LAFAYETTE COLLEGE

Radiation Protection Program

Department of Public Safety - Environmental, Health and Safety
Standard Operating Procedure (SOP) #16

Purpose

To provide guidelines for working with radiation producing equipment and to ensure the safe procurement, use, storage, and disposal of radioactive materials at Lafayette College.

Scope

This program includes authorized users of radioactive materials and operators of X-ray equipment in Chemistry, Geology, and Sports Medicine.

NOTE: The College's Radioactive Materials License (PA-1214) from the Pennsylvania Department of Environmental Protection's Bureau of Radiation Protection was terminated on May 6, 2014. The College removed all radioactive materials authorized under the license in accordance with 10 CFR 10.36 - Expiration and Termination of Licenses.

Definitions

Absorbed dose - The quantity of radiation energy transferred to any absorbing material (human tissue, air, shielding, etc.).

Absorption - The dissipation of radiation energy into an absorbing medium.

Activity - The number of disintegrations occurring in a sample per unit time.

Attenuation - All radiation, whether particulate or electromagnetic, possesses energy. Attenuation is the reduction of this energy, or of the radiation's intensity, as it passes through matter.

Authorized User - An individual who has received approval to use radioactive materials by the Radiation Safety Officer.

Backscattering - The scattering of radiation in a direction generally opposite to that of the incident radiation.

Becquerel - The international system (SI) unit of activity that is equivalent to one disintegration per second (dps).

Body burden - The total quantity of a radionuclide present in the body.

Curie (Ci) - The amount of material undergoing 3.7 x 10 to the tenth disintegrations per second (dps).

Dose - A general term denoting the quantity of a radionuclide present in the body.

Half-life - For a single radioactive decay process, the time required for the activity to decrease to half its value by the process.

Incident or Minor Accident - Any time that radioactive material is used in such a manner that it is beyond the control of the user, an incident may be considered to have occurred. This definition is very broad and meant to include minor accidents or near misses.

Isotopes - Nuclides having the same atomic number but different mass numbers.

Loss of Sources - The Radiation Safety Officer must be notified at once whenever radioisotopes or radioactive sources have been lost or misplaced or material released into the environment in excess of limits set forth in these regulations.

Minor Accident Involving Radioactive Contamination - A radioactive spill is to be considered "minor" when it can be satisfactorily cleaned up by laboratory personnel in a reasonable period of time without danger to any individual. A practical limit might be one-half hour to accomplish cleanup with no radiation exposure in excess of 20 mrem. These accidents are reportable to the Radiation Safety Officer.

Minor Contamination of Body Surfaces and Clothing - When hands, body surfaces, clothing or shoes become contaminated, steps should be taken as soon as possible to remove loose contamination. Some degree of fixed contamination will in certain cases be unavoidable, and the following maximum limits are suggested for hand, body surfaces, or personnel clothing and shoes:

- Alpha activity - 100 disintegrations/minute per 100 cm^2
- Beta activity - 500 disintegrations/minute per 100 cm^2

Major Accidents Involving Radioactive Contamination - A radioactive spill is to be considered "major" when there is a significant or unknown hazard to individuals from irradiation, or from absorption, ingestion, or inhalation of the activity.

Overexposure (less than acute) - All cases of suspected overexposure in excess of the weekly limits for radiation workers (100 mr Whole Body) must be reported at once to the Radiation Safety Officer.

- < 25 r exposure - No immediate examination is necessary.
- 25 to 100 r exposure - Arrangements will be made for an appropriate medical examination.

Rad - The unit of absorbed dose which is equal to 100 ergs/g of the absorbing material.

Radiation - any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light.

Radiation emergencies - are incidents which involve actual or suspected exposure to 100 r or more to any part of the body, or gross radioactive contamination resulting in ingestion, inhalation, absorption, or wound contamination of hazardous amounts of radioisotopes. (Hazardous amounts cannot be given a general definition, but should be interpreted in the direction of patient safety.)

Radioactive decay - A spontaneous, energy-releasing atomic transition that involves a change in the state of the nucleus of an atom.

Radioactivity - The tendency of unstable nuclides to undergo radioactive decay.
Rem - The unit of dose equivalent which is used to measure human health effects.

Roentgen - A unit which is used to measure the intensity of both X-ray machines and gamma sources in air.

RSO - Radiation Safety Officer

Scattering - A process in which a change in direction or energy of an incident particle is caused by a collision with a particle or a system of particles.

Scintillation counter - A counter in which the light flashes produced in a scintillator by ionizing radiation are converted into electrical pulses by a photomultiplier.

Specific activity - Activity of one gram of radioactive material, which is expressed as Ci/g of the material.

Supervised User - An individual who has been trained in radiation safety and will be supervised by an Authorized User while working with radioactive materials.

US NRC - United States Nuclear Regulatory Commission, Region I, 475 Allendale Road, King of Prussia, PA 19406-1415. Telephone (215) 337-5313, 337-5398, 337-5260.

Responsibilities

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Radiation Safety Officer (RSO)

- Conduct quarterly inspections of all laboratories using or storing regulated quantities of radioactive materials to:
    - Ensure that the terms and conditions of our licenses are met, and that all required records are maintained.
    - Ensure that radioactive materials are properly secured against unauthorized removal at all times when not in use.
    - Ensure that the laboratory is in compliance with applicable standards.
- Review and "sign-off" on all purchase requisitions for radioactive material to:
    - Ensure that only authorized users are ordering licensed radioactive material.
    - Ensure that we do not exceed allowable quantities of licensed radioactive material.
- Review and approve the applications of those who would like to become Authorized Users. This approval will be based on the qualification of the individual to handle radioactive materials in a safe manner on the basis of experience, training and proposed facilities.

- Correspond with PA DEP when amendments to the license are required and/or the license needs renewed.
- Maintain records of wipe tests from contamination checks during the receipt and use of radioisotopes.
- Supervise the decontamination of any area found to have unacceptable levels of activity.
- Be knowledgeable in and follow US NRC, PA DEP regulations and College safety procedures.

Authorized Users

- Be knowledgeable in and follow US NRC and PA DEP regulations and College safety procedures.
- Develop all necessary written safety procedures for the experiments being performed and the materials being handled.
- Maintain an accurate data logbook kept in each laboratory where radioactive materials are being used. Information in the logbook shall include:
    - Wipe sample results taken at time of material delivery and wipe sample results taken in the laboratory after radioactive material use.
    - Calibration results of Geiger counter.
    - Any applicable personal dosimeter results.
- Post all necessary radiation signs.
- Immediately inform the RSO of:
    - Theft or loss of radioactive sources.
    - Suspected radiation incidents including spills, overexposure of personnel, damage to facilities and unauthorized release of radioactive material to the atmosphere or the sewer.
- Notify the RSO in writing of any project changes, quantity changes, use of new materials or change in the level of use activity.
- Notify the RSO of the arrangements made for the handling of radioactive material during your absence.
- Advise all female radiation workers of childbearing age orally and in written form of the increased risk of prenatal radiation exposure.
- Handle, store, and dispose of radioactive waste generated by the College in accordance with federal, state, and local regulations.
- Ensure that Supervised Users are adequately trained to work with the isotopes under control.
- Maintain and calibrate all dosimeters and Geiger counters.
- Conduct surveys of the laboratory area with the survey meter and record the results at the end of each workday when isotopes are used.
- Conduct wipe samples in laboratories every month when µCi amounts of radioactive materials are used and weekly when mCi amounts are used.

Supervised User

- Complete the safety training course offered by the Authorized User and RSO
- Follow applicable safety rules established in our Radiation Safety Program.

Temporary Substitute RSO

- Jeff Troxell will act as the temporary RSO.

Supervisors

- Ensure that all ancillary personnel who work in the designated radioisotope use areas (STORAGE, UTILIZATION, AND LABELING OF RADIOISOTOPES) receive proper training. This training must be given initially and annually thereafter.
- Complete the Training Roster Form and return a copy to Environmental, Health and Safety.
- Contact the Environmental, Health and Safety for training support.

Application for Approval as an Authorized User

An Authorized User is an individual who has received approval to use radioactive materials. This approval must be obtained prior to initiating any work involving radioactive materials.

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Information and Training

- Authorized Users shall receive radiation safety training from the RSO prior to handling any radioisotopes and annually thereafter.
- Supervised Users shall receive radiation safety training from the appropriate Authorized User prior to handling any radioisotopes and annually thereafter.
- Record training activity on training log (Appendix II) and send it to the Radiation Safety Officer in Public Safety.

Radioisotope Procurement

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- Complete a purchase requisition and obtain your Department Head's signature.
    - Please indicate that the material must be shipped to:
        Lafayette College
        Kunkel Hall, Room 111
        Easton, PA 18042-1775
        Attn: Jeff Troxell, RSO / (your name)
    - Type the following information on the Purchase Requisition: "Authorized by the Radiation Safety Officer, (DEP license #PA-1214) Signed _____"
- Contact the RSO (X-5330) to review and "sign-off" on the purchase requisition.
- Deliver the requisition to the Purchasing Department for processing. The Purchasing Department will place the order by calling and/or faxing the order to the vendor.

- Inform the Biology Department Secretary and Technician of the estimated arrival time of the material on campus.
- They will call the RSO immediately at X-5330 when the package arrives on campus.
- The RSO will examine the incoming package for leakage, contamination, or damage following the procedure for "Examining Incoming Radioisotope Packages" (refer to Appendix III) and the "Wipe Test Procedure" (refer to Appendix III).
- The initial wipe test results will be conducted and maintained by the RSO. The Authorized User will be notified upon completion of the wipe test.

Radioactive Materials Allowed under the College's former PA DEP Radioactive Materials License PA-1214:

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Element and Mass Number	Chemical and/or Physical Form	Maximum Amount Allowed
Hydrogen 3 (3H)	Any	10 mCi
Carbon 14 (14C)	Any	10 mCi
Sulfur 35 (35S)	Any	10 mCi
Phosphorus 32 (32P)	Any	5 mCi
Iodine 125 (125I)	Any	5 mCi

Special Procedures for Handling ^{32}P and ^{125}I.

In no case will an individual order or handle a stock solution of 1 mCi ^{32}P or greater. ^{32}P will always be handled behind plexi-glass shielding (1 cm or greater).

In no case will an Authorized User purchase or handle a stock solution of 1 mCi ^{125}I, or greater, and in no instance will an individual be exposed to a cumulative level which exceeds 10 mCi of a volatile form of ^{125}I over any three month period. Stock solutions of ^{125}I will be stored within a lead container when not in use. Volatile forms of ^{125}I (NaI) will always be stored and handled in a fume hood with face velocity of at least 0.5 m/sec.

The limitations on the use of ^{32}P and ^{125}I noted above will allow us to safely and successfully conduct our proposed experimentation, and will eliminate the need for routine personal monitoring devices or monitoring for potential thyroid exposure to ^{125}I.

Permissible Dose Limits

Any radiation exposure is undesirable; thus, it is important that all exposures be kept As Low As Reasonably Achievable (ALARA). All users of radioactive material must make every effort to keep their exposures to a minimum. A radiation worker is an Authorized or Supervised User, while all other individuals are considered non-radiation workers.

In restricted areas, control must be such that no radiation workers over 18 years of age will receive in any one-calendar quarter a dose in excess of the following:

- Whole body, head/torso, active blood-forming organs, lens of the eye, or gonads: 1.25 Rem/quarter
- Hands and forearms; feet and ankles: 18.75 Rem/quarter
- Skin of the whole body: 7.50 Rem/quarter

Individuals less than 18 years old and all other non-radiation workers (individuals other than Authorized or Supervised Users) are restricted to a maximum of 0.5 Rem per year (0.125 per quarter).

Precautions in the Handling of Radioisotopes

- Always work over a spill tray or absorbent paper with a plastic backing. Place bottles of radioactive solutions so that they cannot be overturned. Volatile radio isotopic compounds must be handled in an approved fume hood vented to the outside.
- Be sure that all radioactive work areas, storage areas, waste containers and sample containers are properly labeled as containing radioactive materials, and that these are confined to approved areas for the handling and storage of radioisotopes.
- When using radioisotopes always wear a lab coat, disposable plastic or rubber gloves, and use pipettes with disposable tips. NO MOUTH PIPETTING IS ALLOWED! Do not handle radioisotopes if you have open cuts on your hands, even with gloves.
- Always remove your gloves before leaving the immediate area where isotopes are in use. Remove a glove when you handle anything that is not within the immediate work area (e.g., to scratch your nose or use the sink). Work in pairs, with the "clean" member recording data. If you spill onto your gloves, replace them immediately. Remember, your gloves are there to protect you in the event of a spill, and are not to serve as a barrier to allow you to make deliberate direct contact with radioisotopes.
- Never eat, drink, smoke, chew pencils, or apply cosmetics when in the laboratory.
- Always remove your gloves and wash your hands every time you leave the laboratory.
- In the event of an extensive spill, it is essential to minimize the spread of the radioisotope. The laboratory supervisor should supervise the following procedures:
    - Close the door and keep others out of the room. Send someone who has not been contaminated to notify the Radiation Safety Officer (Jeff Troxell, 901 Bushkill Dr. and call Public Safety's Emergency Extension 4444.
    - Apply absorbent paper to any free liquids and keep them from spreading. Powders should be covered with a damp paper towel.

- When the spill has been contained, remove contaminated clothing and gently wash hands and other body surfaces, which have become contaminated. Use soap and do not be modest. DO NOT wash so vigorously as to abrade your skin.
- The RSO will supervise further containment control and decontamination procedures.

Special Handling Requirements for Iodination

In no case will an Authorized User purchase or handle a stock solution of 1 mCi of ^{125}I, or greater, and in no instance will an individual be exposed to a cumulative level which exceeds 10 mCi of a volatile form of ^{125}I over any three month period. Stock solutions of ^{125}I will be stored within a lead container when not in use. Volatile forms of ^{125}I (NaI) will always be stored and handled in a fume hood with face velocity of at least 0.5 m/sec.

The limitations on the use of ^{125}I noted above will allow us to safely and successfully conduct our proposed experimentation, and will eliminate the need for routine personal monitoring devices or monitoring for potential thyroid exposure to ^{125}I.

In addition, the following procedures shall be followed:

- Conduct a radiation survey and wipe test after use.
    - Use the Mini Monitor 900 Series with the 42A Detector to conduct the radiation survey.
- Conduct iodination and store milli Curie (mCi) quantities of radioiodine in the fume hood.
- Notify the RSO prior to new procedures.
- Conduct a dry run prior to the performance of unfamiliar procedures in order to preclude unexpected complications.

Accidents, Emergencies, and Incidents

In case of an ACCIDENT, INJURY, AND/OR SPILLED RADIOISOTOPE, contact: Jeff Troxell, Director of Public Safety, Public Safety, 610-330-5330.

Major Emergency Procedures

- Notify all persons not involved (i.e.., not contaminated) in the spill to vacate the room at once.
- If the spill is liquid, and the hands are protected, right the container.
- If the spill is on the skin, flush thoroughly with water in the sink.
- If the spill is on clothing, discard outer or protective clothing at once in a large plastic bag and close it.
- Switch off all fans.
- Vacate the room.
- Notify the Radiation Safety Officer as soon as possible.
- Take immediate steps to further decontaminate personnel involved, as necessary.
- Decontaminate the area. Personnel involved in decontamination must be adequately protected.
- Monitor all persons involved in the spill and cleaning to determine adequacy of decontamination.

- Permit no person to resume work in the area until a survey is made and approval of the Radiation Safety Officer is secured.
- Prepare a complete history of the accident and subsequent activity related thereto for the Radiation Safety Officer.

Minor Spills Involving No Radiation Hazard to Personnel

- Notify all other persons in the room at once.
- Permit only the minimum number of persons necessary to deal with the spill into the area.
- Confine the spill immediately.
- Notify the Radiation Safety Officer as soon as possible.
- Decontaminate.
- Monitor all persons involved in the spill and cleaning.
- Permit no person to resume work in the area until a survey is made, and approval of the Radiation Safety Officer is secured.
- Prepare a complete history of the accident and subsequent activity related thereto for the Radiation Safety Officer.

Accidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors, and Gases

- Notify all other persons to vacate the room immediately.
- Hold breath and close escape valves, if possible.
- Vacate the room.
- Notify the Radiation Safety Officer at once.
- Ascertain that all doors giving access to the room are closed and sealed at the bottom. Post conspicuous warnings or guards to prevent accidental opening of doors.
- Monitor all persons suspected of contamination. Proceed with decontamination of personnel.
- Report at once all known or suspected inhalations of radioactive materials.

With Assistance from Radiation Safety Officer

- Evaluate the hazard and the necessary safety devices for re-entry.
- Determine the limits of contamination.
- Decontaminate the area.
- Perform air survey of the area before permitting work to be resumed.
- Submit a complete history of the accident and subsequent activities to the Radiation Safety Officer.

Injuries to Personnel Involving Radiation Hazard

- Wash minor wounds immediately under running water, while spreading the edges of the gash.
- Report all radiation accidents of personnel (wounds, overexposure, ingestion, and inhalation) to the Radiation Safety Officer as soon as possible.
- If there is a serious injury, dispatch the patient to the Emergency Room of St. Luke's Easton at once.
    - If there is contamination without serious injury, remove clothing and carry out gross decontamination, and then dispatch the patient to the Emergency Room at St. Luke's Easton 866-785-8537.

NOTE: If possible preserve all conditions contributing to the accident, to allow post-incident dose measurements. Nothing should be moved or changed without authorization of the Radiation Safety Officer.

- Do not permit the person involved in a radiation injury to return to work without the approval of the attendant physician and the Radiation Safety Officer.
- Prepare a complete history of the accident and subsequent related activity for the Radiation Safety Officer.
- Complete the "Employer's Report of Occupational Injury or Disease" for College employees and our Accident Investigation Form.
- Send anyone with exposure to X-rays to Bailey Health Center for treatment. Employees/students working with X-ray producing equipment must report all exposures to the RSO (X-5331 or X-4444). Symptoms of sufficient exposure to X-rays are radio dermatitis. This is characterized by dry skin, hair loss, telangiectasia, spider-like angiomas and hyperkeratosis. Exposure may look like insect bites.

Fires or Other Major Emergencies

- Notify all other persons in the room and building at once.
- Give the location of the emergency to the Public Safety Dispatcher at extension 4444.
- Attempt to put out fires if radiation hazard is not immediately present.
- Govern fire-fighting or other emergency activities by the restrictions of the Radiation Safety Officer.
- Monitor all persons involved in combating the emergency.
- Following the emergency, monitor the area and determine the protective devices necessary for safe decontamination.
- Decontaminate (refer to Section 13.0).
- Permit no person to return to work without the approval of the Radiation Safety Officer.
- Prepare a complete history of the emergency and subsequent related activities for the Radiation Safety Officer.

Monitoring: Contamination Limits

Before monitoring an accident or cleaning up a spill the individual should be aware of how the survey instrument is used and its limitations. Information on instruments may be found in their individual instruction manuals.

CONTAMINATION LIMITS (Maximum)

- For hands, body surfaces, personnel clothing and shoes
  - Alpha activity: 100 disintegrations per minute per 100 cm^2
  - Beta activity: 500 disintegrations per minute per 100 cm^2

The levels of "permissible" contamination are largely predicated on the methods of controlling the contaminated items and local environment.

Theft or Loss of Radioactive Materials

The program director and/or user shall notify the Radiation Safety Officer immediately after the occurrence of any theft or loss of radioactive materials. An attempt will be made to indicate the location of the radioactivity prior to its disappearance.

Decontamination Procedures

Philosophy

- Prevent Spread of Contamination. The Radiation Safety Officer should be called for assistance as soon as possible whenever a spill occurs. The first consideration after personnel safety is to decontaminate. Many factors must be considered, including tracking by persons, movement by air currents (hoods, fans, etc.), water, dusting, mopping, and other physical actions. To confine it, decontaminate the spill from the outside toward the center.
- Make a Plan. Successful decontamination calls for planned action. A spur of the moment action or attempt to decontaminate can cause more harm than good. Perhaps the best thing to do after a spill is to go sit in front of the laboratory door and make a thorough plan of the steps to be taken in the decontamination procedure.
- Monitoring. Make full use of instruments and available assistance. Each step of the decontamination should be monitored. One person should be kept clean to operate the instruments and do other monitoring. When the instruments become contaminated any progress is hopeless. Protective clothing, footwear, gloves, and gas masks should be used as needed.
- Records. Complete records should be made of each action. Copies should be sent to the Radiation Safety Officer.
- Waste Disposal. Provisions must be made for disposal of cleaning solutions and contaminated articles. In some instances, it may be judged better to dispose of a contaminated article than to attempt to decontaminate it.

Personnel Decontamination

Prompt removal of surface contamination is necessary to prevent possible transfer of radioactivity to internal organs by ingestion, absorption, or through wounds, cuts, or abrasions, and also to prevent possible radiation overexposure of the skin. It is imperative that the methods used in decontamination should not spread material or assist the contaminant in entering the body.

The following procedures have been used for removal of a wide variety of contaminants from personnel. (More drastic methods must be performed only under medical supervision.)

- Remove contaminated clothing and put it in a suitable container.
- Monitor the person carefully to determine the level and location of contamination.
- Cleanse contaminated areas with mild detergent and water giving special attention to hair and fingernails. (Surgical brushes may be used for cleansing but care must be taken to avoid abrading the skin. Avoid use of abrasive or strongly alkaline cleansers.)
- Use copious amounts of rinse water. However, use caution to avoid contaminating minor cuts or breaks in the skin.

- Where available, special hand cleaners will facilitate removal of contamination. (The Radiation Safety Officer maintains a limited stock of this material for emergency use.)
- Suitable materials, which can be used to remove stubborn contamination by metallic elements, are as follows:
    - Citric acid paste (citric acid and water) - rinse thoroughly!
    - Mixture of equal volumes of saturated solution of potassium permanganate and 1% solution of sulfuric acid.
        - Pour over wet hands and rinse thoroughly.
        - Potassium permanganate may be used alone although it is not as effective.

Facility Decontamination

Contact the Radiation Safety Officer for assistance whenever there is any hazard to personnel, any doubt on how to decontaminate, or when efforts fail to remove the contaminants.

- Monitor to determine the level and location of contamination.
- Post with appropriate signs to keep people out of area.
- Mark off contaminated areas (masking tape is useful for this purpose).
- Plan decontamination procedures - obtain adequate supply of decontamination materials.
- Cover clean areas with paper or plastic sheeting to prevent spread of contaminants.
- Wear protective clothing such as rubber gloves and shoe covers.
- Work from the perimeter toward the center. Do not use excessive water since this may cause the contamination to run off.
- Take care not to track contamination. Monitor all persons leaving contaminated area - particularly check soles of shoes and hands.
- Isolate and retain mops, rags, brushes, and wash solutions until these are monitored.

Facility Decontaminating Agents

Experience has shown that technique is often more important than the specific decontaminating agent used. For this and other reasons, it is difficult to assign a best method for a certain decontamination problem. Several methods used, which have been successful, are listed below.

- Damp rag.
- Water and detergent.
- Dilute complexing agent such as Versene (soaking in Versene is considerably better than simple washing). Action is accelerated if the versene is heated.
- Mild acids (citric or very dilute HC1 or HNO_3.
- Alternating the above steps.
- Special procedures for stubborn cases:
    - Metals - Strip oil and grease from surface; then use high-normality acids. Even concentrated acids or aqua regia may be used if surfaces can stand this treatment.
    - Concrete/Brick - Try mild acid solutions. Call Radiation Safety Officer
    - Glassware - Use ordinary chromic acid cleaning solution.
    - Floor Coverings - If well waxed before contamination, remove wax with appropriate stripping agents.
    - Wood - Sanding.
    - Painted Surfaces - Paint strippers.

Storage, Utilization and Labeling of Radioisotopes

The use and storage of radioactive materials will be limited to the following locations on the Lafayette College Campus:

Building/Room	Type	Authorized User
Hugel Hall/Room 34	Darkroom	Husic
Hugel Hall/Room 323	Laboratory	Husic
Hugel Hall/Room 325	Laboratory	Husic
Hugel Hall/Room 325A	^{125}I decay-n-storage	Husic

1. These areas must be clearly labeled at the entrance (visible from the hallway) with the appropriate magenta on yellow radiation symbol containing the words DANGER (OR CAUTION) RADIOACTIVE MATERIALS.
2. Also, each work, storage, and waste disposal area within the lab should be clearly marked with the appropriate tape marker, as should all containers or devices containing radioisotopes.
3. NRC and DEP form 3 ("NOTICE TO EMPLOYEES") (Appendix V); "IN CASE OF ACCIDENT..." sign (Appendix V); and the posting which reads the following (**Parts 19, 20, 21, Section 206 of Energy Reorganization Act, procedures adopted pursuant to Part 21, and license documents are available for your examination in room 11 Marquis Hall)** must be conspicuously placed within all designated working areas.

Monitoring Procedures

The following radiation detection instruments will be used:

1. Survey Meter - Technical Associates PUG-1 Serial No. 9971 with a thin window Geiger probe for alpha, beta, and gamma radiation. Biology Room 302A

   Survey Meter - Mini-Monitor 900 Series, serial# 046259. Detector 42A, serial# 0795. Chemistry Room 222, Hugel Hall.

   Survey Meter - RPI GM-1/EWGM. Biology Room 211

2. Liquid Scintillation Counter - Beckman Model LS 60000 TA - for routine experimental measurement of all isotopes, and for analysis of wipe test samples.

   Our license requires periodic testing for contamination of work and storage areas.

   Authorized Users shall conduct wipe tests once a month when µCi amounts of radioactive materials are in use and weekly if mCi amounts are in use (Appendix IV).

Wipe tests of storage areas, lab benches, sinks, floors or any other potentially contaminated surface are all appropriate. Written documentation of the results shall be provided to the R.S.O. when completed.

NOTE: Although the minimum requirements for wipe tests are once a month and weekly depending on the amount of radioactive materials used, a survey meter should be used to survey the area after every use.

Waste Management

All radioactive waste must be segregated and disposed of in the appropriate waste container located in the radioisotope suite, room 302A Kunkel Hall.

The types of waste containers are:

1. WASTE FOR INCINERATION
2. SCINTILLATION VIAL WASTE
3. SPECIAL WASTE

1. **Waste for Incineration**
    a. Place contaminated waste for incineration into the drum labeled WASTE FOR INCINERATION - DCS 2/93 (refer to the list of approved material for incineration on the outside of the drum).
    b. Record the appropriate information on the "Radioactive Waste Log" attached to this container.
    c. When the container is full, call the Public Safety at X-5330 to schedule a waste pickup.

Note: Place only waste approved for incineration in this container and eliminate voids in the bag and/or drum to the extent practical. NO LIQUIDS.

Note: Do not place sharp objects, such as pipettes or broken glass, into the solid waste disposal bag without first placing them in a small container which will protect the plastic liner from being pierced by the object.

2. Scintillation Vial Waste

a. Place all scintillation vials, with the cocktail fluid in the vial, into the inner liner of the container labeled SCINTILLATION VIAL WASTE - VXR 2/93.
b. Record on the log sheet (on the lid of the container) the quantity and chemical form of each radioisotope being disposed (Appendix VII).

3. Special Waste

a. Decay-in-Storage
   i. Retain water-soluble isotopic waste with short half-lives (^{32}P, ^{35}S and ^{125}I) until their residual radioactivities are sufficiently low (for at least 10 half-lives). Segregate all waste in its proper container and label the container for its contents. Initiate a "decay-in-storage" log (APPENDIX VIII) and store in designated area.

Note: The ^{125}I waste will be separated and stored in a closed container in the designated hood, Hugel Hall, Rm 325A.

Note: ^{35}S waste will be stored in a container in Kunkel Hall, Room 302A and/or 211.

Note: ^{32}P dry waste will be stored in a plastic lined, 1.2 cm thick, acrylic container in Kunkel Hall, Room 302A (dimensions = 18" x 18" x 29.5"). 32P liquid waste will be stored in glass bottle with in a 1.2 cm thick, acrylic container.

   ii. Survey the waste, without shielding, in a low background area with our survey meter.
   iii. Dispose of the waste as normal trash only if the radiation level is indistinguishable from background, and that all radioactive labels have been removed or deface.

b. Sanitary Sewerage System

   Low activities of dilute aqueous solutions containing radioisotopes will be disposed of in a labeled sink in the authorized laboratory areas to the sanitary sewer system as per section 20.2003 of Part 20, U.S.N.R.C. Rules and Regulations, April 30, 1992 (Appendix IX). Record and maintain all disposals into the sanitary sewer system.

c. Other

   Liquid scintillation fluid, animal carcasses, and liquids containing non-regulated levels of radioisotopes will be appropriately stored, and removed for disposal, as outlined in sections 20.2004 and 20.2005 of Part 20, U.S.N.R.C. Rules and Regulations, April 30, 1992 (Appendix IX).

Radiation Producing Equipment

All radiation producing equipment must be register with the RSO, Public Safety, 901 Bushkill Drive, X-5330. The following is a list of equipment used at Lafayette College:

1. PANalytical EMPYREAN X-ray System – Located in Van Wickle Hall, Room 007. Instructions and training must be obtained from Professor Tamara Carley, Geology before operating this equipment. Refer to the "Special Operating Instructions" on the next page.

2. Tracer 5i Portable XRF Spectrometer – Located in Van Wickle Hall, Room 001. Instructions and training must be obtained from Professor John Wilson, Geology, before operating this equipment. Refer to the "Special Operating Instructions" on the next page.
3. Sedigraph 5100 Analytical X-ray – Located in Van Wickle Hall Room 005. Instructions and Training must be obtained from Professor John Wilson, Geology.
4. Hologic Minic C-arm Fluoroscope – Located in Bourger Varsity House Training Room. Instructions and Training must be obtained from Matthew Bayly – Sports Medicine.
5. XtaLAB Mini II X-ray – Located in Hugel Hall Room 234. Instructions and training must be obtained from Professor Chip Nataro, Chemistry, before operating this equipment. Refer to the "Special Operating Instructions" on the next page.

Special Operating Instructions for Items 1&2

No individual may bypass or otherwise circumvent a safety device unless the individual has obtained written approval from the Radiation Safety Officer (X-5330). The Radiation Safety Officer shall grant the permission only if the following exist:

1. A trained repair technician makes a request to the Chemistry or Geology Department Head to circumvent a safety device. The Chemistry or Geology Department Head must contact the RSO for review and approval.
2. The period for the bypass of the safety device is no more than 30 days unless permission is obtained from the PA DEP for a longer period.
3. A readily discernible sign bearing the words "Safety Device Not Working" or words containing a similar warning is placed on the radiation source housing.

NOTE: These requirements apply equally to maintenance and regular operating personnel.

Appendix I

Application for Approval as an Authorized User

Name: _____

Department: _____Date:_____

Please complete the following:

1. Elements and Mass Number of Isotope_____
2. Chemicals and/or Physical Form_____
3. Amount Requested_____
4. Proposed Use Area_____
5. Proposed Storage Area_____
6. Proposed Activities of Radioisotopes:

_____

_____

_____

_____

_____

_____

_____

_____

7. Training in Radiation Safety and Experience in the Handling of Radioactive Materials:

_____

_____

_____

_____

_____

8. Forward the completed application to your Department Head and then to Jeff Troxell, RSO, Public Safety, 901 Bushkill Drive.

_____

__

To be completed by Public Safety:

Date RSO reviewed_____approved___ not approved___

Date mailed to PA DEP for approval_____

approved___ not approved___ Reason for disapproval:

_____

_____

_____

_____

Appendix II

Radiation Safety Training

I, _____, have read and understand the contents of Lafayette College's Radiation Safety Program. The written program consists of information on the following topics:

Purpose
Scope
Definitions
Responsibilities
Application/Approval as an Authorized User
Information and Training
Radioisotope Procurement
Permissible Dose Limits
Precautions/Handling of Radioisotopes
Special Handling Requirements for Iodination's
Accidents/Emergencies/Incidents

1. Emergency Procedure: Major
2. Emergency Procedure: Minor
3. Accidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors, and Gases
4. Injuries to Personal Involving Radiation Hazard
5. Fires or Other Major Emergencies
6. Monitoring: Contamination Limits
7. Theft or Loss of Radioactive Materials

Decontamination Procedures

1. Philosophy
2. Personnel Decontamination
3. Facility Decontamination

Storage, Utilization, and Labeling of Radioisotopes
Monitoring Procedures
Waste Management

1. Waste for Incineration
2. Scintillation Vial Waste
3. Special Waste

Radiation Producing Equipment

Appendix I: Application Authorized for Approval as an Authorized User
Appendix II: Training Log
Appendix III: Examining Incoming Radioisotopes Package Procedure
Appendix IV: Wipe Test Procedure
Appendix V: DEP Form 2900-PM-RP0003

Appendix VI: Emergency Numbers
Appendix VII: Radioactive Waste Log
Appendix VIII: Decay-in-Storage Log
Appendix IX: Part 20 - NRC Disposal by Release into Sanitary Sewerage
Appendix X: Laboratory Radiation Survey
Appendix XI: Fetal Protection Program

Trainee Signature	**Trainer Signature**	**Date**

(Return completed form to Public Safety)

Appendix III

Examining Incoming Radioisotope Package Procedure

All packages delivered to Lafayette College containing radioactive material will be examined as soon as practicable after receipt of the package, but not later than 3 hours after the package is received. The package will be monitored for potential radioactive contamination and radiation levels following these guidelines:

1. Don protective gloves.
2. Survey the outside of the package with the PUG-1 survey meter. If the level does not exceed background, continue with this procedure. If the package is contaminated notify the RSO at X4444 Campus Emergency as soon as possible.

   If the contamination exceeds 22,000 dpm or 0.01 uCi the R.S.O. will immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile:

   PA DEP - Bureau of Radiation Protection
   P.O. Box 8469
   Harrisburg, PA 17105-8469

   Phone: 717-787-2480
   Fax: 717-783-8965

3. Conduct a wipe sample of the package exterior following the guidelines of our Wipe Test Procedure (refer to Appendix IV).
4. Survey the packing material inside the package with the PUG-1 survey meter. Refer to item #2 if there is contamination.
5. Conduct a separate wipe sample of the interior package following the guidelines of our Wipe Test Procedure (refer to Appendix III).

   Note: If the wipe sample results exceed 22,000 dpm or 0.01 uCi notify the R.S.O. immediately.

6. Dispose of gloves, vials, etc. according to our waste procedure.
7. Notify the Authorized User that their package is ready to be picked up in Room 302A Kunkel Hall.

Appendix IV

Wipe Test Procedure

Wear gloves and handle filter paper disk with forceps at all times when doing wipe samples. Areas where mCi quantities of isotopes are used must be checked for potential contamination every week. Areas where µCi quantities are used must be checked monthly (preferably on the 15th of the month).

Background Count Vial

Prepare a background count vial by placing a clean filter paper disk into a small mini-vial and add 4.5 ml of scintillation cocktail to it.

Wipe Test Vials

For each area to be checked:

1. Wet a small filter paper disk.
2. Wipe the counter top, floor, or object with the wetted filter paper.
3. Place the filter paper into small mini-vial.
4. Add 4.5 - 5.0 ml scintillation cocktail and swirl.
5. Put the mini-vial into a larger scintillation counting vial.

Obtaining CPMs with the Scintillation Counter

1. Place the following racks in order in the scintillation counter:
    a. first, the white rack with known calibration samples (samples in slots on the left).
    b. second, the white rack with the background vial followed by your wipe test samples and the User #2 card in the appropriate slot.
    c. lastly, the red rack with a "Halt" card in the appropriate slot.
2. Close the lid of the scintillation counter.
3. Press the green "Auto Count" button.
4. The count should take about thirty minutes and you should receive a printout of the values. Write the exact location of the wipe test area next to the corresponding results. Compare the CPM from your samples to the CPM of the background vial. Any area for which the CPM readings are more than double the CPM reading of the background vial must be cleaned with detergent and tested again.
5. Keep one copy of the printout in the laboratory notebook and send the other to the Radiation Safety Officer in Public Safety.
6. Remove the large counting vial from the scintillation counter. Dispose of the mini-vial with scintillation cocktail into an appropriate waste container and record the approximate µCi addition on the waste drum log sheet. Save the larger counting vials and replace them on the

shelf.

Appendix V

DEP Form 2900-PM-RP0003

2900-PM-RP0003 Rev. 2/2008

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF RADIATION PROTECTION

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION; NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS; EMPLOYEE PROTECTION

In Title 25 of its Rules and Regulations, the Pennsylvania Department of Environmental Protection has established standards for your protection against radiation hazards and has established certain provisions for the options of workers engaged in work under a Department license or registration.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to:

1. Apply these Department of Environmental Protection regulations and any conditions of your employer's radioactive materials license to all work involving radiation sources.
2. Post or otherwise make available to you a copy of the Department of Environmental Protection regulations, licenses, and operating procedures which apply to work in which you are engaged, and explain their provisions to you.
3. Post Notice of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with these provisions of the Department of Environmental Protection regulations and operating procedures which apply to the work in which you are engaged. You should observe their provisions for your own protection and protection of your co-workers. If you observe a violation or possible safety concern, you should report it immediately to your supervisor or contact DEP. You may be personally subject to enforcement action if through deliberate misconduct you cause or attempt to cause a violation of DEP requirements or deliberately provide inaccurate or incomplete safety information to DEP or your employer.

WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive materials in restricted and unrestricted areas.
2. Measures to be taken after accidental exposure.
3. Personal monitoring, surveys, and equipment.
4. Caution signs, labels, and safety interlock equipment.
5. Exposure records and reports.
6. Options for workers regarding Department inspections.
7. Related matters.

REPORTS ON YOUR RADIATION HISTORY

1. The Department of Environmental Protection regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or the license. The basic limits for exposure to employees are set forth in Chapter 219 of the regulations. This chapter specifies limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personal monitoring is required pursuant to Chapter 219:
   (a) Your employer must advise you annually of your exposure to radiation, and
   (b) You may request a written report of your radiation exposure when you leave your job.

INSPECTIONS

All activities involving radiation are subject to inspection by representatives of the Pennsylvania Department of Environmental Protection. In addition, any worker or representative of workers who believes that there is a violation of the Department regulations of the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Bureau of Radiation Protection. The request must set forth the specific grounds for the notice, and must be signed by the worker as the representative of the workers or their self. During inspections, Department inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which that worker believes contributed to or caused any violation as described above.

INQUIRIES

Inquiries dealing with matters outlined above can be sent to the Bureau of Radiation Protection, Pennsylvania Department of Environmental Protection, P.O. Box 8469, Harrisburg PA 17105-8469.

Telephone (717) 787-3720
Facsimile (717) 783-8965

POSTING REQUIREMENTS

Copies of this notice must be posted in a sufficient number of places in every establishment where activities covered by the regulations are conducted to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

Appendix VI

Emergency Numbers

In case of an ACCIDENT, INJURY, AND/OR SPILLED RADIOISOTOPE, contact the Public Safety emergency number **610-330-444**

The Dispatcher will contact Jeff Troxell at:

- 610-330-5604 (Work)
-

NOTE: During Jeff Troxell' absence the following will act as the Temporary RSO.:

Jeff Troxell – Public Safety

- 610-330-5332 (Work)
- 717-360-2110 (Home)

Appendix VII

Radioactive Waste Log

Date	Authorized User	Isotope	Activity (µCi)	Amount (µl)	Comments

Appendix VII

Appendix VIII

Decay-in-Storage Log					
Survey Meter Used:					
Isotope Stored	Storage Date (last addition)	Storage Completion Date	Final Survey Results (mR/hr)	Background Survey (mR/hr)	Surveyed by (initials)

Notes: Condition 14 of our NRC License requires us to keep our decay-in-storage material for ten half lives. After ten half lives survey the waste in a low background area (away from other waste etc.). Use an appropriate instrument that is sensitive to the waste in storage. Remove or obliterate all radioactive labels prior to disposal as normal waste.

Half life for 35S is 87.9 days x 10 half lives = 879 days or 2.4 years.
Half life for 32P is 14.28 days x 10 half lives = 142.8 days or 4.6 months.
Half life for 125I is 60 days x 10 half lives = 600 days or 1.64 years.

Appendix IX

Nuclear Regulatory Commission
Disposal by Release into Sanitary Sewerage

§ 20.2003 Disposal by release into sanitary sewerage.

(a) A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

(1) The material is readily soluble (or is readily dispersible biological material) in water; and

(2) The quantity of licensed or other radioactive material that the licensee releases into the sewer in 1 month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in table 3 of appendix B to part 20; and

(3) If more than one radionuclide is released, the following conditions must also be satisfied:

(i) The licensee shall determine the fraction of the limit in table 3 of appendix B to part 20 represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in table 3 of appendix B to part 20; and

(ii) The sum of the fractions for each radionuclide required by paragraph (a)(3)(i) of this section does not exceed unity; and

(4) The total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 5 curies (185 GBq) of hydrogen-3, 1 curie (37 GBq) of carbon-14, and 1 curie (37 GBq) of all other radioactive materials combined.

(b) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in paragraph (a) of this section.

[56 FR 23403, May 21, 1991, as amended at 60 FR 20185, Apr. 25, 1995]

Page Last Reviewed/Updated Tuesday, August 29, 2017

Appendix X

Laboratory Radiation Survey

Please complete and return to Jeff Troxell, Public Safety, 901 Bushkill Drive. Test all areas, which could potentially be contaminated.

Authorized Users: _____ Survey Date: _____

AREA CHECKED	ROOM #, BUILDING	CPM ON WIPE TEST
_____	_____	_____ _____
_____	_____	_____ _____
_____	_____	_____ _____
_____	_____	_____ _____
_____	_____	_____ _____
_____	_____	_____ _____

SIGNATURE: _____

Appendix XI

Fetal Protection Program

Introduction

Lafayette College would like to inform all individuals, who work in restricted radiation areas, of the health risks to unborn babies.

Qualified scientists have recommended that the radiation dose to fetus from occupational sources of radiation should not exceed 0.5 rem. Exposures to staff and students at Lafayette College have traditionally been kept well below suggested governmental standards.

Studies have shown that the risk of leukemia and other cancers in children increase if the mother is exposed to a significant amount of radiation during pregnancy. According to a report by the National Academy of Sciences, the incidence of leukemia among children under 10 years of age in the United States could rise one and one-half times if fetuses were routinely exposed to 1 rem of radiation before the birth. The Academy has also estimated that an equal number of other types of scientific studies have shown a much smaller effect from radiation, regulatory agencies are now requiring licensees to inform women of the possible risk so that they may take the steps they think are appropriate to protect their offspring.

Any questions you may have about the following statement should be directed to your supervisor or Jeff Troxell, Radiation Safety Officer (RSO).

General Background

As someone who regularly works with ionizing radiation sources equipment, you may be exposed to more radiation than the general public. However, Federal and State governments have established exposure limits for all occupationally exposed adults at 1.25 rems per calendar quarter, or 5 rems per year. No clinical evidence of harm has ever been seen in an adult working within these levels for a lifetime. Because the risk of undesirable effects may be greater for young people, persons under 18 year of age are permitted to be exposed to only 10 percent of the adult occupational limits or 0.5 rems per year. This lower limit is also applied to members of the general public, which include unborn children.

The amount of radiation a person receives is called the "dose" and is measured in "rems". The average person in the United States receives a dose of 0.1 rem from natural sources each year. The dose from natural radiation is higher in some states, such as Colorado, Wyoming and Utah, due to increased

altitude and higher levels of radiation from the radioactive materials in the soil. There the average person may get as much as 0.2-0.3 rem each year.

Natural background radiation levels may be much higher in certain local areas. In some beach areas of Brazil and in some areas of India, doses of 5-15 rems per year have been measured. It should be noted that even in these areas, increased cancer or birth defect rates have not been observed.

Many people receive additional radiation for medical reasons. The annual diagnostic radiation dose averaged over the United States population from diagnostic x-rays is 0.07 rem per year. The average dose from one chest x-ray is about 0.03 rem.

Radiation can also be received from such common materials as the rock, brick or concrete we have in our homes, from consumer products such as television and glow-in-the-dark watches and from air travel. The approximate annual dose in the United States from consumer products and air travel is about 0.003 rem.

Radiation, like many things, can be harmful. The degree of damage is dependent on many factors such as the total dose received, how fast that dose is received, the part of the body exposed, the type of radiation, the state health of the person exposed and the degree of repair of internal radiation damage.

For example, a very large dose to the whole body (such as 600 rems in one or two hours) probably would result in death. But, if the same total dose (600 rems) was received over a period of several weeks (as in the case of cancer therapy), the person will survive. Similarly, animal studies in rats have shown that 5 rems spread out over the entire pregnancy will not result in birth defects.

It should be noted that large doses such as 600 rems result only from rare accidents which we have never had at Lafayette. It also requires a dose this large to cause permanent sterility. There is a repair mechanism at work in our bodies. At doses as high as 1 rem per day (360 rems per year), the repair rate is as high as 90 percent. At doses in the occupational exposure range of 5 rems per year or lower, this repair rate increases to greater than 99 percent over the next 30 days.

Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposure when the established radiation limits are not significantly exceeded. This was true even for exposures received under the early occupational exposure limits, which were three times higher than the present limit (15 rems per year versus 5 rems per year today). Thus, the risk to individuals at the present occupational exposure levels is considered to be very low. However, it is impossible to say that the risk is zero.

Everything we do involves some risk. We occasionally read about someone choking on food and dying. So even eating carries a risk with it. Table A-1 gives a comparison of different types of risk to the fetus. As can be seen, at occupational exposure rates, the risk of detrimental effects are low. In an attempt to decrease the risk of radiation-induced effects still further, Lafayette College constantly strives to keep actual exposures as far below the limits as practicable.

Prenatal Irradiation

The current exposure limits for people working with radiation devices have been developed and carefully reviewed by nationally and internationally recognized groups of scientists. It must be remembered, however, that these limits are for adults. Special consideration is appropriate when the person being exposed is, or may be, an expectant mother.

Scientific research has indicated that unborn babies are more sensitive to radiation than adults. Therefore, particular efforts should be made to keep the radiation exposure to an embryo or fetus, as a result of the occupational exposure of the mother, at the very lowest practicable level during the entire pregnancy. Depending on the type of radiation, the dose to the fetus may be much less than the dose to the mother because of attenuation by the mother's body before the radiation can reach the fetus.

Several studies have been performed to evaluate the risk that cancer, and especially leukemia, may develop during the first 10 years of the child's life. One study involved a follow-up with 77,000 children exposed to radiation before birth. Another study involved a follow-up with 20,000 such children. In addition, 1,292 children who received prenatal exposure during the bombings of Hiroshima and Nagasaki were studied. Most of the evidence suggests a relationship between prenatal exposure and an increased risk of childhood cancer or leukemia. Additionally, research has shown that the greatest risk is during the first eight weeks of pregnancy. This necessitates protecting the fetus of a woman who may not even know she is pregnant at this early time.

Studies have shown that the risk of leukemia and other cancers in children increases if the mother is exposed to a significant amount of radiation during pregnancy. According to a report by the National Academy of Sciences, the incidence of leukemia among children under 10 years of age in the United States could rise one and one-half times if fetuses were routinely exposed to 1 rem of radiation before birth. The Academy has also estimated that an equal number of other types of cancers could result from this level of radiation. Although other scientific studies have shown a much smaller effect from radiation, Lafayette College feels that it is prudent to inform women of the possible risk so that they may take the steps they think are appropriate to protect their offspring.

Conclusion

Lafayette College has made every attempt over the years to insure that radiation exposures to its employees and the general public are as low as reasonably achievable. All proposed uses are reviewed to insure that radiation sources are properly handled. Every attempt is made to design installations so that personnel receive much less than 0.5 rem per year. We have succeeded in keeping radiation exposures well below the legal limits.

We also subscribe to the philosophy that all unnecessary radiation should be avoided. In line with this philosophy, we post all radiation restricted areas with warning signs. Staff and students are urged not to loiter in areas posted with these signs.

While Lafayette College continues to keep radiation to all personnel as low as reasonably achievable, there are certain low risks associated with prenatal radiation exposure. You will be advised of the levels of radiation in your work area as determined from periodic surveys and personnel monitoring so that you may be exposed to more than 0.05 rem in a nine-month period, Public Safety will explore the possible ways to reduce your exposure and advise you accordingly. If your exposure is less than 0.05 rem in a nine-month period and you are concerned about the risks involved, the matter will be further discussed with you.

All inquiries for exposure data or information should be directed through your department to Public Safety (extension 5330).

Table A-1

Effect and Frequency of Certain Maternal Factors on Pregnancy Outcome

Maternal Factor	Effects	Rate of Occurrence in Exposed Population
German Measles	Defects of heart, lens of eye, skeletal muscles, inner ear, and teeth.	2 in 3
Cigarette Smoking	In general, babies weigh 5 to 9 ounces less than babies of mothers who do not smoke during pregnancy.	
Less than 1 pack per day	Infant death	1 in 5
One or more pack per day	Infant death	1 in 3
Alcohol Consumption		
2 drinks per day	Babies weigh 2 to 6 ounces less than babies of mothers who do not consume alcohol.	1 in 10
2 to 4 drinks per day	Signs of fetal alcohol syndrome (growth deficiency, brain	1 in 10
4 or more drinks per day		
Chronically alcoholic		1 in 3 to 1 in 5

	dysfunction, characteristic facial signs).	
Maternal Age		
20 years	Down's Syndrome (mental and physical growth retardation)	1 in 2300
35 to 39 years		1 in 64
40 to 44 years		1 in 39
Aspirin	Clubfoot	1 in 13
High Altitude (mean altitude)		
263 feet	Low birth weight (higher risk); babies weigh less than 5.5 pounds.	1 in 15
5,000 feet		1 in 10
10, 500 feet		1 in 4
Radiation		
Childhood cancer:		
1 rem	Childhood leukemia before the age of 12 years.	1 in 3333
1 rem	Deaths from other childhood cancers before the age of 10 years.	1 in 3571
Bomb exposure at 4 – 13 weeks gestation:		
From 15 to greater than 100 rems (Hiroshima)	Small head size with severe mental retardation at greater than 25 rads.	1 in 4
Greater than 150 rems (Nagasaki)		