CHAPTER 4 FACILITIES AND EQUIPMENT CONSIDERATIONS

1.0 PURPOSE AND SCOPE

The purpose of this chapter is to describe the criteria for radiological use facilities and equipment in all areas controlled under the University of Georgia's radioactive materials license. This chapter provides guidance to the Radiation Safety Committee, Radiation Safety staff, and to prospective and Authorized Users in evaluating the adequacy of radiological use facilities and equipment.

2.0 PRECAUTIONS

Proper facilities and equipment are an essential component of a good radiation safety program. Facilities and equipment that are inadequate or are improperly used or maintained may cause unsafe conditions with the potential to result in excessive personnel exposure or a loss of radiological controls.

3.0 LABORATORY CLASSIFICATION SCHEME

University of Georgia laboratory facilities shall be evaluated for suitability for use with unsealed radioactive materials in accordance with the guidelines of the following classification scheme. In the event that a deviation from this classification scheme is approved by the RSC, appropriate documented justification will be maintained. This classification scheme is referenced in *NUREG-1556, Vol. 11, Consolidated Guidance about Materials Licenses: Program-Specific Guidance about Licenses of Broad Scope.* Additional information about laboratory classifications is referenced from *The Health Physics and Radiological Health Handbook, Revised Edition, 1992*.

1) Table 3.1 describes the relative radiotoxicity of various radionuclides.
2) Table 3.2 describes the laboratory classification scheme. Basic chemical laboratories are considered class C. Class B is a specifically designed radioisotope laboratory. The class B designation includes a certified fume hood, appropriate radiological waste containers, dedicated radioactive material storage enclosures, and washing facilities suitable for decontamination use. As described in *Appendix K of NUREG 1556*, "In the case of a conventional modern chemical laboratory with adequate ventilation and non-porous work surfaces, it may be possible to increase the upper limits of activity for type C laboratories toward the limits for type B for toxicity groups 3 and 4."
3) The criteria describing the modifying factors as listed in Table 3.3 is also used in the consideration of appropriate facilities for radioisotope use. Modifying factors take into consideration the type of operations performed or planned.

Table 3.1
Radiotoxicity Table of Representative Radioisotopes

Radiotoxicity Group	Radioisotopes
Very High (group 1)	Pb-210, Po-210, Ra-223, Ra-226, Ra-228, Ac-227, Th-227, Th-228, Th-230, Pa-231, U-230, U-232, U-233, U-234, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-243, Cm-242, Cm-243, Cm-244, Cm-245, Cm-246, Cf-249, Cf-250, Cf-252
High (group 2)	Na-22, Cl-36, Ca-45, Sc-46, Mn-54, Co-56, Co-60, Sr-89, Sr-90, Y-91, Zr-95, Ru-106, Ag-110m, Cd-115m, In-114m, Sb-124, Sb-125, Te-127m, Te-129m, I-124, I-125, I-126, I-131, Cs-134, Cs-137, Ba-140, Ce-144, Eu-152, Eu-154, Tb-160, Tm-170, Hf-181, Ta-182, Ir-192, Tl-204, Bi-207, Bi-210, At-211, Pb-212, Ra-224, Ac-228, Pa-230, Th-234, U-236, Bk-249
Moderate (group 3)	Be-7, C-14, F-18, Na-24, C1-38, Si-31, P-32, P-33, S-35, Ar-41, K-42, K-43, Ca-47, Sc-47, Sc-48, V-48, Cr-51, Mn-52, Mn-56, Fe-52, Fe-55, Fe-59, Co-57, Co-58, Ni-63, Ni-65, Cu-64, Zn-65, Zn-69m, Ga-72, As-73, As-74, As-76, As-77, Se-75, Br-82, Kr-85m, Kr-87, Rb-86, Sr-85, Sr-91, Y-90, Y-92, Y-93, Zr-97, Nb-93m, Nb-95, Mo-99, Tc-96, Tc-97m, Tc-97, Tc-99, Ru-97, Ru-103, Ru-105, Rh-105, Pd-103, Pd-109, Ag-105, Ag-111, Cd-109, Cd-115, In-115m, Sn-113, Sn-125, Sb-122, Te-125m, Te-127, Te-129, Te-131m, Te-132, I-130, I-132, I-133, I-134, I-135, Xe-135, Cs-131, Cs-136, Ba-131, La-140, Ce-141, Ce-143, Pr-142, Pr-143, Nd-147, Nd-149, Pm-147, Pm-149, Sm-151, Sm-153, Eu-152, Eu-155, Gd-153, Gd-159, Dy-165, Dy-166, Ho-166, Er-169, Er-171 (9.2 hr), Tm-171, Yb-175, Lu-177, W-181, W-185, W-187, Re-183, Re-186, Re-188, Os-185, Os-191, Os-193, Ir-190, Ir-194, Pt-l91, Pt-193, Pt-197, Au-196, Au-198, Au-l99, Hg-197, Hg-197m, Hg-203, Tl-200, Tl-201, Tl-202, Pb-203, Bi-206, Bi-212, Rn-220, Rn-222, Th-231,Pa-233, Np-239
Low (group 4)	H-3, O-15, Ar-37, Co-58m, Ni-59, Zn-69, Ge-71, Kr-85, Sr-85m, Rb-87, Y-9lm, Zr-93, Nb-97, Tc-96m Tc-99m, Rh-103m, In-113m, I-129, Xe-131m, Xe-133, Cs-134m, Cs-135, Sm-147, Re-187, Os-191m, Pt-193m, Pt-197m, Th-232, Th-Nat, U-235, U-238, U-Nat

Table 3.2
Laboratory Classification Scheme

Radiotoxicity Group	Class C Laboratory Quantity	Class B Laboratory Quantity
Very High	< 10 µCi	10 µCi to 10 mCi
High	< 100 µCi	100 µCi to 100 mCi
Moderate	< 1 mCi	1 mCi to 1 Ci
Low	< 10 mCi	10 mCi to 10 Ci

Table 3.3
Modifying Factors

Operation Description	Modifying Factor
Storage (stock solutions)	X 100
Simple wet operations	X 10
Normal operations	X 1
Complex wet operations with risk of spills and simple dry operations	X 0.1
Dry and dusty operations	X 0.01

4.0 FUME HOOD CRITERIA

Chemical type fume hoods provide a working area with a controlled inward airflow from the room to the hood exhaust system. Hoods should be used for gases, for unsealed volatile radioisotopes, and for processes such as evaporation that may release gases and vapors. Fume hoods provide emergency ventilation and exhaust for accidental spills, as well as routine exhaust of effluents. The criteria for radiological use of fume hoods is provided below.

1) Up to 1 millicurie of non-volatile*, non-dust generating, not highly toxic radioisotopes may be used without a fume hood, if the materials and protocols are deemed acceptable by the RSC.
2) Up to 10 millicuries may be approved for use in a standard fume hood, if the materials and protocols are deemed acceptable by the RSC.
3) Up to 50 millicuries may be approved for use in a radioisotope fume hood with stainless steel lining and HEPA filtration, if the materials and protocols are deemed acceptable by the RSC.

***Note:** Volatile radioisotopes include, but are not limited to, the following: H-3 as tritiated water, $NaBH_4$, or acetic anhydride; C-14 as carbon dioxide gas; S-35 as cysteine or methionine compounds, I-125 or I-131 as unlabeled NaI or if combined with chlorine or in an acidic solution.

5.0 PORTABLE SURVEY INSTRUMENT REQUIREMENTS

- A radiological use laboratory must have a portable survey instrument suitable for detecting the radiation produced by the radioactive materials to be used. A borrowed instrument is only acceptable as a backup.
- This requirement does not apply to laboratories using exclusively H-3 or in other limited use situations that may be approved by Radiation Safety on a case by case basis.
- A suitable instrument typically has a thin window detector, calibration adjustment mechanism, and a display in units of millirem per hour. Instruments that display results exclusively in counts per minute are suitable for contamination (not radiation) monitoring only.
- Instruments must be calibrated on an annual basis. Calibration of portable radiation monitoring instruments is provided by the Radiation Safety staff.

6.0 COUNTING INSTRUMENTATION REQUIREMENTS

- A counting instrument suitable for determining the quantity of radioactive material present in a given sample media must be available to all Authorized Users of unsealed radioactive materials.
- A shared counter is considered appropriate, but the room where the counter is located should be listed on each user's radioactive materials permit, unless otherwise approved by the RSO.
- A liquid scintillation counter is recommended for use with isotopes that primarily emit beta radiation.
- Other counters such as gas proportional counters, gamma well counters, etc. may be more suitable for counting specific isotopes, such as low energy gamma emitters.
- Counting instruments should only be used in accordance with the manufacturers design criteria.
- Instrument performance checks including the measurement of radioactive standards should be conducted at a frequency adequate to ensure proper operation of counting instrumentation.

7.0 RADIATION SHIELDING AND DOSE RATE EVALUATIONS

- Radiation shielding in the form of bricks, panels, storage containers, and other shapes should be used when appropriate to keep exposure rates ALARA.

- Plexiglas, Lucite, or other high-density plastic shielding is recommended when using milliCi quantities of P-32.
- Lead shielding is recommended for use with milliCi quantities of I-125/131, or with other gamma emitting isotopes with potential exposure rates of ≥1 mrem/hr @ 1 foot.
- Shielded shipping containers should be used for storage of radioactive materials after receipt, unless other containers having equivalent or better shielding is used.
- Radioactive materials that have the potential to generate significant dose rates, especially in the form of sealed source irradiators, should be evaluated by dose rate calculations in addition to any vendor supplied data. Formulas for use in dose rate calculations are available in Chapter 9, *Laboratory Procedures*.
- Upon initial setup of a sealed source irradiation device that has the potential to generate a dose rate in excess of 5 mrem/hr @ 30 cm, surveys by the Radiation Safety staff should be used to establish operational parameters and verify dose rates for restricted and unrestricted areas.

8.0 GENERAL CONSIDERATIONS

- Bench top or open work areas may be used for handling small quantities of solid materials in a form not likely to become airborne or dispersed, and for small quantities of liquids of such low volatility as not to cause airborne contamination or toxicity problems.
- Trays and/or absorbent surface covers (secondary containment) to catch and retain spilled liquids should be used in all appropriate radioisotope work locations.
- Radioactive materials that are handled or used in unsealed forms should be confined to control the release of materials and to prevent the spread of contamination. Gaseous, volatile, and fine particulate solid materials should be handled in fume hoods as described in section 4.0 of this procedure.
- Sinks used for sewer disposal of radioisotopes must be properly monitored and maintained. Prior to maintenance or repair of discharge plumbing, the piping should be flushed with water and surveyed for the presence of radioactivity.
- Containers for radioactive waste should be placed near the waste-generating areas and away from frequently occupied areas, when practical. Secondary containment should be used for liquid waste containers. Waste containers should be shielded as needed to keep dose rates ALARA.
- Radioactive materials security devices must be adequate to prevent unauthorized access and should be commensurate with the relative hazard of the radioisotopes involved (i.e. large quantity sources may require additional security).
- A physical barrier is required between radioactive material areas and areas used for eating, drinking, food storage, etc. There should be walls and doors separating these areas.
- Proper lighting, good housekeeping, and appropriate laboratory safety equipment must be maintained.
- Additional information about personnel protective equipment (PPE), personnel dosimetry, and safe work practices are discussed in the *Laboratory Procedures* chapter of this manual.