include fume hoods, sinks, refrigerator/freezer, etc.). Include a detailed map of the location(s) with this application:
<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Describe radiation survey procedures, methods of locating and remediating radioactive contamination, and record keeping of survey results:</strong></td>
</tr>
<tr>
<td><strong>If human subjects, animals, biological materials (recombinant DNA, human or non-human primate tissue, blood or body fluids, Select Agents or Biotoxins, or infectious agents) are to be used with radioactive materials, summarize and attach approved protocols:</strong></td>
</tr>
<tr>
<td><strong>In the event of an accident, describe emergency procedures:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant’s Signature:</td>
<td></td>
</tr>
<tr>
<td>Dean or Department Chairperson’s Signature:</td>
<td></td>
</tr>
<tr>
<td>Reviewed, Radiation Safety Officer’s Signature:</td>
<td></td>
</tr>
</tbody>
</table>
Notice of Radiation Machine Acquisition

This form shall be completed and returned to the Radiation Safety Officer (RSO) prior to the purchase of a radiation machine.

Scott Dunkle, RSO, TCU Box 298860, SWR 475, Ph: (817) 257-5395, s.s.dunkle@tcu.edu

Research Director:

<table>
<thead>
<tr>
<th>Name:</th>
<th>Department:</th>
<th>TCU ID#:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TCU Box #:</th>
<th>Office Location:</th>
<th>Phone #:</th>
<th>Email:</th>
</tr>
</thead>
</table>

Address of laboratory or place of use and storage:

<table>
<thead>
<tr>
<th>Street Address:</th>
<th>City, State</th>
<th>Zip:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fort Worth, TX</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building:</th>
<th>Room #:</th>
</tr>
</thead>
</table>

Machine Information:

<table>
<thead>
<tr>
<th>Type of Machine:</th>
<th>Manufacturer:</th>
<th>Model:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Maximum Operating Conditions:</th>
<th>Serial Number (completed upon receipt):</th>
<th>Acquisition Date (completed upon receipt):</th>
</tr>
</thead>
</table>

Describe in detail how the machine will be used. What will be studied?

Proposed personnel monitoring devices:

Describe procedures which will ensure radiation doses to faculty, staff, and students are As Low as Reasonably Achievable (ALARA):

I acknowledge that I am familiar with the Texas Administrative Code and the specific regulations pertaining to X-ray Registration R00109 that apply to this radiation machine. I am aware of all postings, surveys, training, and safety operations and procedures required to manage this machine in a safe and regulatory compliant manner.

Research Director Signature: Date:
# Notice of Radiation Machine Discard/Transfer

This form shall be completed and returned to the Radiation Safety Officer (RSO) upon discard/transfer of a previously acquired radiation machine.

Scott Dunkle, RSO, TCU Box 298860, SWR 475, Ph: (817) 257-5395, s.s.dunkle@tcu.edu

<table>
<thead>
<tr>
<th>Current Owner:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Department:</td>
<td>TCU ID#:</td>
</tr>
<tr>
<td>TCU Box #:</td>
<td>Office Location:</td>
<td>Phone #:</td>
</tr>
</tbody>
</table>

Current address of laboratory or place of use and storage:

<table>
<thead>
<tr>
<th>Street Address:</th>
<th>City, State</th>
<th>Zip:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fort Worth, TX</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Building:</th>
<th>Room #:</th>
</tr>
</thead>
</table>

Machine Information:

<table>
<thead>
<tr>
<th>Type of Machine:</th>
<th>Manufacturer:</th>
<th>Model:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Maximum Operating Conditions:</th>
<th>Serial Number:</th>
<th>Acquisition Date:</th>
<th>Transfer Date:</th>
</tr>
</thead>
</table>

If discarding…

Describe in detail how the machine will be discarded

If transferring, please complete the following regarding the future owner and place of use/storage:

<table>
<thead>
<tr>
<th>Name:</th>
<th>Phone #:</th>
<th>Email:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Institution:</th>
<th>Department:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Street Address of Use/Storage:</th>
<th>City, State</th>
<th>Zip:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Building:</th>
<th>Room #:</th>
</tr>
</thead>
</table>

Current Owner’s Signature:  
Date: 

Radiation Safety Officer’s Signature:  
Date: 

Rev. 02/2013  
Texas Christian University  
Page 1 of 1
### Request for Radiation Dosimeter

The following information is necessary for initiation of Radiation Dosimeter Service. Complete all blanks; use N/A where not applicable.

<table>
<thead>
<tr>
<th>Last Name:</th>
<th>First Name:</th>
<th>Middle Name:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TCU ID#:</th>
<th>Date of Birth:</th>
<th>Sex:</th>
<th>Position:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faculty</td>
<td>Staff</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employment Start Date:</th>
<th>Home Phone:</th>
<th>Other Phone (cell, beeper, etc.):</th>
<th>Email:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Campus Office Extension:</th>
<th>Campus Lab Extension:</th>
<th>Department:</th>
<th>Supervisor:</th>
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<table>
<thead>
<tr>
<th>Local Address:</th>
<th>State</th>
<th>Zip</th>
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<tbody>
<tr>
<td>Street</td>
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<thead>
<tr>
<th>Permanent Address (if different than above):</th>
<th>State</th>
<th>Zip</th>
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<td>Street</td>
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</tbody>
</table>

I will be working with the following radioactive materials and/or radiation producing machines:

<table>
<thead>
<tr>
<th>Isotopes</th>
<th>Maximum Activity</th>
<th>Building</th>
<th>Room Number</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Type of Radiation Producing Machine</th>
<th>Building</th>
<th>Room Number</th>
</tr>
</thead>
</table>

Within the past year I have worked at the following institution(s) where my radiation exposure was monitored: None

<table>
<thead>
<tr>
<th>Name of Institution:</th>
<th>Name of Institution:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Department:</th>
<th>Department:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Street Address:</th>
<th>Street Address:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>City, State, Zip</th>
<th>City, State, Zip</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Employment Dates:</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Employment Dates:</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
</table>

I authorize the release of all my radiation exposure data from the institutions listed above.

Signature ___________________ Date ___________________

RETURN THIS REQUEST THRU CAMPUS MAIL TO: Scott Dunkle, Radiation Safety Officer
TCU Box 298860

You may be entitled to know what information Texas Christian University (TCU) collects concerning you. You may review and have TCU correct this information according to procedures set forth in UTS 139. The law is found in sections 552.021, 552.023 and 559.004 of the Texas Government Code.

Disclosure of your Social Security Number ("SSN") is required of you in order TCU to comply with records management requirements as mandated by Texas Health and Safety Code Ch. 401; 25 Tex. Admin. Code section 289.231, 289.232; 30 Tex. Admin. Code section 336.352, 336.405 State law. Further disclosure of your SSN is governed by the Public Information Act (Chapter 552 of the Texas Government Code) and other applicable law.

I agree to inform of co-employment as a radiation worker while at TCU as a radiation worker. If you are issued dosimetry, information will be furnished to the dosimetry vendor to provide lifetime tracking of dose and kept in a secure, confidential database, akin to a medical record. Information requested allows you to be unambiguously identified across institutions.

Rev. 02/2013
Appendix D: Facility Diagrams

The following diagrams illustrate usage and storage locations of radioactive materials and radiation machines on the TCU campus.
No radiation activity in SWR 124 or SWR 126

<table>
<thead>
<tr>
<th>Meter ID</th>
<th>Calibration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mRems/hr 6</td>
</tr>
<tr>
<td>2</td>
<td>mRems/hr 7</td>
</tr>
<tr>
<td>3</td>
<td>mRems/hr 8</td>
</tr>
<tr>
<td>4</td>
<td>mRems/hr 9</td>
</tr>
<tr>
<td>5</td>
<td>mRems/hr 10</td>
</tr>
</tbody>
</table>
SWR 159 is used for storing equipment and as an office space. Currently there is no radiation activity in SWR 159.
SWR 358 is a teaching lab in which radioactive sources could be used in teaching labs. SWR 359 is a storage room. Currently there is no radiation activity in SWR 358 or SWR 359.

<table>
<thead>
<tr>
<th>Meter ID</th>
<th>Calibration Date</th>
<th>Calibration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mRems/hr 6</td>
<td>mRems/hr</td>
</tr>
<tr>
<td>2</td>
<td>mRems/hr 7</td>
<td>mRems/hr</td>
</tr>
<tr>
<td>3</td>
<td>mRems/hr 8</td>
<td>mRems/hr</td>
</tr>
<tr>
<td>4</td>
<td>mRems/hr 9</td>
<td>mRems/hr</td>
</tr>
<tr>
<td>5</td>
<td>mRems/hr 10</td>
<td>mRems/hr</td>
</tr>
</tbody>
</table>
Texas Christian University
Fort Worth, Texas

Radiation Survey

<table>
<thead>
<tr>
<th>Location:</th>
<th>Date:</th>
<th>Licensed User:</th>
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<tbody>
<tr>
<td>SWR 331</td>
<td></td>
<td>Dr. E. Couch, Biology</td>
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There are no radioactive materials currently used or stored in this room.

Legend:
- = Rad work area
- = Rad storage area
- = Rad Waste area

as of 2/14
Radioactive materials are not stored here permanently. This area is only to be used for radioactive materials receiving.
Texas Christian University
Fort Worth, Texas

Radiation Survey

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<tr>
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<tr>
<td>RIC 259</td>
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<td>Dr. Joel Mitchell</td>
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= Rad work area
= Rad storage area
= Rad Waste area

as of 2/14
Radiation Survey

Location: Waste Storage Area

Date: 

Licensed User:
TCU Safety Department

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Fort Worth, Texas

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Coolant
Hallway
Cabinets

Only x-ray equipment in this room

SWR 338

= Rad work area
= Rad storage area
= Rad Waste area

as of 2/14

Coolant

Bruker Analytical X-Ray Machine
Model: A25-X1-1 Standard
SN: 4562
50 kV 60 mA

Desk

SWR 338

outside

SWR 339

N

Texas Christian University
Fort Worth, Texas

Licensed User:
Dr. Kayla Green
Radiation Survey

Location: SWR 480
Date: 2/14
Licensed User: Dr. Jeffery L. Coffer

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Texas Christian University
Fort Worth, Texas
X-Ray Diffractometer
Model: Phillips
PW1720
SN: 2096

Only x-ray equipment in this room

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Texas Christian University
Fort Worth, Texas

Radiation Survey

Location: SWR 127
Date: 
Licensed User: Dr. T.W. Zerda, Physics
Radiation Survey

Texas Christian University
Fort Worth, Texas

Location: DMC 003
Date: as of 2/14
Licensed User: Dr. Michelle Kirk

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Only x-ray equipment in this room

- Fluoroscope
- GE OEC HP mini-C-arm
- Fluke Model 451P Survey Meter
  - SN: 1828
  - 76 kVp, 0.143 mA

- Location:
- Date:
- Licensed User:

Diagram:
- Yellow circle: Rad work area
- Purple circle: Rad storage area
- Green circle: Rad Waste area

Legend:
- N: North
- Waiting Area
- Office
- Locker Room
- Hallway
- DMC 003
- Fluoroscope
- GE OEC HP mini-C-arm
- Fluke Model 451P Survey Meter
  - SN: 1828
  - 76 kVp, 0.143 mA
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Fort Worth, Texas

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Bone Densitometer
GE Lunar iDXA
SN: 200057GR

Office
Desk
Hallway
Outside

Only x-ray equipment in this room

RIC 256
Dr. Joel Mitchell

Location: RIC 256
Date: 
Licensed User: Dr. Joel Mitchell
Radiation Survey

Texas Christian University
Fort Worth, Texas

Location: SWR 243A
Date: 2/14
Licensed User: Dr. Rhiannon Mayne

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X-ray Fluorescence Machine
Bruker Tracer III-SD
SN: T3S1097