# Radiation Safety Principles and Work Rules

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

## 1. Control of External Exposure

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

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

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

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

External radiation from beta rays is rather simply controlled. A few millimeters of solid material is sufficient to totally absorb most commonly encountered beta radiations. Where radioactive material emits both beta and gamma radiations, shielding considerations will be controlled by the gamma radiation. One must also recall that beta rays produce a penetrating x-ray called Bremsstrahlung.

The intensity of Bremsstrahlung varies directly with the square of the energy of the beta radiation and the average atomic number of the shielding material. Low atomic number materials such as lucite or glass should, therefore, be used for shielding of beta radiation whenever possible. When working with energetic beta emitters, care must be taken to avoid exposing hands above opened containers where the dose rate can be on the order of rads per minute for commonly used quantities of beta emitters such as phosphorus-32.

## 2. Control of Internal Exposure

Distance, time and shielding are obviously not available for protection when the source of radiation is internally incorporated into the body. Incorporation of radioactive material into the body is most easily controlled by preventing exposure to unsealed sources of radioactive material. All significant quantities of unsealed radioactive material must be used inside properly designed exhaust-ventilated enclosures.

In a well-designed low moderate level laboratory, protective clothing consisting of laboratory coats and rubber or plastic gloves should be worn when working with radioactive material. A second reason for preventing radioactive contamination is based on interference with technical considerations, avoiding contamination of radiation measuring instruments and cross-contamination of experiments. If this technical contamination is controlled, internal exposure of laboratory personnel will usually not be a serious problem.

## 3. Work Rules

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

1. Do wear lab coats and impermeable gloves when working with radioactive material.
2. Do work with radioactive material in an exhaust-ventilated enclosure.
3. Do store and transport containers of radioactive solutions on trays that will hold the contents of the primary container in the event of breakage.
4. Do line trays and working surfaces with absorbent paper. Absorbent paper with an impermeable base is commercially available.
5. Do keep radioactive solutions in sealed containers.
6. Do clearly label all containers of radioactive material and post all radiation and storage areas with the standard radiation warning symbol. Labels on containers should bear the legend, "**CAUTION – Radionuclide**" and quantity of radioactive material, and the date of assay.

   Placards for posting of radiation and storage areas should bear the legend, "**CAUTION Radioactive Materials**".
7. Do conduct work with radioactive material in accordance with written radiation safety and operating procedures.
8. Do carry out new procedures in a "dry run" with inactive materials before using radioactive material.
9. Do monitor around work areas after each procedure where there is any possibility of contamination and otherwise on a regular periodic basis. Keep records of such surveys.
10. Do clean up spills promptly.
11. Do not eat, drink, smoke or apply cosmetics in areas where unsealed radioactive materials are used.
12. Do not pipette by mouth.