030-05976

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ENVIRONMENTAL RESEARCH LABORATORY
200 S.W. 35TH STREET
CORVALLIS, OREGON 97333

REGION V

June 15, 1989

89 JUN 19 A10:42

Frances Brown
U.S. Nuclear Regulatory Commission
1450 Maria Lane, Suite 210
Walnut Creek, California 94596

Dear Ms. Brown:

As per our telephone discussion, since our program remains essentially unchanged, this letter is a formal request for renewal of NRC license #36-12343-02 (expiration date 12/31/89).

I am still the Radiation Safety Officer. Licensed material is used only at our facilities at 200 S.W. 35th Street and 1350 S.W. Goodnight Avenue, Corvallis, Oregon. Waste is stored in the same secured area at 200 S.W. 35th Street.

We have added two new principal investigators (see Attachment 1 for training and experience). Our sealed source inventory has changed slightly with the addition of four alpha sources to control static electricity in electronic equipment (see Attachment 2 for source description and monitoring program).

Finally, I have included an updated version of our Radiation Safety Handbook for your files (Attachment 3).

Since our program is basically unchanged, I believe this letter and attachments are sufficient to renew our license.

Sincerely,

Jay D. Gile

Jay D. Gile
Radiation Safety Officer

FEE EXEMPT

70996

New Investigator Training and Experience

A. Dr. Paul Rygiewicz

Paul has worked with 86RB, 35S, 36Cl, 14C, and 32P on nutrient uptake and molecular biology experiments using mycorrhizal fungi and nonmycorrhizal and mycorrhizal coniferous seedlings.

Paul has successfully completed the core course Principles of Radiation Protection, presented by the Department of Environmental Health and Safety, University of Washington, in 1982 (verification on file with ERL-C Radiation Safety). This course certified individuals to become authorized uses of radioactive isotopes. In addition, Paul has received the standard ERL-Corvallis radiation safety training.

B. Dr. Anne Fairbrother

Although Dr. Fairbrother has had no formal training, she has gained experience through the ERL-Corvallis radiation safety training course including instruction in use of a sample oxidizer and liquid scintillation counter for 3H and 14C. In addition, she was trained by Dr. Nancy Kerkvliet in the use of 51Cr in an immune assay in 4/89.

UNIVERSITY OF WASHINGTON
ENVIRONMENTAL HEALTH AND SAFETY DEPARTMENT

CERTIFICATE OF TRAINING

THIS CERTIFICATE VERIFYS THAT

Paul Rygieuicz

Completed the core course

PRINCIPLES OF RADIATION PROTECTION

As presented by the Department of Environmental Health and Safety

In

May 1982

This course covers Basic Radiation Physics, Biological Effects of Radiation, Radiation Protection Procedures, and Regulatory Rules and Regulations. It meets the basic training requirements for radiation workers as set forth by the University of Washington Radiation Safety Committee to satisfy conditions of the University's Radioactive Materials License.

Michael J. O'Brien

Michael J. O'Brien, Radiation Safety Officer

ALPHA-EMITTING SOURCES

June 14, 1989

DESCRIPTION

Manufacturer's Name:	Nuclear Products Company 2519 No. Merced Avenue So. El Monte, CA 91733 213-283-2603
Trade Name:	StaticMaster
Radionuclide:	Polonium 210 (Po-210) Sealed Source (ceramic microspheres)
Activity:	0.5 millicuries
Half-Life:	$t_{1/2}$ = 138 days

General License

QUANTITY

4 x 0.5 mCi sources

LABORATORY USE

Control the static energy around analytical balances and microscopes.

LABORATORY MONITORING PROGRAM

Alpha sealed sources are leak tested and inventoried once per quarter. The source housing is swiped with an alcohol saturated cotton swab. Swabs are counted by gas flow proportional counter.

Source is considered leaking if contamination is found to be greater than or equal to 0.005 microcuries.

I, ______________________, certify that I have read the attached radiation handling and safety document. I have discussed questions with either my supervisor or the Radiation Safety Officer. I recognize that this information represents a general summary and that additional information is available upon my request. Please detach and return.

Signed ________________________________ Date __________ ______

ERL-C RADIATION SAFETY PROGRAM

New Employee Orientation

January 1989

ERL-C RADIATION SAFETY ORIENTATION

I. Radiation Basics

A. There are three common types of ionizing radiation: Alpha, Beta, and Gamma.

<u>Alpha Radiation</u> is particulate radiation consisting of two protons and two neutrons (e.g., helium nucleus) ejected from an unstable nucleus. Generally, alpha-emitting isotopes are not used as tracers in biological investigations, largely because they are elements of high atomic number not normally significant in biological systems. Alpha particles have a very limited range, usually only a few centimeters in air. Alpha radiation does not create any great external health hazard since the outer layer of skin is thick enough to absorb most alpha radiation. However, if ingested or inhaled, alpha emitters can pose a significant problem since most of the energy would be dissipated in a very small volume of tissue.

<u>Beta Radiation</u> is a type of particulate radiation that consists of either positrons (protons) or negatrons (electrons). Generally, the terms "beta particle" or "beta radiation" will refer to the negatron or electron. Beta particles are approximately 1/7300 the mass of an alpha particle. This smaller mass and associated higher velocity results in a much greater range through matter than alpha particles. The range of some beta particles may be as long as

several meters, therefore requiring something more substantial than distance from the source for radiation protection. The external radiation hazard is not normally significant provided that the source is not being handled directly; glass or metal containers will absorb most, if not all, of the beta radiation. Internal exposure is a much greater hazard because many beta nuclides are isotopes of elements commonly found in living tissue. As a result, these radionuclides may be readily incorporated into the body. It is because of this aspect that beta-emitting isotopes are among the most commonly used radiotracers in biological and chemical systems.

Gamma Radiation is not particulate, but rather electromagnetic (e.g., photons) radiation originating and emitted from the nucleus of the atom. Photons are electrically neutral with zero mass. This allows the gamma ray to have a much greater effective range than either alpha or beta particles of similar energy. Gamma radiation poses a much greater external radiation problem because of this higher penetration power and therefore must be stored in a lead container. Gamma rays can easily pass through the human body. While either an external or internal source can irradiate the entire body, the gamma rays cannot become trapped in an isolated area as with alpha, thus reducing the localized effect. For reasons similar to beta radiation, gamma-emitting isotopes are used in tracer studies. X-ray radiation is similar to gamma radiation only lower in energy and originates in the electron shells.

Many terms (Excitation, Ionization, Bremsstrahlung, Photoelectric Effect, Compton Effect, or Pair Production) specifically describe the manner in which alpha, beta, or gamma radiation interacts with other matter. Ionization, in general, describes the activity leading to tissue damage. With ionization, the radiation transfers its energy to an orbital electron of the particle it strikes. This electron is then frequently ejected, in which case it can interact with additional particles, creating additional ionization and/or tissue damage by changing the tissue structure. The amount of ionization that can occur depends upon the energy associated with the radiation and, of course, the specific type of interaction with the atoms of the surrounding material.

B. Of the many isotopes used in research, those most likely to be encountered at ERL-C are tritium (^{3}H), carbon-14 (^{14}C), phosphorus-32 (^{32}P), and nickel-63 (^{63}Ni). Tritium, an isotope of hydrogen, is a low-energy beta emitter. The principal beta particle has an energy of 0.019 million electron volts (MeV). Its range in air is approximately 0.7 cm. This is generally considered the bottom end of the energy spectrum for beta emitters. Each time a beta particle is emitted from ^{3}H or any other isotope, it is considered part of the process of physical decay, or change, from the unstable isotope to a more stable form. The term "half-life" (t-1/2) is commonly used to describe the life-span of an isotope. It is defined as the time required for the activity of the isotope to decrease by one-half. For tritium (^{3}H), the t-1/2 is 12.3 years.

Carbon-14 is also a low-energy beta emitter. Its principal beta particle has an energy of 0.156 MeV, with a range of approximately 21 cm in air. The t-1/2 for ^{14}C is 5,730 years.

Phosphorus-32 can be considered a high-energy beta emitter with an energy of 1.712 MeV (range in air, approximately 700 cm). The t-1/2 for ^{32}P is 14.3 days.

Nickel-63 is a low-energy beta emitter (0.067 MeV) typically used for electron capture instrument detectors as sealed sources (i.e., the isotope is "sealed into" the detector to prevent escape and subsequent work place contamination through normal use). It has a t-1/2 of 92 years.

By reviewing the energy and t-1/2 for an isotope, one can gain an appreciation of the hazards or contamination problems associated with an isotope. Both ^{3}H and ^{14}C are low-energy sources so that glass can be used for containment. However, their long half-life could create a lengthy contamination problem if spilled in a laboratory. With ^{32}P, the opposite situation exists. Because of the higher energy, heavier shielding must be employed. However, if spilled, it could physically decay to a safe level in a relatively short time.

C. The standard unit of measure in radiation is the "curie" (Ci) which is defined as the number of disintegrations occurring in one gram of pure radium every second; or, 3.7×10^{10} disintegrations per second (dps). Because the curie is a relatively large unit, it has been subdivided into millicurie (mCi: 3.7×10^{7} dps), the microcurie (uCi: 3.7×10^4 dps or 2.22×10^6 dpm), and the picocurie (pCi, 2.2 dpm).

Disintegrations per minute (dpm) refers to the actual number of disintegrations or emissions occurring in a sample. Counts per minute (cpm) refers to the disintegrations detected by the radiation counter, which is only a fraction of the dpm's. This loss is due to detector inefficiency as well as interference by the sample and/or counting medium. The raw data collected from a radiation detector will generally be expressed as cpm. The cpm values are then corrected or converted to dpm to determine the actual amount of radioactivity present.

D. There are three general routes of human exposure: dermal, inhalation, and ingestion. As previously indicated, <u>dermal</u> or <u>external</u> exposure to beta emitters used in the quantity typically found in a laboratory generally does not provide any significant whole-body irradiation. Likewise, local irradiation would normally only involve the superficial layers of skin. Dermal exposure can be minimized by simply avoiding direct contact with the source, by storing it in a glass or lead container, and wearing protecting clothing. Inhalation and ingestion may generally be treated together as internal exposure. Weak beta emitters, such as ^{3}H or ^{14}C, can pose a significant hazard for two reasons: because of their short range, most of the beta particle energy will be dissipated within a very small volume of tissue; and beta emitters are used as radiotracers because of their importance to biological systems. They can be selectively concentrated, thus providing a more intense local irradiation. The actual internal hazard will depend not only on the isotope, but its chemical form as well. Internal exposure can be avoided by working in hoods or wearing respirators whenever appropriate, and never eating, drinking, or smoking in a laboratory.

Consistent with 10CFR20

E. Exposure limits are expressed as maximum permissible concentration (mpc) for air and water, and maximum permissible body burden (mpbb) for humans (CRC Handbook of Radionuclides and NBS Handbook 69).

Isotope	Air (mpc)	Water (mpc)	Human (mpbb)
^{3}H	5×10^{-6} uCi/ml	1×10^{-1} uCi/ml	1000 uCi
^{14}C	4×10^{-6} uCi/ml	2×10^{-2} uCi/ml	300 uCi
^{32}P	7×10^{-8} uCi/ml	5×10^{-4} uCi/ml	60 uCi

II. Principles of Radiation Safety

A. Good Laboratory Technique will insure both the integrity of the experiment and personal safety. Know the isotope that you are working with, not only from a radiation perspective, but be aware of the chemical form and physical properties as well. Frequently, the chemical hazard associated with the material is far greater than the hazard from the radioisotope label. This type of information is generally available through the literature, safety protocols and MSDS, and from your co-workers.

Wherever possible, work with isotopes should be carried out in a hood or contained area (e.g., glove box), especially when preparing stock solutions or working with a concentrated solution. Work surfaces should be covered with absorbent paper which is changed at a regular interval depending upon work intensity.

Protective clothing should be worn at all times when working in <u>any laboratory</u>; this includes: lab coat, eye protection, gloves (the exact type of glove will be dictated by the chemical being used, not necessarily the fact that it is radiolabeled); and shoe coverings(an option dependent upon the nature of the work). Lab coats should be changed regularly (no less than biweekly), shoe coverings may be reused, but gloves <u>are not reused</u>; once removed they are discarded. Gloves should be turned inside out as they are removed to avoid contamination.

The following list of reminders for working with radioactivity should be observed when working in ERL-C radiation laboratories:

1. Coats and other personal belongs, including books (except those required for work), should not be brought into the laboratory.
2. Eating, drinking, smoking, and the application of cosmetics in the laboratory are not permitted.
3. Protective clothing (e.g., lab coat, gloves, safety glasses, etc.) should be worn in the laboratory as appropriate, but not taken into counting rooms, or any areas where radioactive materials are not permitted.
4. Pipetting liquids of any type by mouth or the performance of any similar operation by mouth suction is not permitted.

5. Operations with loose radioactive materials, evaporation of radioactive liquids, or any other process which could release airborne radioactivity must be carried out in a properly filtered hood.

6. No person should work with radioactive material unless gloves are worn.

7. Radioactive liquid wastes should be poured into the labeled liquid radioactive waste containers provided (not down the drains) for future disposal by the RSO.

8. Radioactive solid wastes and other contaminated items should be placed in a labeled radioactive solid waste container.

9. All radioactive wastes must be disposed only under the direct supervision of the RSO.

10. All wounds, spills, and other emergencies should be immediately reported to the RSO and the person responsible for the laboratory operation.

11. If personal contamination is suspected, the responsible laboratory supervisor should be notified immediately. The following personnel are also available for assistance:

    A. Jay Gile 4758

    B. Phil Monaco 4787

12. All new personnel should read pamphlets on radiation protection which may be obtained from the librarian or RSO.

B. In the Event of an Accident

1. External personal exposure: If the contamination is restricted to the protective clothing, discard those items immediately in a radioactive waste container. In the event the material penetrates to the skin, wash the area immediately with cold tap water and soap. Following these steps, the worker should notify his/her immediate supervisor; together they should notify the Radiation Safety Officer (RSO) to determine further action.

2. Internal exposure (inhalation/ingestion): Notify supervisor and RSO immediately to initiate appropriate action.

3. Area Contamination

EMERGENCY PROCEDURES FOR LABORATORIES AND AREAS WHERE RADIOACTIVE MATERIALS ARE USED

Minor Spills (microCurie levels):

1. NOTIFY: Notify persons in the area that spill has occurred.
2. PREVENT THE SPREAD: Cover the spill with absorbent paper or whatever seems appropriate to contain the spill and limit spread.
3. REPORT: Immediately report the incident (or ask someone else to report the incident) to the person responsible for the work area and to the Radiation Safety Office.
4. CLEAN UP: Use disposable gloves. Carefully fold the absorbent paper, insert it into a plastic bag, and dispose. Also dispose

of any other contaminated items. Do not risk unnecessary contamination or radiation dose (exposure) in order to clean up the spill. Decontamination will be supervised by the Radiation Safety Staff.

5. SURVEY: With a GM survey meter, check the area around the spill. Also check your hands, feet, and clothing for contamination before leaving the area.
6. Do Not leave the area without having contacted one of the people listed above in step 3.

Major Spills (milliCurie to Curie levels):

1. CLEAR THE AREA: Notify all persons not involved with the spill to vacate the room.
2. PREVENT THE SPREAD: Cover the spill with absorbent paper or whatever seems appropriate to contain the spill and limit the spread. Do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.
3. SHIELD THE SOURCE: If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure. Shielding would not normally be required for low energy beta emitters (< 0.2 MeV).
4. CLOSE THE ROOM: Leave the room and post a warning sign and lock the door(s) to prevent entry. Be careful not to contaminate other areas of the building. Put on plastic booties and

remove gloves and lab coat. Immediately wash hands if possible.

5. CALL FOR HELP.

6. PERSONNEL DECONTAMINATION: Make whatever preliminary radiation surveys are possible. Emphasize hands, feet, and clothing. Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Staff. If it is after normal working hours and there is radioactivity on the skin, flush thoroughly and then wash with mild soap and lukewarm water while awaiting the arrival of help. Stopper any sink used to save all the wash water.

C. Shielding and Storage

The most commonly used isotope at ERL-C (Carbon-14) requires little in the way of special handling to protect the worker from radiation exposure. The combination of storing materials in covered glass containers and the use of protective clothing are generally sufficient. Materials that are stored in freezers can be in sealed plastic containers; paper by itself is not acceptable, nor is wood. Although metal may be acceptable, glass is generally considered the most appropriate because of its unreactive nature. Again the chemical, not the radiation, may dictate additional storage precautions such as wrapping the glass in absorbent paper and storing that in metal to minimize breakage. With certain chemicals and radioisotopic labels (e.g., ^{32}P or ^{3}H), prolonged storage should be avoided because of the possibility of both chemical degradation and radiolysis even under refrigeration.

All radioactive materials must be stored in a secured area. Either securing (locking) the refrigerator, freezer, or cabinet in a lab or the lab itself is acceptable. Whether the radiolabeled materials are stored under refrigeration or in a cabinet (e.g., solvent cabinet) will generally depend upon the specific chemical.

D. Radioactive Material Inventory

Each principal investigator authorized to work with radioisotopes maintains his/her own inventory. That inventory consists of only those materials for which Radiation Safety Committee approval has been granted. Each investigator is responsible for maintaining an accurate record of the inventory. Quarterly reports are filed with the RSO indicating any change in the status of that inventory and on an annual basis the RSO performs an inventory of all radioactive materials at ERL-C.

E. ERL-C Radioactive Waste Disposal Techniques

Temporary disposal of radioactive wastes in labs will be into containers clearly marked for radioactive waste.

1. Water soluble liquids with a concentration of < 0.05 uCi/g (not to exceed 1000 uCi/day ^{14}C, ^{3}H; 10 mCi ^{32}P and ^{86}Rb) may be discharged into the sanitary sewer. This does NOT include toluene-based counting cocktails or organic solvents such as

2
20.303 b(1)
(5) $5x10^{-4}$
(5) $7x10^{-4}$

hexane, ether, or acetone. There is one disposal site: the sink in Room 190 in the main building.

2. Toluene- or xylene-based liquid scintillation media and organic solvents will be concentrated in a (4 liter) bottle in a hood or well ventilated area. A small stream of air introduced into the waste bottle can expedite this process. The residue in the bottle will then be disposed of as radioactive solid waste only if the radioactivity exceeds 0.05 uCi/g.

3. Liquid scintillation vials will be emptied, blotted on absorbent paper, placed in a plastic bag inside a cardboard box, and compacted in the trash compactor. This can then be disposed of in the dumpsters served by Corvallis Disposal.

4. Laboratory paraphernalia such as gloves, paper towels, absorbent paper, etc. will be disposed as nonradioactive solid waste unless known to be contaminated (> 1000 dpm/g).

5. Soil, plant, or animal material with a concentration of < 0.05 uCi/g may be placed in the dumpster.

6. The investigator and the RSO will maintain records for each disposal activity indicating investigator, date, total activity, and concentration.

7. All items disposed of as radioactive must be labeled as such; those that were not disposed as nonradioactive must <u>not</u> have any radioactive labeling.

F. Monitoring

One of the first aspects of monitoring involves the effective use of warning signs or labels. All areas involved in the use of radioactive materials must have warning signs prominently displayed at the entry point. Refrigerators, freezers, or cabinets containing radioactive materials in such labs must also be labeled. In general, any container of radioactive material in any form (stock solution, sample, waste) must have a warning label. Area warning labels are available from the RSO; all others must be purchased through the sponsoring program.

1. Personnel Monitoring

All personnel working with radioactive material will wear a personal dosimeter supplied and maintained by the RSO or participate in a urine bioassay conducted quarterly. In the event of suspected contamination, personnel monitoring will be increased.

2. Work Area

It is the responsibility of each principal investigator to monitor his/her work area(s) daily during any activity involving the use of radiation. This monitoring data will be submitted daily to the RSO for concurrence and entrance into the record. The daily area monitoring activity not only insures that the work areas are uncontaminated, but more importantly provides a quick indication of the exposure of the individuals working in that area. The RSO will conduct monthly spot checks of the work areas. (quarterly inspections of exit points and exhausts.)

G. Shipping Radioactive Materials from ERL-C

Packaging and labeling of radioactive materials from ERL-C will be done by the users under the direction of the RSO and will conform to all appropriate and applicable requirements regulating the movement and transportation of dangerous goods and materials. These regulations are governed by the Nuclear Regulatory Commission (10 Code of Federal Regulation), the Department of Transportation (49 Code of Federal Regulation), and the International Air Transportation Association (IATA).

III. Detection Methods Available at ERL-C

A. Liquid scintillation counting is the primary means of radiation detection routinely used at ERL-C. The method is appropriate for analysis of ^{3}H-, ^{14}C, or ^{32}P-labeled materials used in tracer studies. This technique is also used by principal investigators for routine work area monitoring (Section II, F) and by radiation safety personnel for monitoring of personnel and work areas. ERL-C has two liquid scintillation counters for common use, located in the main building. Each instrument has its own operation manual available from the individual responsible for the instrument. In addition, ERL-C has a slide tape series on liquid scintillation as well as reference material.

E. Other detection devices which the ERL-C Radiation Safety Officer maintains for monitoring purposes are thin window Geiger-Muller detectors and a gas-proportional counter. Upon request, these units are available to individual investigators for limited use.

IV. Licensure

A. The Nuclear Regulatory Commission (NRC), formerly the Atomic Energy Commission (AEC), is charged with the responsibility of developing and enforcing regulations relating to the use of radiation or radioactive material by both the public and private sectors of the economy.

The NRC has issued ERL-C a "Type B specific license of broad scope." This license entitled ERL-C to receive, possess, use, and transfer any chemical or physical form of by-product material specified in 33.100 (10 CFR Part 30) Schedule A. Essentially, we are allowed to use any isotope from this list we choose for our work. The amount of a particular isotope we are allowed to possess is listed in Schedule A, Column 1. Normally, radiotracer studies are conducted at or below the milliCurie level; therefore, possessing large quantities is not necessary or recommended.

B. ERL-C Radiation Safety Program

1. The Radiation Safety Officer is responsible for the daily operation of the ERL-C Radiation Safety Program including, but not limited to, maintenance of the personnel and work area monitoring programs, receipt and shipment of material, waste

disposal, maintenance of all ERL-C radiation records, and responding to requests by lab personnel, EPA Headquarters, or the RC regarding radiation matters. Basic training in radiation safety but not radiotracer methodology is provided by the RSO. In addition, the RSO serves as an ex-officio member of the ERL-C Radiation Safety Committee of the ERL-C Health and Safety Committee. The ERL-C Radiation Safety Officer (RSO) is Jay Gile (ext. 4758).

2. The ERL-C Radiation Safety Committee is responsible for determining the ERL-C policies regarding the use of radioactive materials. The Committee also has the responsibility of reviewing all applications for use of radioactive materials at ERL-C and by ERL-C employees at other facilities. All investigators must obtain Committee approval before using any isotopes. In addition, the Committee is responsible for conducting regular operating and safety audits as well as to provide a continuous program of radiological training and education. Members of the ERL-C Radiation Safety Committee are:

   Bill Hogsett (ext. 4632)

   Joel McCrady (ext. 4620)

   Craig Mc Farlane (ext. 4670)

   Jay Gile, ex-officio member (ext. 4785)

   Bill Moke, ERL-C Health and Safety Officer, ex-officio member (ext. 4372)

   Phil Monaco, Radiation Safety Technician (ext. 4787)

V. Use of Radioactive Isotopes at ERL-C

A. Request for Use

All investigators must submit a request for use to the Committee for approval. Application format and assistance are available from the RSO. Upon obtaining approval, the investigator need not submit a new application for each subsequent experiment, unless there is a substantial deviation from the original application. Notice of minor modifications may be in the form of a memo to the RSO. Principal investigators must have prior adequate training or experience in radiotracer methodology and safety or make their own arrangements to obtain such training prior to use approval. In addition, PIs are responsible for providing adequate and thorough training to all workers assisting them with the research. Personnel under the age of 18 are not permitted to work with radiation at ERL-C. As part of the procurement process for radioactive materials, the RSO reviews all requisitions for radioactive materials. Upon receipt of the item, the RSO inspects the package for contamination and verifies the contents with the purchase order. The materials can then be released to the investigator.

VI. Reference List

1. Radiotracer Methodology in the Biological, Environmental, and Physical Sciences by C. H. Wang, D. L. Willis, and W. D. Loveland.
2. Radiation Monitoring by J. E. Wade and G. E. Cunningham (US AEC).
3. Advances in Tracer Methodology, Volume 3, ed. by Seymour Rothchild.
4. Radioecology by V. Schultz and A. W. Klement, Jr.

5. Radiation Protection by J. Shapiro.

6. CRC Handbook of Radioactive Nuclides, ed. Yen Wang.

7. Code of Federal Regulations, 10 Part 30.

8. Safe Handling of Radioactive Materials, Department of Commerce Handbook 92.

9. Radiation Protection in Educational Institutions, NCRP Report 32.

10. National Bureau of Standards Handbook 69.

11. International Air Transportation Association, Dangerous Goods Regulations (Attachment A to IATA Resolution 618).

All of the above references are available through the RSO or ERL-C library.