Sealed Source User Radiation Safety Training

If you **ONLY** wish to be added to a campus Radiation Use Authorization (RUA) that is strictly for possession and/or use of sealed radioactive sources, you must complete the UC Berkeley initial Sealed Source User Safety Training. (If you completed that training in a previous calendar year, you may also be required to complete the annual RUA retraining.)

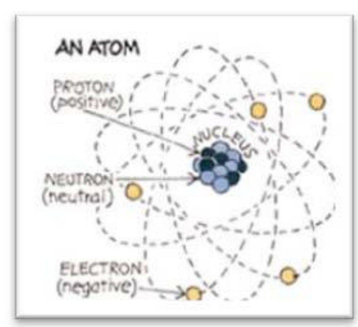
If you wish to be added to a campus RUA that authorizes both sealed radioactive sources and unsealed radioactive material, **STOP HERE** because you are required to complete the Radioactive Material (RAM) User class in place of this training. Information regarding the Radioactive Material User Training is available on the EH&S website at: **{**HYPERLINK "http://ehs.berkeley.edu/radsafety/training.html"**}**.

A common misconception is that another university's or LBNL's radiation training satisfies UC Berkeley's training requirements. However, radiation safety training from other organizations can't substitute for training provided by UC Berkeley. In particular, the radiation safety training and requirements for LBNL radiation use will be quite different from that at UC Berkeley, because the two institutions are covered by different regulations from different government agencies.

1) RADIATION PHYSICS

a) Basic Physics Review

i) The atom is made up of a nucleus of protons and neutrons, surrounded by a cloud of electrons. The number of protons and electrons determine the chemical nature of the atom. The number of neutrons determines if the atom is stable or radioactive.



ii) All isotopes of a particular element have the same atomic number (number of protons) but different atomic mass (number of neutrons). Because all isotopes of an element have the same atomic number, their chemical nature is identical. However, the radioactive nature of the isotopes varies.

iii) Unstable (or radioactive) isotopes emit energetic particles and/or electromagnetic (EM) radiation in the form of photons. All radioactive isotopes eventually decay to stable isotopes.

iv) Stable isotopes can be made radioactive (activated) by bombardment with energetic protons (e.g., in particle accelerators) or neutrons (e.g., in reactors).

v) Radioactive decay is a disintegration process by which a radioactive isotope radiates energy in order to become a stable isotope.

(1) Radioactive decay is random when observed for short periods. Only by observing over long periods of time does a regular pattern emerge. This pattern of decay we call the physical half-life.
(2) The half-life is defined as the time required for half of the atoms of a particular isotope to decay. The value of the half-life is specific to the isotope and may vary from microseconds to millions of years.
(a) The half-life has been determined for each isotope, and can be used to perform decay calculations.

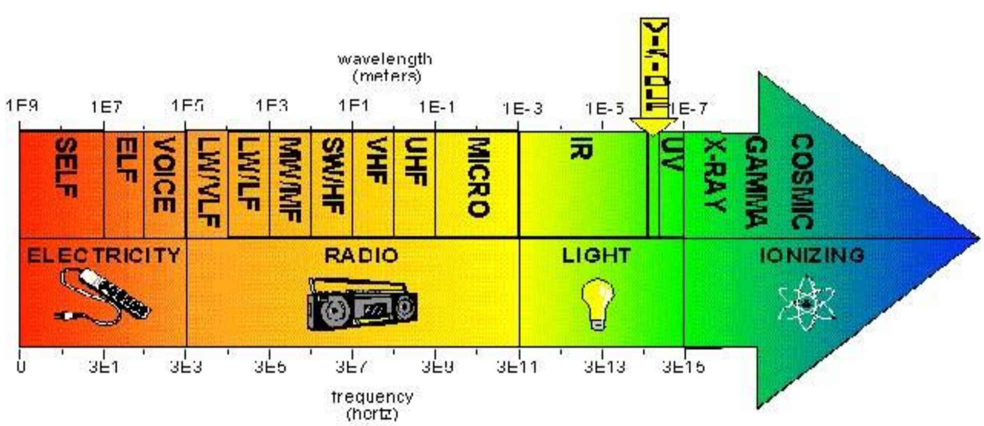
(b) As a rule of thumb, whenever an isotope has undergone 10 half-lives, enough atoms will have decayed to make the radiation field emitted indistinguishable from the "background" level.

b) Types of Radiation and Characteristics

i) Electromagnetic (EM) radiations (photons) differ from one another in frequency, wavelength and energy. The EM spectrum diagram below shows the break point between ionizing radiation and non-ionizing radiation. This training program will focus on ionizing radiation. By definition, ionizing radiation has sufficient energy to disrupt the structure of an atom, causing the formation of charged ion pairs. These ions can cause chemical changes (damage) in human tissue. Ionizing radiation may

ii) Ionizing radiation falls into two categories: directly ionizing and indirectly ionizing.

iii) Alpha radiation is directly ionizing. Alpha particles are Helium nuclei consisting of two protons and two neutrons. They have a charge of +2, a mass of 4 AU (atomic units), and are very energetic, on the order of 3 to 5 MeV (million electron volts; particle energy is measured in the eV or electron volt).



(1) The large charge and great mass makes alphas readily interact with matter, giving them a short range (a few centimeters in air).

(2) Alpha emitting isotopes are of no concern as an external radiation hazard, but can be a hazard if they enter the body by inhalation, injection, and/or absorption through the skin.

iv) Beta particles are directly ionizing energetic electrons emitted from the atom with a spectrum of energies. The average energy of the betas emitted is about 1/3 of the maximum energy beta emitted. The mass of the beta is 1/1800 of an AU and it has a charge of + (positron) or - 1.

The range of a beta particle depends on its energy and the material it is traveling through.

v) Bremsstrahlung (x-rays) and gamma rays are photons with no mass or charge. Gamma rays are emitted at a discrete energy which depends on the isotope, whereas bremsstrahlung consists of a spectrum. Photons are indirectly ionizing EM radiations with no charge or mass.

The range of EM radiation is theoretically infinite. Depending on the energy of the photon, a half-value layer may be determined for a specific shielding material that defines the thickness required to reduce the radiation field intensity by one half.

vi) Neutrons are indirectly ionizing particles with no charge, but with a mass of 1 AU. They are typically produced in particle accelerators, nuclear reactors, and isotopic neutron generators.

The energy of emitted neutrons will depend on their source, but will be observed as a spectrum.

c) Radiation Interaction with Matter and Attenuation (Shielding)

i) Radiation shielding is a matter of attenuation. Radiation deposits energy in the shielding material and is thereby attenuated. Energy deposited in the shield cannot be absorbed in tissue. This reduces the radiation hazard.

ii) The ranges of various charged particles are well known. These values can be used to determine the type and thickness of material required to reduce or stop this type of radiation.

(1) Alpha particles, due to their mass and charge, readily interact with matter and are stopped by a single sheet of notebook paper.

(2) Low Z materials should be used to shield beta particles (e.g., ^{90}Sr betas will be attenuated in 9.2 mm of Plexiglas). Neutrons are shielded with low Z materials such as water or borated polyethylene.

(3) Using high Z materials to shield betas may result in Bremsstrahlung production, replacing the beta hazard with an x-ray hazard. Users should not use lead to shield beta emitters without prior consultation with EH&S Radiation Safety.

(4) The range of EM radiation is theoretically infinite. Shielding is accomplished by use of the half-value layers. A half-value layer is the thickness of a material necessary to reduce the radiation intensity by 50%. Lead, concrete, or steel are among the best shielding material for photons. Contact EH&S Radiation Safety

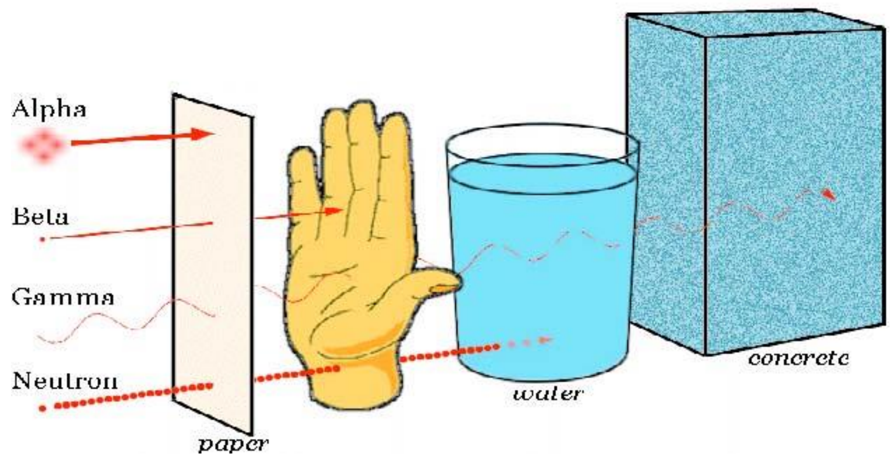
regarding shielding applications.

2) RADIATION UNITS

a) The Curie (Ci) is the unit of radioactivity. It is equal to 3.7×10^{10} (nuclear) disintegrations per second (dps) or 2.22×10^{12} disintegrations per minute (dpm). The international unit used is the Becquerel (Bq) which is equal to 1 dps.

i) Because the Ci is so large and the Bq is so small, we often use prefixes to define levels of activity. Examples of these prefixes follow:

(m) milli (10^{-3}) (K) kilo (10^{3})
(u) micro (10^{-6}) (M) mega (10^{6})
(n) nano (10^{-9}) (G) giga (10^{9})
(p) pico (10^{-12}) (T) tera (10^{12})



b) The Roentgen (R) is the unit of radiation exposure (ionization in air) for photons. The R (or mR) is the unit usually seen on the meter face of Geiger counters. 1R=2.58×10^{-4} coulombs/kg in air.

i) Radiation exposure field measurements are expressed in mR/hr exposure rates.

c) The Rad (Radiation Absorbed Dose) and Gray (Gy) are the units of absorbed energy dose to any material by any type of radiation. The Rad is most often used in medical applications or associated with beta radiation dose-rates.

i) 1 Rad = 100 ergs per gram. 1 Gray = 100 Rads

d) The Rem (Roentgen Equivalent Man) and Sievert (Sv) are units of dose equivalence that take into account the biological effects from the different types of radiation. These units are only applicable to humans.

i) 1 Sievert = 100 Rem.

ii) Dosimetry reports usually express the recorded radiation doses in mRem.

e) Quality Factors (QF) are used to take into account the different biological impact of different types of radiation, even when the energy deposited per gram of irradiated human (or animal) tissue (i.e. the number of rads) is the same.

i) Rad x QF = Rem. Quality factors are as follows:

(1) 1 for beta, gamma, and x-rays;

(2) 20 for alpha particles.

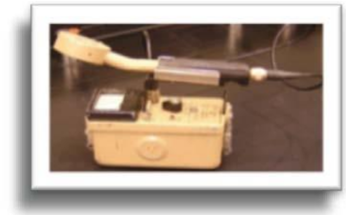
(3) Neutrons of unknown energy are assigned a quality factor of 10. Neutrons of known energy have a varying quality factor that range from 2 to 11 depending on their energy.

3) DETECTION AND MEASUREMENT

a) Ionizing radiation is not detectable with the human senses. Radiation survey instruments are therefore used to determine the presence of radiation fields.

b) Geiger Mueller (or GM) detectors are the most common type of survey instrument. They detect the ion pairs formed when beta, gamma or x-ray radiation cause ionizations in the gas in the detector. GM survey meters typically read out in cpm and cps, but can sometimes read in mR/hr.

i) The accuracy of GM survey meters depends on the energy of the radiation being measured. They are used to detect betas and gamma photons. While the GM survey meters may read out in mR/hr, they are usually calibrated in cpm and should not be used to determine actual dose-rates.



ii) GM METERS WILL NOT DETECT VERY LOW ENERGY BETAS.

c) Solid scintillator detectors utilize a solid (e.g. a NaI crystal) with a photo multiplier tube. These instruments are most useful in detecting

photon radiation. The thickness of the NaI crystal determines the energy efficiency of the detector. Thin crystals are used to detect low energy gammas (e.g., ^{125}I).

d) Counting efficiencies can vary widely depending on the isotope and the detection method. Counts per minute (cpm) are not the same as disintegrations per minute (dpm), but rather relate to one another as: cpm/efficiency = dpm. Consult with EH&S Radiation Safety to determine the detector efficiency for the isotopes you are working with.

e) Meter surveys are routinely performed to verify: the adequacy of shielding designs; checking for “streaming” dose-rates from gaps in the actual shielding configuration; and contamination control.

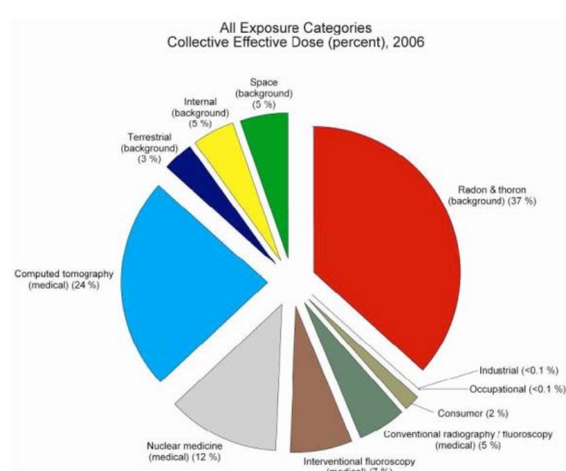
4) RADIATION BIOLOGY & ALLOWED RADIATION DOSES

a) Natural Background and Man Made Radiation Doses

i) Each of us receives about 300 mRem/year from naturally occurring radioactive material. These include solar cosmic radiation, radon (gases) from soils, and internal dose from K-40.

ii) We also receive about 70 mRem from man made sources, primarily from medical applications.

iii) Your altitude above sea level and the location and construction materials in your home also can influence your background dose (e.g., In Denver (the



“mile high city”), the background dose is about twice the dose is in Berkeley).

b) Internal verses External Exposure

i) External exposure is the passage of particulate or EM radiation into or through the body tissue from radiation sources that are located outside of the body.

ii) Internal exposure results from isotopes which have been deposited inside the body. Internal deposition can only result from one of the four entry pathways: ingestion, inhalation, absorption through the skin, and skin punctures. **For sealed source users, the only way to get an internal exposure is to mis-handle a sealed source that has been breached (e.g., leaking radioactive material).**

(1) Internal exposures can be avoided by: wearing gloves; using remote handling devices; and checking the source, source container, and work area for loose contamination after using the source.

(2) The biological half-life of any internally deposited isotope is determined by its residence time in the body and varies with the chemical nature of the element.

(3) The effective half-life takes into account both the biological half-life and the physical half-life of the isotope. The effective half-life is used in calculating the absorbed dose to tissue from a deposited isotope if it is shorter than either the physical or biological half-life.

c) Acute verses Chronic Doses and Effects

i) Chronic radiation doses are received over many years. The biological effects of chronic whole body doses up to regulatory limits (150 Rem over 30 years) have proven undetectable and may not exist.

ii) Acute radiation doses are received in a very short duration (e.g., a few minutes or hours).

(1) The biological effects of acute whole body doses under 10 Rem have been proven to be almost undetectable. At acute doses of 10 to 75 Rem, temporary changes in blood cell chromosomes have been observed.
(2) At acute doses of 75 to 300 Rem biological effects include erythema (skin reddening), and acute radiation syndrome (ARS - loss of hair, nausea, dehydration and possible death) have been observed.

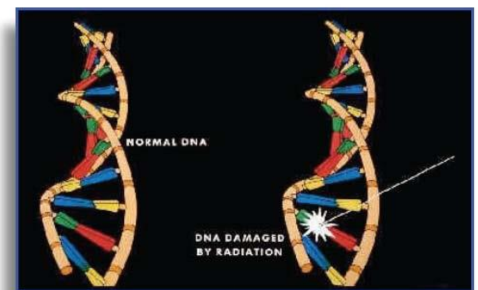
(a) The LD 50/30 for humans (the lethal dose for 50% of a population exposed within 30 days without medical treatment) is 300 to 350 Rem.

(3) At acute dose of > 550 Rem, 99% of those exposed may die without medical help and due to additional physical complications.

d) Somatic verses Genetic Effects i) Somatic effects occur in the person (or fetus) receiving the radiation dose. Somatic effects can be caused by acute or chronic exposure. Cataracts and cancer are somatic effects identified with radiation exposure.

ii) Genetic effects of radiation have been observed in animals. These are effects to the offspring of male or female animals that were exposed before conception occurred and are due to damage to the egg or sperm. Genetic effects have not been observed in humans, but are believed to occur based on animal studies.

(1) The BEIR VII (Biological Effects of Ionizing Radiation) report (2006) from the National Academy of Sciences uses information from the Hiroshima and Nagasaki atomic bomb survivors and various epidemiological and experimental studies to estimate the additional cancer induction risk from low level exposures to ionizing radiation.



(a) NAS study estimates additional cancer induction risk to be slightly higher than earlier BEIR reports but overall very low (<0.1% increase) in the low dose regions (1000 to 10,000 mrad).

(b) In the absence of radiation exposure, the cancer rate is about 25% in the US (that is, overall about one in four people will develop cancer during their life).

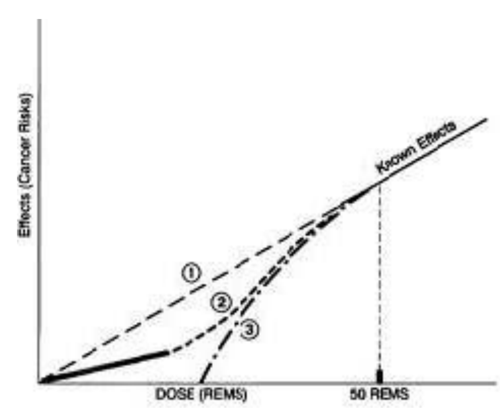
e) Radiation Risk Models and the ALARA Concept

i) Because of the uncertainty of human health effects at low radiation doses, a number of dose/response models have been proposed.

(1) The linear model of dose response assumes a direct relationship between radiation dose and effects down to zero exposure. (#1 on graph)

(2) The quadratic model indicates there may be limited risk present at low doses. (#2 on graph)

(3) The threshold model assumes a "threshold" dose of about 10 Rem must be received in order to see any effects. (#3 on graph)



ii) Most experts and regulators agree that the linear model presents the safest assumption of the risk relationship for radiation exposure. This view drives the ALARA concept which aims at keeping radiation exposures **A**s **L**ow **A**s **R**easonably **A**chievable.

f) Risk verses Benefit

i) While there are no unique risks associated with radiation exposure, it is well understood that there are substantial benefits resulting from radiation use.

ii) Below is a table of comparative risks associated with everyday activities verses exposure to ionizing radiation.

Health Risk	Estimated Life expectancy lost
Smoking 20 cigarettes a day	6 years
Overweight (15%)	2 years
Alcohol (US average)	1 year
Auto Accidents	200 days
Occupational Radiation Dose (300 mRem/yr)	15 days
Occupational Radiation Dose (1 Rem/yr)	51 days

5) ALLOWED OCCUPATIONAL RADIATION DOSES

a) The allowed Total Effective Dose Equivalents (TEDEs) are published in Title 17, CCR (California Code of Regulations). The TEDEs include both the external dose (measured and calculated) and the internal dose (bioassay) received by the individual during the calendar year.

UID (look up this number – which is NOT your employee or student ID number -at {HYPERLINK "https://calnet.berkeley.edu/directory/"} . If you can't look it up, just leave box blank, please don't guess):	
Last name:	
First name:	
Middle name:	
e-mail address:	

b) The occupational (whole body) TEDE is not allowed to exceed 5,000 mRem/year.

c) The (shallow) dose to the skin of the whole body is not allowed to exceed 50,000 mRem/year.

d) The dose to the extremities (from the elbows down and from the knees down) is not allowed to exceed 50,000 mRem/year.

e) The dose to the lens of the eye is not allowed to exceed 15,000 mRem/year.

f) The dose to any individual organ is not allowed to exceed 50,000 mRem/year.

g) The fetal TEDE is not allowed to exceed 500 mRem during the 9 month gestation period.

h) The (whole body) TEDE for the general population or a minor (under 18 yrs of age) is not allowed to exceed 100 mRem/year.

6) SEALED SOURCES

a) Title 17, CCR, UCB's Radiation Safety Manual, and the UCB Radioactive Materials License addresses the definition and management of sealed radiation sources.

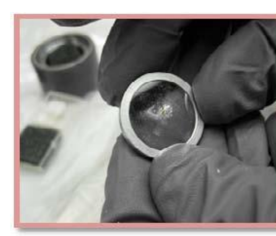
b) A sealed source is permanently encapsulated in such a manner that the radioactive material will not be released under the most severe conditions likely to be encountered in the transportation, use, or storage of the source.

i) Types of sealed sources at UCB include: plated sources; encapsulated for calibration purposes; electron capture devices in gas chromatographs; sample irradiators, and ionization static eliminators and neutralizers.

(1) Additional sources may be classified as "sealed sources" by the manufacturer (e.g., exit signs, smoke detectors)

ii) Sealed sources should always be accompanied by a Sealed Sources & Device (SS&D) registry certificate from the manufacturer. Otherwise, the source may be classified as unsealed radioactive material. Contact the manufacturer to get a copy of the SS&D.

iii) Many items on campus get referred to as "sealed sources," when in fact they may be thin window foils. **Never touch or tape the active area of foil sources. Sealed sources are not indestructable.**



(1) These types of sources can be easily torn or accidentally destroyed exposing the user and surrounding areas to loose radioactive material. These types of sources should be handled with great care in order to avoid accidental contamination.

(2) It's also worth noting that sources, including sealed sources in devices, can degrade over time and begin to leak. Often these types of sources will be rated with a shelf-life and should be replaced when they exceed that shelf-life. The manufacturer should provide you with the expected shelf-life of the sealed source.

iv) Some sealed sources are now required to be included in the Increased Controls (IC) program (e.g., ^{137}Cs sample irradiators) which requires additional controls and clearances, including background checks by UCPD. The process of getting clearance can sometimes be time consuming. Contact EH&S Radiation Safety early on if you are planning to use a sealed source requiring IC controls.

c) RUA Precautions: You should periodically review your RUA precautions, as the precautions may specify PPE requirements and or handling procedures that are designed for your safety. Not following the precautions can cause accidents, area contamination, and personnel exposures.

d) <u>Leak test</u> is defined as wiping the most accessible area (but not directly from the surface of a calibration or other thin window source) where loose radioactive material would accumulate if the integrity of the sealed source was breached in order to determine the amount of radioactive material released.

i) Semi-annual leak tests are required on all alpha and neutron emitting sealed sources > 10 uCi and beta/gamma emitting sealed sources > 100 uCi. These leak tests are performed by EH&S Radiation Safety staff during routine or renewal surveys. Additionally:

(1) Gas chromatography sources (e.g., ^{63}Ni foils) and ^{210}Po static eliminators are considered sealed sources and require leak testing on a semi-annual basis as specified by the manufacturer.

(2) Sealed gas sources, ^{3}H-3 and ^{85}Kr, are exempt from leak testing.

e) A semi-annual comprehensive physical inventory must be performed <u>by the RUA Holder</u> on <u>all</u> sealed sources and/or devices being held under their RUA. The EH&S Radiation Safety staff will verify the completion of the physical inventory during routine and renewal surveys.

i) Document completion of the inventory: in the RUA Logbook with initials and date; with an initialed copy of the RSIS sealed source inventory; or in the Lab Contact's files. This documented inventory must be retrievable at any time and kept until the RUA is terminated.

ii) Sealed sources containing quantities of radioactive material that are not required to be leak tested, should be checked for contamination, including the storage location, on a regular basis by the RUA Holder during their routine work activities or the semiannual inventory.

iii) Contact EH&S Radiation Safety if any leakage of radioactive material is found or suspected during the semi-annual inventory. Never handle these sources without disposable gloves.

f) It must be determined in all cases which sources are in fact considered "sealed". Contact the EH&S Radiation Safety if there is any questions.

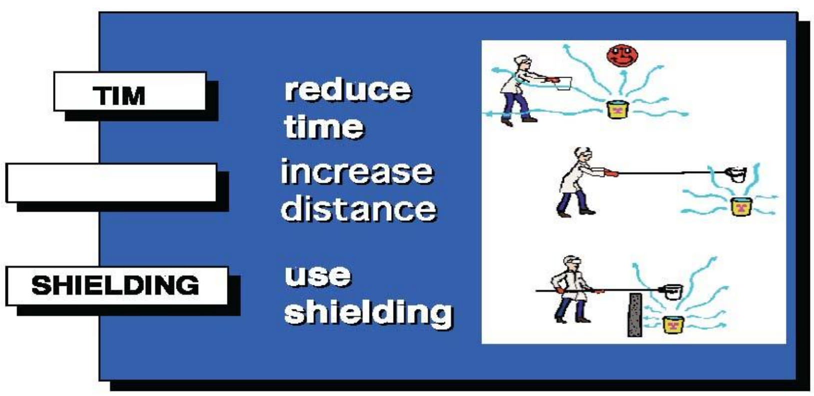
7) RADIATION CONTROL METHODOLOGY

a) The ALARA Concept

i) Simply stated, the ALARA concept is the practice of maintaining radiation exposures to levels **A**s **L**ow **A**s **R**easonably **A**chievable. This philosophy is the basis of modern radiation protection.

b) Limiting External Radiation Exposure

i) The three basic elements to be considered in an external radiation protection program are time, distance, and shielding.



(1) Time: Radiation field measurements are always expressed as a rate (i.e. mRem/hr or cpm). The amount of time spent in a radiation field should be kept to the minimum required to perform the task.

(a) EM radiation follows the inverse square law. The intensity of the radiation field decreases with the inverse square of the distance from the source. For example, standing twice as far from a source will reduce the radiation field intensity to 1/4 (2^2) of the original intensity.

(2) Distance: Maintain the maximum distance possible from EM radiation sources that will still allow the work to be done. The decrease in intensity will be dependent on the isotope and present activity of the sealed source.
(a) From a point source (e.g., a uCi instrument check source), a distance of a few centimeters can greatly reduce the dose to the extremities. While a using tongs may be required to handle a mCi ^{137}Cs or ^{60}Co source)
(b) Particulate radiations (alpha, beta and neutrons) obey the inverse square law but also have finite absorption ranges.
(c) While it is appropriate to maintain the maximum distance possible from particulate radiation sources, shielding is more effective in reducing dose.
(3) Shielding: Shielding is used to reduce field intensity by attenuating the energy of the radiation. Always use the appropriate shielding for the isotope being used. For particulate radiation, use a thickness of shielding at least 10% greater than the particle range in the shielding material.

(4) A fourth "good practice" is to reduce the overall number of sources when possible or practical. Contact EH&S Radiation Safety for disposal of unwanted sealed sources.

c) Preventing unexpected radiation exposures

i) Radioactive contamination from a sealed source is when source's encapsulation has been breached releasing unwanted loose radioactive material in places or on people. There should never be dispersible contamination when properly working with sealed sources.

ii) Personal Protective Equipment (PPE) (e.g., disposable gloves, lab coat) is used to minimize accidental deposition of RAM on the worker if the source is breached. The RUA will specify the PPE requirements for the work activities.

(1) Lab coat – With sleeves long enough to cover the arms to the wrists, and long enough to cover the torso to the thighs. Wear with the closures fastened.

(2) Disposable gloves – Worn to protect the skin of the hands and wrists. Specialty gloves may also be recommended depending on the isotope and dose-rate. Don't forget to survey your hands and PPE as specified by your RUA.

iii) Appropriate remote handling tools – Serves the dual purpose of reducing the potential for hand contamination while reducing extremity and whole body doses (e.g., tweezers, forceps, tongs, shields, and shielded containers). This offers you shielding as well as adding some distance between your extremity and whole body to the sealed source.

d) <u>Survey Monitoring Methods</u> - Radiation monitoring (surveying) is required as specified in your RUA conditions. Failure to monitor as required may result in an unplanned personnel exposure and/or the spread of contamination from a leaking source.

i) Survey Meter Monitoring -Survey meters are used to determine the approximate location and gross nature of the dose-rate and/or contamination and adequacy of shielding. With the exception of very low energy betas, virtually all beta and gamma emitters can be detected with a GM (Geiger Mueller) survey meter.

(1) Some sealed sources contain alpha (e.g., ^{210}Po) or neutron (e.g., ^{241}AmBe) emitting isotopes. An alpha meter or neutron meter must be used for these surveys.

(2) Loose contamination -The appropriate survey method is to position the probe surface ¼” (alpha) or ½” to 1” (beta) above the suspected surface and then slowly "paint" the area, listening for variations in the click rate. You must monitor slowly (about one probe width per second) and at close range to accurately determine if there is loose contamination.

(3) Dose-rates - Ion chambers are recommended for sealed sources where there is a dose-rate > 2 mR/hr at 30 cm from the exterior of the source. Review your RUA to determine if a survey meter is required. The RUA Holder is responsible to provide the survey meter.

ii) Wipe (Swipe) Monitoring – EH&S Radiation Safety routinely uses this method to confirm if a sealed source’s integrity has been breached allowing the unwanted release of radioactive material. It is the only reliable method for quantitative determination of contamination levels.

(1) Your precautions will specify if you are required to perform wipe tests on a routine basis and the counting methodology. Not all RUAs require wipe surveys. If you suspect a breached source, you can perform a wipe survey and contact EH&S Radiation Safety.

(a) Contamination levels are normally expressed in cpm/100 cm^2 but require conversion to dpm/100 cm^2 for regulatory reporting requirements. Wipe methods involve wiping ~ 100 cm^2 surface with a wipe material (filter paper or Q-tip for hard to reach areas) and then counting the wipe in the LSC or with the GM. A background (uncontaminated) wipe is counted as a blank control. Check your RUA to determine if counting the swipe with the GM is allowed.

iii) Record Keeping - Documentation of all self-surveys (dose-rate and contamination) must be maintained. These forms are also used to document incidents. Check your RUA to see if you are required to perform self-surveys. Blank self-survey forms are available on the EH&S website at: **{** HYPERLINK "http://ehs.berkeley.edu/radsafety/forms.html" **}**

(1) The dose-rate and wipe locations should correlate to a survey map by means of numbers so that the elevated areas (dose-rates or contamination) can be easily identified, decontaminated, or the source relocated/shielded, and resurveyed.

(2) Records should be maintained until the RUA is terminated. The records should then be returned to EH&S, Radiation Safety.

iv) Decontamination – If a source is suspected of leaking or has been breached and equipment/areas may have become contaminated:

(1) Immediately notify EH&S Radiation Safety if there was a possibility of skin, clothing, or area contamination for assistance with defining the extent of the contamination.

(2) Do not decontaminate the area or any sealed sources without the assistance of EH&S Radiation Safety.

(3) Dispose of any contaminated waste from decontamination efforts in an appropriately marked rad waste can.

v) Emergencies -**Report potential personnel exposures, elevated dose-rates, or contamination incidents to EH&S immediately. Assist medical requirements.**

(1) If possible, remove the individual from the source of radiation

(2) Isolate any potentially contaminated areas to prevent the spread of the radioactive material

(3) Keep all involved personnel near the area until someone from EH&S Radiation Safety has responded to assist you.
(4) THE MOST IMPORTANT THING TO REMEMBER ABOUT AN EMERGENCY IS TO CALL EH&S RIGHT AWAY!
(a) Radiation Safety: call 2-3073 during business hours.

(b) After hours: call 911 from a campus phone or 510-642-3333 from a cell phone and ask for UCB Radiation Safety.

e) Dosimetry

i) Dosimeters are small wearable devices that monitor and record your radiation dose.

(1) They may be issued as a whole body dosimeter or extremity dosimeter (ring). Check your RUA to see the prescribed type of dosimetry as your RUA may not require dosimetry or only under specified conditions (e.g., handling sealed sources with dose-rates > 1 mR/hr/mCi @ 1 meter). The form for requesting a dosimeter is available on the EH&S website at: **{**HYPERLINK "http://ehs.berkeley.edu/radsafety/forms.html"**}**.

ii) Assigned dosimeters:

(1) Must be worn as required by the RUA. Whole body dosimeters should be worn on the center of the chest and TLD rings should be worn under the disposable glove on the hand expected to receive the highest exposure. The TLD ring should be oriented with the TLD chip (under the name label) facing the radiation source,

(2) Stored away from sources, dose-rates, and in an area free from radiation fields when not being worn, and

(3) Always exchanged on a timely basis.

iii) Notify EH&S Radiation Safety:

(1) If you have lost or have contaminated the dosimeter,

(2) If you are working with radiation at an institution other than UCB so that your dosimetry results can be requested,

(3) Of any medical procedure or travel that may cause an exposure to your dosimetry or affect bioassay results, or

(4) Any change in work involving radiation so that an evaluation can be performed to determine whether dosimetry is needed or not.

f) Posting, Labeling, and Marking

i) At a minimum, all sealed sources, radioactive material (RAM) use areas, equipment, and storage containers must be marked with the radiation trefoil symbol, and where possible, the words “caution radioactive material”

Radiation Safety
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(1) Failure to mark RAM with the trefoil symbol is the most common cause of

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new locations, change in experiment description, acquisition or dispos
of sources.

unplanned exposures, lost sources, contaminated equipment, and potential spread of contamination to unauthorized areas and personnel.

ii) Each sealed source shall be marked with the RSIS assigned SS#, isotope, activity, and original activity date.

iii) Controlled areas are designated by a RAM or Radiation Area sign. Uncontrolled areas cannot exceed a dose rate of > 2 mR/hr, 100 mR/week, or 500 mR/yr.

iv) Posted Radiation Areas may have whole body dose rates between 5 to 100 mR/hr. High Radiation Areas may have whole body dose rates between 100 to 5,000 mR/hr.

g) Laboratory Hygiene – Appropriate housekeeping must be maintained in the RAM work areas at all times.

i) Do not allow clutter to accumulate. The fact sheet for "Clutter as a Laboratory Safety Concern" can be found at: **{** HYPERLINK "http://www.ehs.berkeley.edu/pub/factsheets/70cluter.pdf" **}**

ii) The storage and/or consumption of food or beverages are prohibited in laboratories working with hazardous materials. The Campus policy for food and beverages in laboratories can be found at: **{** HYPERLINK "http://campuspol.chance.berkeley.edu/policies/foodinlabs.pdf" **}**.

h) Responsibilities

(1) Normally, all sources should be kept under lock and key when use or a user is not in direct attendance. Challenge anyone entering your lab that you do not know. Check your RUA to confirm security requirements.

ii) **It is the responsibility of the Principal Investigator (PI) to assure that the material is secure and kept under their control at all times.**

i) All authorized sources of radioactive material, areas in which the material (sources) is

(2) The inventory is required to be kept up to date and maintained in the Radiation Safety Inventory System (RSIS) and checked on a regular basis to assure the

accuracy of the RSIS information (i.e., location change). Information on accessing RSIS is available on the EH&S website at **{**HYPERLINK "http://ehs.berkeley.edu/radsafety.html"**}**

(a) Users should update RSIS whenever a source's storage/use location is changed. This is done by selecting the source in RSIS and choosing "change location" from the drop-down menu. This is especially important for sources that are permanently installed in a device or machine (e.g., LSC counter, static eliminators, gas chromatographs, density gauges)

(b) Basic instructions for using RSIS with sealed sources is available on the EH&S website at **{** HYPERLINK "http://ehs.berkeley.edu/radsafety/rsissealedsourced.pdf" **}**

(3) In some cases, the use of a check-out log may be appropriate in maintaining control over source disposition.

iii) Immediately report any lost, missing, or unexpected sources that are not on your RSIS inventory to EH&S Radiation Safety. Also report any suspected contamination, leaking sources, or potential personnel exposure.

8) UCB RADIATION SAFETY PROGRAM DOCUMENTS

a) You should read and be familiar with the documents in items below. These documents define and explain the UCB Radiation Safety Program. If you are interested in the California regulations, copies of the Title 17, California Radiation Control Regulations and the UCB Radioactive Materials License are available for review at the Radiation Safety, 3rd Floor University Hall (2-3073).

i) A copy of the current campus Radiation Safety Manual is available on the EH&S website at **{**HYPERLINK "http://ehs.berkeley.edu/radsafety.html"**}**. This document outlines the UC Berkeley Radiation Safety Program and gives instructions on how to obtain, modify, or terminate an RUA.

ii) The RUA (Radiation Use Authorization) document should be posted in your work area. This document gives detailed information on the isotope(s) and activity of the sealed sources authorized, the persons allowed to use the sealed sources, and the specific safety precautions required for their use.

iii) A current copy of the campus Radiation Safety Logbook is available on the EH&S website at **{**HYPERLINK "http://ehs.berkeley.edu/radsafety.html"**}**.

iv) The Radioisotope Safety & Emergency Procedure poster (often referred to as the yellow sheet) should be found posted in all areas designated on the RUA. The poster covers the basics of using RAM at UCB and emergency response. This poster is available from EH&S Radiation Safety and from the EH&S website at: **{**HYPERLINK "http://ehs.berkeley.edu/radsafety.html"**}**.

v) The Notice to Employees should be found posted in a conspicuous location in all buildings in which RAM is used. The poster covers the rights and responsibilities of RAM users under California law.

9) Questions? a) Who is the EH&S Radiation

Safety Team? i) We assists Campus Users As

Follows:

- Provide safety information
- Identify, assess, and mitigate hazards
- Provide safety consulting
- Assist users with regulations

❿ Provide emergency response b) Please do not hesitate to contact us if you have any questions or

concerns.

Note!! You are not authorized to start work with sealed sources until you have received credit for completing this training and been added to the specific RUA.

In order to receive credit for completing this initial sealed source user training AND be place on the RUA, you must complete the following form, sign, and submit a copy to EH&S Radiation Safety as noted below.

Sealed Source User Record of Training Completion (RD-52)

Please print legibly to assist us in crediting you with completion of this training.

By my signature, I confirm I have read the training material titled *"Sealed Source User Radiation Safety Training"* and

Health Risk	Estimated Life expectancy lost
Smoking 20 cigarettes a day	6 years
Overweight (15%)	2 years
Alcohol (US average)	1 year
Auto Accidents	200 days
Occupational Radiation Dose (300 mRem/yr)	15 days
Occupational Radiation Dose (1 Rem/yr)	51 days

UID (look up this number – which is NOT your employee or student ID number -at {HYPERLINK "https://calnet.berkeley.edu/directory/"} . If you can't look it up, just leave box blank; please don't guess):	
Last name:	
First name:	
Middle name:	
e-mail address:	

understood its contents.

____________________ Month/Day/Year

Please keep a copy of this completed form in your files.

Mail, fax, or email form: **Attn: EH&S Radiation Safety**, 317 University Hall, Mail Code 1150, FAX: 510 643-7595, **{**HYPERLINK "mailto:radtraining@berkeley.edu"**}**