APPENDIX - V GUIDE TO LABORATORY SURVEYS

Introduction

Routine laboratory surveys are an important part of the overall radiation safety program in a laboratory. Surveys provide a direct measure of the presence of radioactive material inadvertently spilled on a person, surface or piece of equipment, and are an indication of the radiation hazard during an experiment. It is vital that individuals working with radioactive materials are aware of accepted procedures for performing such surveys. The information which follows is a suggested guide for performing surveys of laboratory areas. Questions about the mechanics of performing surveys or the interpretation of this guide may be referred to the Radiation Safety Section.

What Is Contamination?

There are two types of contamination - "REMOVABLE" and "FIXED". Removable contamination is that which may be wiped off a surface or object, similar to dust on a piece of furniture. The presence of removable contamination is determined by wipe tests, and in some situations by the use of a survey meter. If contamination is present in large enough quantities and is removable, it may also be detected by a survey meter when a wipe test of the surface is placed near the probe. Fixed contamination is that which has become bound by chemical or other means to the surface upon which it was deposited. This form of contamination can only be detected by a survey meter. Because it is fixed to the surface, a wipe test will indicate no activity. A meter survey may indicate that large quantities are indeed present on the surface.

What Is a Survey?

A survey is an evaluation of work areas, instruments and apparatus, floors, sinks, faucet handles, drawer fronts, doorknobs, telephones, light switches, refrigerators, etc. for the presence of radioactive contamination. The following methods can be used to perform a survey:

1. wipe test
2. survey meter scan

Survey results should be documented. These records should also be kept in such a manner that all information is readily obtainable by laboratory staff, for inspection by the Radiation Safety Section, and Federal and State Regulatory Agencies.

How is a Wipe Test Survey Performed?

A filter paper, such as Whatman 41 or its equivalent, should be used. An area of ~ 100 cm^2, or an object, is simply wiped with the filter paper. The filter paper is then placed in a liquid scintillation vial with a sufficient quantity of scintillation cocktail (Optifluor, Ultima Gold or an approved equivalent) and counted in a liquid scintillation counter (LSC). It is necessary to establish a background level. To do this, follow the above procedure with an unused filter paper. Be certain that the LSC is equipped to count all the isotopes that may be used in the laboratory (see next section). The amount of contamination is the difference between the count rate of the actual wipe test and the background count rate. An area should be cleaned if this difference (wipe test CPM – background CPM) is greater than 100 counts per minute. Save the LSC data sheet. When numerous wipes are being taken, such as when a complete lab survey is being performed, locations of wipes should be recorded on a lab diagram. If one or more wipes reveals contamination, the location of the contamination can then be determined.

Liquid Scintillation Counting

Liquid scintillation counting is a method of assaying a radioactive sample by surrounding or dissolving that sample in a solution that fluoresces (emits light) when the solution absorbs the energy of the radiation. The light flashes are detected by the scintillation counter and are converted to electronic pulses that are proportional to the energy of the radiation. The pulses are then analyzed and the sample assayed.

Liquid scintillation counting is an excellent way to quantify beta activity. It can also be used to distinguish between (and quantify) beta emitters if the beta energies are significantly different. Liquid scintillation counters are normally manufactured so that differing energy "windows" or "channels" can be pre programmed into the counter. These channels are set based on energy levels of the nuclides to be counted. Examples of nuclides and their maximum beta energy levels typically used and counted here at Yale include:

Nuclide	Max Beta Energy
^{3}H	18.6 kev
^{14}C	156.0 kev
^{35}S	167.0 kev
^{33}P	256.0 kev
^{32}P	1710.0 kev

Typical liquid scintillation counters generally have three channels in which detected counts are listed. The channels correspond with energy levels of the nuclides being counted. When using a liquid scintillation counter, be sure to check the program you are counting your samples on, to verify your samples energy is within the counted spectrum. Many lab scintillation counters are set so that ^{3}H counts appear in the first channel, ^{14}C and ^{35}S counts show up in the second or middle channel, and ^{32}P appears in the third channel. Samples can also be counted "wide open" so that a fuller range of beta energies will be included. This will, however, result in an elevated background count rate.

What is a Survey Meter?

A survey meter is a portable handheld, electronic instrument consisting of three elements. It is used to detect ionizing radiation. The three elements are:

1. Probe: converts the incident ionizing radiation to an electrical signal which is sent to the electronics package.
2. Electronics Package: converts the electrical signal to a visual indication on the meter scale of the intensity of the ionizing radiation field.
3. Speaker (Optional): provides an audible indication in addition to the visual.

It is recommended that a "pancake" type Geiger Mueller (GM) probe be used for isotopes which emit beta radiation and an energy compensated GM probe be used for gamma emitting isotopes, except for ^{125}I. A low energy gamma scintillation detector (solid crystal) should be used for ^{125}I. It should be noted that **^{3}H cannot be detected at all with a standard lab survey meter**. Wipe test surveys must be performed to monitor for ^{3}H contamination. Please contact the Radiation Safety Section for information on what type of instrument is best for specific applications, and for vendor information.

MODEL 44-38
Energy Compensated
Thin Wall G-M Detector

MODEL 44-9
Pancake G-M Detector

MODEL 44-3
Low Energy Gamma Scintillator

Meter Function Tests

Each time the meter is turned on, the batteries should be checked. There is a battery check position on the range switch of most quality units. Changing weak or dead batteries will greatly increase the life of your instrument as batteries can leak a corrosive liquid, which may destroy the unit or result in costly repairs.

The cable connecting the probe to the electronics package is another element that should be checked. With prolonged use this cable may become defective, giving either no reading or false high readings sporadically, even in the absence of a radiation field. If you suspect there is a problem with the cable, switch cables with another meter that is working properly. If the meter response is normal, then you have a "bad" cable. If you need information on meter supplies, please contact the Radiation Safety Section at 785-3550.

One should verify than an instrument does indeed respond to a radiation field. This may be performed by using a "check source", or alternatively, a known source of radiation in your laboratory. A check source contains a very small quantity of radioactive material, commonly in the form of a disk. This disk may be securely glued or epoxied to the side of a meter. A measurement should be taken at a constant distance. This reading should be recorded as an operational check.

How to Perform a Meter Survey

Once batteries have been checked and meter is confirmed to be operational, the range switch on the meter should be rotated all the way to the lowest number. This is the most sensitive scale. With the appropriate probe, a meter survey is conducted by slowly passing the probe over the area or object to be surveyed. Be certain that the pass is at a constant velocity (1 probe width per sec is recommended) and sufficient time is allowed for the meter to respond. The distance from the contaminated object or area should also be constant. A distance of 1cm is suggested. Care should be taken not to contaminate the probe itself!

Begin any survey by checking yourself first. Each finger should be checked with special attention paid to thumbs. Wrist and forearm areas should be surveyed as well as lab coat sleeves, fronts and pockets. Personal surveys should also include monitoring the bottoms of shoes. Shoe soles are a excellent indicator of the presence or absence of floor contamination.

All readings should be recorded. When recording measurements, counts per minute (cpm) or milliroentgens per hour (mR/hr) should be used. The correct unit is determined by the type of probe being used. When a pancake or scintillation probe is used, cpm is the correct unit. When the energy compensated probe is used, mR/hr is the correct unit. Questions related to the correct use of units should be directed to the Radiation Safety Section.

Please be certain that all readings are recorded as "net". To do this, determine the normal background reading by observing a meter reading in an area where radioactive materials are not used or stored. Subtract this reading from all other measurements taken, prior to recording them.

It is normal to observe fluctuations on the meter scale, particularly near areas of low contamination. In this event use an average of the meter fluctuation. General background readings found in Yale buildings are usually from 30 – 150 cpm with a pancake probe and 200 – 500 cpm with a scintillation probe.

How Often Are Surveys to be Performed?

Individuals should survey themselves and their work areas on an "as used" or "daily basis". Radiation Safety recommends frequent surveys of hands and other skin areas to identify and rectify contamination, thus preventing significant doses and internal exposures. An operating survey meter should be within arms reach whenever working with radioactivity.

The Radiation Safety Section suggests that complete surveys of work areas (wipe tests and meter surveys) be performed at a frequency which is commensurate with your isotope work and probability of contamination**. Such surveys should be fully documented and should be performed at least monthly**. The frequency of surveys may need to be increased depending on the radioisotope use in your area. Situations or circumstances may dictate an increased frequency. Call the Radiation Safety Section for advice.

How to document Surveys Properly

It is suggested that all documentation of lab surveys contain the following information:

1. Room number and floor plan map;

2. Location number, indicating on the map where the wipe test or meter reading was taken;

3. Wipe test results (even if background), such as liquid scintillation counter printout;

4. Survey meter results (even if background);

5. Name of person performing the survey;

6. Date of survey;

7. If applicable, list the monitoring results following decontamination to include:
    a. wipe test
    b. survey meter reading

Personal and post experimental surveys may be documented using the check off sheet on the following page.

Personal monitoring checklist - sample

The following areas should be monitored after each experiment which involves radioisotopes. Please be sure that the proper survey instrument is used.

Personal Survey					Work Area Survey				
Name	**Date**	**Hands**	**Body**	**Shoes**	**Work Bench**	**Floor**	**Equip**	**Regular Trash**	**Describe Any Contamination Found**

Please indicate any contamination found and results after cleaning. Also, skin contamination and spills should be reported to the Radiation Safety Section immediately at 785-3555.