

## **SOME SPECIFIC PROCEDURES AND RULES FOR THE INAA LABORATORY**

### **Receipt and Cleanup of Samples**

Personal exposure to radiation and the possibility of a contaminating accident are greatest during the time samples are processed after being returned from the reactor. The samples are most intensely radioactive at this time. The aluminum foil used to hold the sample tubes together is particularly nasty. It contains high levels of  $^{24}\text{Na}$  produced from the Al as well as a variety of other radioactive isotopes from impurities in the foil. Unlike a cleaned silica tube, it can contaminate anything it touches (gloves, paper towel, forceps). Treat it accordingly. Wear gloves when removing the foil and put the foil in the waste bag provided in the back of the hood. Until washed, the silica tubes should be treated as having surface contamination. They contain  $^{24}\text{Na}$  from fingerprints and from contact with the Al foil. Some specific instructions:

(1) Wear glasses or safety goggles to protect your eyes from beta radiation and the possibility of an exploding tube. If you're helping someone else, be sure to remind him (=Randy) to put on safety glasses.

(2) Never unpack samples alone; be sure someone is in the room in case you need assistance.

(3) Record all required exposure readings in the log book and the "Radioactive Shipment Receipt Report."

(4) Check the can and Pb pig in which the samples are shipped for contamination. If the can is not contaminated (it never has been), throw it in the regular trash after removing the "Radioactive" labels. The inside of the pig may give a positive reading if the samples were shipped back without a plastic bag. If it is, use an acid squirt bottle to wash the inside of the pig and pour the wash acid in a liquid waste container to evaporate. (This is physically difficult to do because the pig weighs 30 lbs. Get help if you need it.) Record the occurrence in the log book. Take a wipe on the outside of the can and the outside of the lead pig. Put the wipes on a piece of paper, label which is which on the paper, and remind Randy to measure them.

(5) Be sure to put all the Al foil in the radioactive trash bag. Gloves and paper towels should be put in a plastic bag and stored in the hood. After at least a week, check the bag with a

survey meter. If the reading is at the background level (which it usually is), the bag can be put in the regular trash. If not, dispose of it in the radioactive trash bag.

(6) Once the tubes are cleaned, there is no danger of *contamination* from touching the tube. You should wear gloves at least until the time the Al is disposed, the tubes are washed, and the wash liquids have been poured into the containers in the dishpan. Be careful not to touch anything outside the hood with a contaminated, gloved hand (e.g., survey meter, door handle, your nose).

However, both the silica tubing and the rock samples inside are radioactive, thus touching the tube results in *exposure*, but not in *contamination* of your fingers. The sample is emitting gamma rays to which the tubing is essentially transparent. This is the radiation we observe on the gamma-ray detectors. Because we only measure the gamma-rays it's easy to forget that they also emit beta radiation. Most beta particles from the sample do not pass through the silica tube. However, high energy betas, such as those from  $^{32}\text{P}$  (a major activation product in terrestrial rocks, with a half-life of 14.3 days), are not totally shielded by the tube. These can result in a significant dose to the skin with prolonged exposure.

The tubing is also radioactive, and that requires some explanation. The tubing is made of ultrapure silica ( $\text{SiO}_2$ ), so there is practically no radiation associated with activation of impurities in the tubing (this is important to our analysis because the mass of a tube is much greater than the mass of the sample inside). Fortunately for us, the oxygen in the silica does not activate with thermal neutrons and silicon activates only poorly. Even more convenient, the only radioactive isotope of silicon that is produced in the irradiation is  $^{31}\text{Si}$ , which has a half-life of only 2.6 hours, so it has decayed away by the time we receive our samples. However, because the half-life of  $^{31}\text{Si}$  is short compared to the irradiation duration (12–48 hours), some  $^{31}\text{Si}$  produced in the tubes during irradiation decays to  $^{31}\text{P}$  during the irradiation and this is converted to  $^{32}\text{P}$  by neutron capture. Thus, the silica tubes themselves are emitting high-energy betas, even during the “long count.” This is why the irradiated empty tubes register on the survey meters a few weeks after irradiation even though we see no peaks in the gamma-ray spectrum.

(8) Be certain to remove all “Radioactive” labels from the shipping box before throwing it out or taking it home.

## Exposure

Remember, there are three ways to minimize personal exposure:

- 1) minimize exposure time
- 2) increase distance
- 3) increase shielding

Alone or in combination these methods can be used to minimize your exposure. Lead bricks are not totally opaque to gamma rays. For the 1332 keV peak of  $^{60}\text{Co}$  or the 1368 keV peak of  $^{24}\text{Na}$ , for example, 4% of the gamma rays will pass through a 2-inch Pb brick.

## Survey Meters

Learn how to use these things. They are calibrated in two scales, mR/hr and counts per minute (cpm). Area readings should be recorded with the mR/hr scale. To do a wipe test, moisten a Kimwipe and wipe an area of about  $100\text{ cm}^2$  (4" x 4"). Hold the wipes as close to the detector as possible without touching it. Take all survey meter readings of low-level materials (wipes, the can, the Pb pig) in a region of the room with low background (like near the windows). Never record a reading of "0", use something like "<0.02 mR/hr" or "<20 cpm". See Chapter 14 of the Radiation Safety Manual.

One survey meter should always be kept in rooms 344 and 346.

## Security

The only areas where radioactive materials should be left unattended are in the hood in room 346, the detectors and storage areas in room 344, and the sample storage area in room 350. Do not leave radioactive samples lying around anywhere else.

## Joking

Many people have a fear of radioactivity. We have a responsibility to other people in the Department to work with radioactive materials in a safe manner. We also have the responsibility to put their minds at ease, regardless of how irrational their fears might be from our point of view. Bottom line: Don't make glow-in-the-dark jokes, etc. Assure our visitors and colleagues that we only work with small amounts of radioactivity (which is true), that we go to great lengths

to prevent exposure to ourselves and everybody else in the building (also true), and that all our procedures are monitored by the University Radiation Safety Office (also true).

## **Pregnancy**

If you are pregnant, think you are pregnant, or are intending to be pregnant, read Chapters 13 and 15 of the Radiation Safety Manual.

## **In Case of a Spill**

The procedures to follow in case of a “spill” are listed on the yellow “Emergency Procedures” sheets posted in rooms 344 and 346. However, these instructions appear to assume that the spilled radioactive material is a liquid. We don’t use liquids; all of our radioactive material is powdered or granular solids. For us, a “spill” would be the breaking of a silica tube containing radioactive rock. The instructions for a “minor spill” would apply to nearly any situation we might have. A “major” spill would be the breakage of a large number of tubes, the explosion of a tube such that the contents were scattered, the inadvertent spread of contamination because a broken tube was not immediately detected, or the contamination of a person and associated clothing.

If you break a tube, don’t panic. It’s not the end of the world (Randy’s done it several times). Try to prevent the spread of contamination. If radioactive powder is spilled on you or your clothing, do not move unnecessarily. Do not touch anything needlessly. If this means that you have to wait for someone to find you, then so be it. You shouldn’t be working alone, anyway, except to change samples. If material is spilled on or exploded onto your clothing or if you step on a tube, you should remove the offending clothing or shoe, preferably with someone else’s assistance. Place these in a plastic bag. *Advice:* Wear a lab coat when unpacking samples.

The best way to cleanup spilled powder is with moist paper towels. Wear gloves. Put the towels in plastic bag for disposal in the radioactive waste. Survey the area (see instructions on “Emergency Procedures” sheet). There is a spill cleanup kit in room 344 near the sample storage shield.

Sometimes, improperly sealed tubes are discovered during the washing step after they are returned from the reactor. These can usually be remedied with a drop of epoxy glue or by

resealing with the oxygen torch. If a tube is returned broken from the reactor, the contamination is easily contained in the hood. Wrap the broken tube in paper towel and dispose in the radioactive waste. Wash the remaining tubes as usual, being particularly careful to contain the wash liquids.

If a tube is broken in the counting lab, the effect of the contamination on our analyses may be of far greater impact than any possible health hazard. It is very important that such a leak be contained and cleaned up thoroughly. Do not hesitate to contact Randy. He will be cheerful and will not abuse you. Again, a wet paper towel is the best cleanup tool. Adhesive tape is sometimes also useful. *Advice:* During a sample change, never remove a silica tube from the plastic tube until you are holding it over the storage area where the other samples are kept. That way, if it falls it won't go far.

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