Chapter 14

Laboratory Safety Principles

A. Radioactive Materials-Jerry Staiger

B. Toxic, Reactive, Carcinogenic, and Teratogenic Chemicals-Keith Carlson

C. Infectious Agents-Jim Lauer

D. Fire and Physical Hazards-Ray Arntson

Note: This workshop consisted of four separate subtitles and presentations.

Radioactive Materials

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PROCEDURES FOR RADIOISOTOPE USE AREAS

All users of radioisotopes must comply with the following procedures and ensure that persons under their direction adhere to these rules.

Identification of Use Areas

- Each door to an area where radioisotopes are used or stored must be posted with a *"CAUTION RADIOACTIVE MATERIAL"* sign, and such areas must be maintained as controlled areas, with doors closed and locked when the area is unattended. For further information on controlled areas, see Appendix F. The name and phone number of the approved user must be on the caution sign, along with the phone number of the Radiation Protection Program. The signs must not be removed from any room except by a Radiation Protection Program staff member following a radiation protection closeout survey.

- Each radioisotope storage area must be conspicuously posted with a *"CAUTION RADIOACTIVE MATERIAL"* sign. Any vessel which contains stock radioactive material must also be labeled with a *"CAUTION RADIOACTIVE MATERIAL"* label such as radiation caution tape. These signs and labels must state the kinds of radioisotopes and the quantity being stored.

- Any area where persons could be exposed to 5 mrem/hour to the whole body or where the exposure could exceed 100 mrem in five consecutive days must be posted with a *"CAUTION RADIATION AREA"* sign.

Contact the Radiation Protection Program for information on the availability of caution signs for various purposes.

Shielding of Radioactive Sources

Appropriate shielding must be provided so that the radiation exposure rate from radioisotope sources is less than 2.5 mR/hour in any controlled area and less than 0.25 mR/hour in any uncontrolled area. Radiation exposure rates should be maintained as low as is reasonably achievable within these limits. Contact the Radiation Protection Program regarding shielding materials and techniques.

Radioactive Gases, Dusts and Aerosols

- All procedures involving radioactive gases, dusts or aerosols or any experiment that might release airborne radioactive contamination must be conducted in a well ventilated hood or other enclosure that has been approved by a Radiation Protection Program staff member. Specifications for such enclosures may be obtained from the Radiation Protection Program.

- Radioactive gases must be stored in gas-tight containers that are kept in approved ventilated areas.

Sealed Radiation Sources

Sealed radiation sources must be handled with tongs or other remote handling devices. (This procedure is not required when handling very low activity check sources.) The dose rate at the hand and body location should be determined before such sources are used or moved. As required under Nuclear Regulatory Commission license conditions, alpha sources will be leak tested by a Radiation Protection Program staff member every three months, and beta and/or gamma sources every six months. Damaged or lost sources must be reported to the Radiation Protection Program immediately.

Periodic Surveys of Radioisotope Facilities

- Each laboratory using radioactive materials (except laboratories using only very low activity sealed sources) must have available a radiation monitoring instrument capable of detecting low levels of contamination. Smear surveys of laboratory use, storage and waste disposal areas must be performed on a routine basis. A minimum frequency of once per month when radioisotopes are in use and once per quarter when the laboratory is used only for storage is required. Permanent records of the results of these surveys must be maintained. For quarterly report requirements, see Appendix D.

- The preferred method for evaluating removable radioactive contamination is to wipe the surface to be evaluated with a filter paper such as Whatman 1 (4.25 cm). A surface of approximately 100 square centimeters should be wiped and the paper counted in an appropriately calibrated liquid scintillation counter or other counting instrument capable of detecting the type of radionuclide being used. Liquid scintillation counting is the preferred method for detecting contamination from low energy beta emitting radioisotopes such as ^{14}C and ^{3}H. It is also a good method for evaluating possible contamination from all other beta emitting radioisotopes.

- According to Nuclear Regulatory Commission license requirements, all smear survey results obtained by individual users must be reported in disintegrations per minute (DPM) per 100 square centimeters, rather than in counts per minute (CPM).

  In order to obtain these results, it will be necessary for the user to indicate on the survey form the gross CPM per 100 square centimeters, the background CPM, the fractional efficiency of the counting instrument for each radioisotope analyzed, and the particular counting system used, i.e., liquid scintillation, auto-gamma, etc. The fractional efficiency (E) can best be determined by counting a known activity of the radioisotope and dividing the count rate (CPM) by the disintegration rate of the known activity (DPM), i.e., E = CPM/DPM. The disintegration rate (DPM) is obtained by multiplying the activity in microcuries (μCi) by 2.22×10^6 DPM/μCi.

- A Geiger-Mueller (G-M) portable radiation survey instrument is often used to detect contamination; however, this instrument is not effective in detecting low energy beta or alpha emitters. Contact the Radiation Protection Program for assistance in determining the appropriate method for evaluating possible contamination in individual laboratories *before* purchasing radiation survey instruments.

- The Radiation Protection Program provides a service of periodically performing radiation protection surveys of all radioisotope laboratories. As part of this survey, a Radiation Protection Program representative will review the records of surveys made by the approved user. A report of these surveys will be sent to the approved user. These surveys do not substitute for the routine surveys performed by the approved user.

Laboratory Equipment Maintenance and Disposal

Radioisotope laboratory equipment intended for disposal or requiring maintenance must not be removed from the radioisotope laboratory until surveyed by the approved user and demonstrated to be free of contamination. If repairs must be made of contaminated equipment, the user must contact a representative of the Radiation Protection Program who will directly supervise the work. No contaminated glassware may be taken to the glass shop for repair or modification unless approved by a Radiation Protection Program staff member.

Use of Radioisotopes in Animals

- Before a permit is granted for use of radioisotopes in animals, a Radiation Protection Program representative will review the animal care procedures with the applicant. The applicant must have adequate animal care facilities and must make provisions for collection and storage of animal carcasses and associated waste.

- Animals that present a potential for airborne radioactive contamination must be housed in a properly ventilated radioisotope hood or room.

- Animal carcasses and associated wastes must be packaged in accordance with the procedures outlined on pages XI-7,8.

- Cages used for housing animals treated with radioisotopes must be labeled with a radiation caution tag that lists the type and quantity of radioisotopes in each animal and the date of administration.

- Absorbent paper used to collect animal urine and feces must be changed frequently to reduce the potential for airborne release of radioisotopes. The contaminated absorbent paper must be disposed of in a radioactive waste container located in the animal care area.

- Routine contamination smear surveys must be made of the cages and room where such animals are housed, and areas that indicate removable contamination must be immediately decontaminated.

- Cages that are to be cleaned in a cage wash facility must first be surveyed for contamination, and contaminated areas must be cleaned to less than 2200 DPM per 100 square centimeters. A tag which instructs the cage washer operator not to recycle the wash water must be attached to the cages.

- If animals containing radioisotopes are to be cared for in general animal care facilities, the applicant must provide training to personnel who will care for the animals following the procedures outlined in Appendix O. If any assistance is needed in the training of animal care personnel or the monitoring of use facilities, contact the Radiation Protection Program.

For further information on the use of radioisotopes in animals, see Appendix O.

Laboratory Design and Plan Review

All plans for radioisotopes laboratory modification and new laboratory construction must be reviewed and approved by a Radiation Protection Program representative. Effective and safe use of radioisotopes requires special design of facilities and equipment. The laboratory should be designed to reduce the possibility of contamination and to be easily decontaminated if accidental contamination should occur.

General Laboratory Considerations

- Good housekeeping should be observed at all times to control contamination and to facilitate cleaning in laboratories where radioisotopes are used.

- Eating, drinking, smoking, and cosmetic application are prohibited in the radioisotope laboratory. Never store food of any kind in a radioisotope laboratory or in any refrigerator or freezer in a radioisotope laboratory. University policy on this regulation is given in Appendix T.

- Mouth pipetting is prohibited in all radioisotope laboratory areas. Use syringes or other remote pipetters. Contact the Radiation Protection Program for information on such equipment. See Appendix T for the policy statement on this regulation.

- Wear laboratory coats, disposable gloves, and when necessary, eye protection when working with radioactive materials. Wash hands thoroughly after removal of gloves.

- To prevent the spread of contamination, use radioisotope trays lined with absorbent paper when working with radioisotopes. Contact the Radiation Protection Program regarding the availability of these trays.

- If there is any possibility of an airborne hazard, all work with radioisotopes must be carried out in an adequately ventilated hood.

For further information, see Appendix F, *"Guidelines for Safe Use of Radioisotopes"*.

Radioisotope Shipments

- Radioisotope shipments must be opened in a hood if there is any possibility of airborne contamination.

- When opening a shipment, wear disposable gloves and examine the contents to determine possible damage or leakage. If damage or leakage is noticed, contact the Radiation Protection Program immediately.

- A smear survey of the shipping box must be conducted. If the smear survey indicates contamination, dispose of the shipping box in the solid radioactive waste container. If a smear survey indicates no contamination, the box may be discarded as non-radioactive waste provided all radiation labels and markings have been removed from the box.

Monitoring

- Radiation survey instruments shall be used to monitor clothing, hands, shoes and the laboratory area. A G-M survey instrument can be used to make contamination surveys for most types of radioisotopes; however, for ^{3}H, ^{14}C, or other low energy beta emitting radioisotopes, it is necessary to make a smear survey of laboratory surfaces, including the floor, using a piece of filter paper such as Whatman 1 (4.25 cm diameter). This paper is then placed in a counting vial and counted in a liquid scintillation counter. The smear survey is the preferred method for evaluating contamination for all beta emitting radioisotopes. It is important that frequent surveys be made to reduce the possibile spread of radioactive contamination. See Appendix D for minimum frequency requirements. Records of these surveys must be maintained by the approved user. Contact the Radiation Protection Program for more details on instrumentation.

- Occupationally exposed pregnant women should maintain radiation exposure to within 500 mrem during the nine month gestation period according to Nuclear Regulatory Commission regulation guide 8.13. For further information, see Appendix S.

- Personnel monitoring devices must be worn when the radiation exposure potential warrants their use. A Radiation Protection Program representative will evaluate the need for film badges in areas where potential external radiation exposure exists.

Storage

Provisions must be made for the proper storage of radioisotopes in the laboratory. Sufficient shielding must be provided to maintain radiation exposure levels within permissible limits. Radioisotopes must be stored in containers that prevent spillage and contamination. See Appendix G for permissible dose limits.

Transportation

When radioisotopes are transported through an uncontrolled area, they must be packaged in a leak-proof, nonbreakable container to prevent release of the radioactive material. When radioactive liquids are in a glass container, the container must be kept in a second, non-breakable vessel that will hold the radioactive contents in the event that the glass container is broken.

Wastes

Radioactive wastes must be disposed of only in approved, appropriately marked containers. Contact the Radiation Protection Program to request disposal service. Do not mix acids and organic solvents as waste. Records must be kept of the radioisotopes and activities in each waste container. These records will be reviewed by Radiation Protection Program staff members. For more detailed information on radioactive waste, see section XI.

Information on Specific Radioisotopes

General laboratory procedures for radioisotope use have been given above. More specific information on radioisotopes commonly used at the University can be found in the following appendices:

Appendix U: Some Commonly Used Radioisotopes and Their Relative Radiotoxicities.

Appendix J: Information and Procedures for Use of ^{3}H and ^{14}C.

Appendix K: Handling and Survey Procedures for High Energy Beta Emitting Radioisotopes.

Appendix L: Precautions in the Use of ^{125}I and ^{131}I.

APPENDIX F

GUIDELINES FOR THE SAFE USE OF RADIOISOTOPES

1. Observe good housekeeping at all times to prevent contamination and to facilitate cleaning.

2. When pipetting radioactive materials, use syringes, remote pipetters, rubber bulbs, or other mechanical devices. DO NOT PIPETTE BY MOUTH.

3. DO NOT EAT, DRINK OR SMOKE IN THE LABORATORY. Do not store food of any kind in the laboratory or in a refrigerator or freezer where radioactive materials are stored.

4. Wear laboratory coats and disposable gloves when working with radioactive materials. Wash hands thoroughly after removing gloves.

5. When working with radioisotopes, use stainless steel or fiberglass trays lined with absorbent paper. Contact the Radiation Protection Program for information about these trays.

6. Wear film badges when the radiation hazard warrants such use. The Radiation Protection Program will evaluate the need for film badges in areas where potential external radiation hazards exist.

7. If there is any possibility of an airborne hazard, do all work in a hood.

8. Transport and store all radioisotopes in a manner that will prevent breakage and spills. When a radioactive liquid is in a glass container, keep the container in a second unbreakable container that would hold the radioactive contents if the glass container were to break.

9. Provide for proper storage of radioisotopes in the laboratory, with sufficient shielding to maintain a safe radiation level.

10. Post proper radiation caution signs on the doors of laboratories in which radioisotopes are used and indicate use and storage areas within the laboratory. Contact the Radiation Protection Program for caution signs.

11. Use a radiation survey instrument to monitor clothing, hands, shoes and the general laboratory area. For ^{3}H and ^{14}C, smears should be taken on laboratory surfaces, including the floor, using a piece of absorbent filter paper. This paper may then be placed in a counting vial and counted in a liquid scintillation counter. It is important that weekly radiation surveys be made to reduce the hazard from radioactive contamination. The laboratory director must keep records of these surveys. Contact the Radiation Protection Program for more details on instrumentation.

12. When opening a shipment, examine the contents to determine if there has been any damage or leaking. Report damaged or leaking shipments to the Radiation Protection Program immediately.

13. If there is any possibility of airborne radiation hazard, open radioisotope shipments in a hood. This is especially important with shipments of particulate matter or materials with high radiotoxicity.

14. If a smear survey indicates contamination, dispose of shipping boxes in a solid radioactive waste container. If a smear survey indicates no contamination, the box may be discarded as non-radioactive waste, provided ALL radiation labels and markings have been removed.

15. Handle sealed radiation sources, regardless of activity, with tongs. Determine the dose rate at the hand and body location before sealed radiation sources are used or moved. Alpha sources must be leak tested by the Radiation Protection Program every 3 months, beta and gamma sources every 6 months. Report damaged or lost sources immediately to the Radiation Protection Program.

16. Do not remove contaminated tools, glassware, or equipment from the laboratory. Store away from non-contaminated equipment. Glassware used with radioisotopes may not be taken to the glassblower without prior approval by the Radiation Protection Program.

17. Dispose of radioactive wastes in appropriately marked approved radioactive waste containers. Do not mix acids and organic solvents as waste. Contact the Radiation Protection Program for waste disposal service.

For further information on any aspect of .radiation safety, contact the Radiation Protection Program, W140 Boynton Health Service, Department of Environmental Health and Safety, 626-6002.

APPENDIX G

EXPOSURE TO INDIVIDUALS TO RADIATION IN RESTRICTED AREAS

MAXIMUM PERMISSIBLE DOSE PER CALENDAR QUARTER

	Rems/Qtr	Rems/Yr
1. Whole body; head and trunk; active blood-forming organs; lens of eye; or gonads	1.25	5
2. Hands and forearms; feet and ankles	18.75	75
3. Skin of whole body	7.5	30
4. Other organs	3.75	15
5. Thyroid	7.5	30
6. Individual in the general public	..	0.5
7. Student	..	0.1
8. Occupationally exposed pregnant women	0.5 rem/ 9 mo. gestation	

APPENDIX J

INFORMATION AND PROCEDURES FOR USE OF ^{3}H AND ^{14}C

1. Both ^{3}H and ^{14}C emit low energy beta radiation (^{3}H - 0.018 MeV, ^{14}C - 0.156 MeV), and therefore present no appreciable external radiation exposure hazard. ***Personnel working with 3H or 14C do not require a film badge monitor.***

2. Shipments of ^{3}H or ^{14}C should be opened in a hood and inspected for damage and contamination before transfer to a storage area. Most ^{14}C shipments can be stored safely in a laboratory freezer or refrigerator. All ^{3}H stock vials and labeled samples should be stored in a glass containment vessel with a metal foil seal. Tritium readily diffuses through plastic containers due to the small molecular size. Proper storage in a glass container will minimize diffusion of the tritium and minimize contamination to surrounding areas.

   If the material labeled with ^{3}H or ^{14}C is volatile, such as $NaB^{3}H_{4}$, 3H2O, or $^{14}CO_{2}$, it should be stored and used in a well-ventilated hood. Before such volatile compounds are used, a "dry-run" of the experiment must be performed under the supervision of a member of the Radiation Protection Program. For further information regarding these procedures, contact the Radiation Protection Program at 626-6002.

3. Because of their low beta energies, ^{3}H and ^{14}C cannot be readily detected with a portable G-M survey instrument. Therefore, in order to evaluate possible contamination of the laboratory, it is necessary to perform contamination smear surveys of radioisotope use areas at least once per month using dry filter paper smears such as Whatman No. 1 filter paper, 4.25 cm diameter. The smears should be counted in a liquid scintillation counting system and the results of each survey recorded on the quarterly report form. Areas showing removable contamination greater than 250 disintegrations per minute (DPM) above background per 100 square centimeters should be decontaminated and resurveyed. (100 square centimeters is approximately equivalent to a smear swipe 24 inches in length.)

4. Individuals who receive $^{3}H_{2}O$, $NB^{3}H_{4}$, or $^{14}CO_{2}$ in quantities of 100 millicuries or more, or those who receive tritium-labeled nucleotides in quantities of 10 millicuries or more, must have a urine analysis performed within one week of experimental use. Shipments of tritiated compounds of these quantities or greater will be stored by the Radiation Protection Program in the Boynton Health Service building until the individual user is ready to use the tritium and requests its delivery. A urine collection container will be provided with the shipment. The individual who uses the tritiated material must collect a urine sample approximately 24 hours after the use. The urine sample should then be delivered to W131 Boynton Health Service for analysis by the Radiation Protection Program.

5. If any spills of radioactive materials or any other emergency conditions arise, notify the Radiation Protection Program immediately at 626-6002.

APPENDIX K

HANDLING AND SURVEY PROCEDURES FOR HIGH ENERGY BETA EMITTING RADIOISOTOPES

I. Materials Required for Stock Solution Transfer

- Tray lined with absorbent toweling.
- Cylindrical lucite stock vial shield.
- Lucite barrier (body shield) to provide eye and body protection.
- Remote handling devices (e.g., tongs, clamps, forceps, hemostats).
- Gloves, surgical and disposable types.
- Lab coat.
- Film badge and TLD ring (wear ring under protective surgical glove with TLD ring label toward palm of hand).
- Portable G-M survey instrument, preferably with pancake style probe for periodic check of hands, handling materials and transport containers to assure contamination control.

II. Protocol for Transfer and Handling of High Energy Beta Emitting Radioisotopes

1. Survey stock solution transfer station (i.e., hood or bench top) prior to bringing stock material to this area. This will assure that the area is free of contamination and will prevent possible cross contamination of individual experiments.

2. Double gloves must be worn during all radioisotope handling procedures. The outer glove should be monitored frequently and, if found to be contaminated, the glove should be removed and properly disposed of.

3. CAUTION - Because of the extremely high external exposure rate, the stock vial solution should never be held in the hands. Always use remote handling devices.

   • Exposure rates from 1 mCi of ^{32}P over 1 square centimeter of skin:
   2000 rads/hr at surface.
   200 rads/hr at 1 centimeter.
   22 rads/hr at 10 centimeters.

   In 1 ml of water the surface dose rate for 1 mCi of ^{32}P is 780 rads/hr or 13 rads/min. Because of these very high exposure rates, the handling of uncovered vessels (open, unshielded top) presents a serious potential for excessive and unnecessary radiation dose to the hands and face. Never place hands or any other part of the body over an open, unshielded vessel containing large activities of ^{32}P in relatively small volumes of liquid.

4. All stock transfer procedures should be conducted in a hood if possible. Open the shipping container in the hood, using a remote handling device to transfer the stock vial to a lucite stock shield. Monitor the empty box with a G-M survey instrument. Remove any radioactive labels and markings before disposal.

5. A likely source of contamination results from opening the stock vial. Caution must be used in removing the vial cover and/or septum with the remote handling device. The tool used to remove the cover must then be treated as contaminated. A small beaker with absorbent gauze in the bottom should be used to isolate the vial cover, as well as the handling device.

6. Care must be taken when dispensing stock solution from the stock vial. Pipette tips or other transfer devices will be highly contaminated and are a major source of contamination of the work station and the individual's hands. A disposable waste receptacle (preferably a one-gallon plastic jug, Chemical Storehouse stock #CX12760), should be conveniently located behind the shielded work station for disposal of these and other contaminated items.

7. Cover each of the sample tubes with a cap or other suitable seal. Hands should be monitored following this procedure to determine if the gloves have become contaminated.

8. Seal the stock solution vial using the handling device initially used to open the vial. Dispose of outer gloves and monitor the surgical gloves prior to putting on a new pair of disposable gloves.

9. Transfer the stock solution in the lucite shield to your permanent storage location.

10. If the sample tubes are to be transferred to another work station prior to conducting the experimental procedure, this area must be equipped and shielded in the same manner as the stock transfer station (as indicated above.) A properly designed shield (lucite block with sample holes) must be used to carry the samples from the stock station area to the work station to prevent unnecessary radiation exposure and accidental spillage. If other laboratory personnel use the areas near the radioisotope work station, lucite side and back shields may be necessary.

11. During the experimental procedures, all items which contact the radioisotope solutions will be contaminated and must be properly handled and/or disposed of as radioactive waste. Hands and handling devices must be monitored frequently to check for possible contamination. Do not leave the work station before removing the outer pair of disposable gloves and monitoring the surgical gloves.

12. If the sample tubes are to be centrifuged, these must be placed in a larger containment vessel which has absorbent gauze placed in the bottom prior to centrifugation. This practice will reduce the possibility of contamination spread in the event that the sample tube is broken.

13. Upon the completion of the experiment, all radioactive waste must be transferred to the proper waste receptacle. The work area must be thoroughly surveyed (both G-M and smear survey) and decontaminated.

If additional information or assistance is needed in determining appropriate precautions in the use of high energy beta emitters, contact the Radiation Protection Program at 626-6002.

APPENDIX L

PRECAUTIONS IN THE USE OF ^{125}I / ^{131}I

Radioiodine, when used in volatile forms, presents the potential for exposure of the thyroid gland to levels of ionizing radiation in excess of permissible limits. To minimize personnel exposure, it is important that the following procedures be strictly adhered to.

BEFORE THE LABELING

1. Persons who plan to use radioiodine in labeling procedures must contact the Radiation Protection Program (626-6002) to obtain authorization for use.

2. All persons associated with the labeling must view the radiation protection training tapes and complete a test questionnaire which will be provided with the tapes.

3. Persons authorized to handle radioiodine must review and be familiar with the precautions and procedures recommended by the Radiation Protection Program.

4. Appropriate personnel monitoring devices must be obtained. These devices are available from the Radiation Protection Program. If 1.0 mCi or more of ^{125}I or ^{131}I is used, a TLD ring must be worn in addition to a film badge. The ring must be worn on the index finger under both pairs of gloves, with the ring label turned toward the palm of the hand.

5. A baseline thyroid scan is required. To schedule a scan contact the Radiation Protection Program at 626-6002.

6. A "dry-run" procedure (no radioactive material used) must be conducted. A member of the Radiation Protection Program staff will be present to make suggestions concerning appropriate precautions and procedures. Call 626-6002 to make arrangements for a dry-run.

7. Upon completion of these requirements, call 626-6002 to schedule a date and time for using the labeling facilities.

GENERAL CONSIDERATIONS

1. Shipments of sodium iodide and other volatile iodinated compounds must be addressed for delivery to 118 Boynton Health Service, 410 Church Street SE, Minneapolis, MN, ATTN: approved user's name. Such materials will be held by the Radiation Protection Program until the scheduled radioiodine labeling.

2. All uses of volatile radioiodine materials, in radioiodine labeling procedures or other operations where volatile radioiodine may be released, are restricted to facilities approved by the Radiation Protection Program. The facility on the Minneapolis campus is the Bond Laboratory, Boynton Health Service. The approved facility on the St. Paul campus is located in Room 338 Animal Science/ Veterinary Medicine building.

Breathing zone and environmental air samples will be taken during the procedure. Copies of air sampling reports, with any relevant comments, will be sent to the approved user under whose permit the radioiodination was done. To assure that personnel radiation exposure and environmental radioiodine releases are maintained within permissible limits, the Radiation Protection Program has developed investigation action levels which correspond to 10% of the MPC-hr. thyroid uptake, and 20% or the quarterly environmental release limit. If any individual exceeds these levels, it will be necessary for an investigation to be made to determine what caused the limit to be exceeded, and to designate corrective action necessary to reduce future levels. Persons exceeding the limits will not be allowed to conduct additional procedures using volatile radioiodine until corrective action has been completed.

4. All persons present during radioiodine labeling or during the handling of other volatile radioiodine must have a thyroid scan within one week of the procedure.

PROCEDURES FOR HANDLING RADIOIODINE

1. Absolutely NO mouth pipetting, smoking, eating, drinking, food or beverage storage or cosmetic application is allowed in radioisotope laboratories.

2. Sheet lead (1/16 inch) which provides adequate shielding for ^{125}I should be used to shield labeling columns, stock vials, collection containers, etc.

3. To prevent contamination of the hood, work surfaces must be completely covered with absorbent pads (Hospital Supplies, inventory #CX41710).

4. A laboratory coat and long protective disposable gloves must be worn to protect skin surfaces from volatile radioiodine releases within the hood. The laboratory coat and disposable gloves must be surveyed frequently, and if contaminated, must be removed and disposed or decontaminated.

5. Disposable gloves must be worn when handling radioiodine, and *double gloving* is required. It is recommended that the bottom glove be latex (Chemical Storehouse, inventory nos. CX40932 - CX40938, according to size).

6. To reduce the possibility of contaminating other areas of the laboratory, the outer gloves should be changed frequently during the procedure. The other gloves must be removed and the hands surveyed before leaving the hood for any reason. All equipment must also be surveyed for contamination before removal from the hood.

7. An appropriate radiation survey instrument (e.g., pancake style G-M, thin crystal gamma scintillation detector), must be available in the laboratory and should be used to survey hands, clothing, and work surfaces during and after labeling procedures to assure that contamination is not present.

8. Contamination smear surveys must be made of the hood and the lab area immediately after each iodination. Contaminated areas should be decontaminated to less than *100 disintegrations per minute per 100 cm^2 above background.* Results of these surveys must be included with quarterly reports and a copy must be kept by the approved user.

LABELING TECHNIOUES

1. To minimize the release of volatile radioiodine, a closed system should be maintained using charcoal traps, syringes, and septum-sealed vials.

   a) Before the radioiodine compound is extracted from the stock vial through the septum, or if the stock vial is to be used as the reaction vessel, the air above the solution in the vial should first be purged through a charcoal trap to equalize the pressure in the vial. A syringe, which has the barrel filled with granular activated charcoal and both ends plugged with cotton or glass wool, should be inserted through the septum to vent the vial. With another syringe, several replacement volumes of air should be injected into the vial.

   b) When the stock vial of iodine is used as the reaction vessel, all reactants should be placed in the vial through the septum with the use of an appropriate syringe. Hamilton-type or disposable tuberculine syringes have proven to work satisfactorily.

   c) If only a portion of the stock iodine is to be used, that aliquot is to be removed from the stock vial through the septum and placed in another septum-sealed vial to be used as the reaction vial. All reactants should then be added or removed, with syringes, through the septum of this reaction vial.

2. Maintaining the pH of the radioiodine solution above 8.0 will also minimize the release of volatile radioiodine.

RADIOIODINE WASTE

1. Solid Waste Contaminated with Radioiodine

   a) All vials, tubes, syringes, disposable pipettes, etc., which may contain volatile radioiodine should be rinsed with 0.1N sodium thiosulfate solution. Then they must be capped or otherwise sealed and placed in a sealed disposable container (Chemical Storehouse, stock # CX12760) before removal from the hood.

   b) Other solid waste (gloves, absorbent toweling, etc.) contaminated with radioiodine must be bagged while in the hood and then placed in the solid combustible waste container.

   c) Sodium thiosulfate solution (see liquid waste section, below) should be used to rinse reusable pipettes, syringes, etc., to combine with any volatile radioiodine present. The rinse solution must then be disposed of as liquid radioiodine waste. (See liquid waste section below.)

   d) If a sephadex type column is used for fractionating, the column should be sealed at both ends and if possible placed in a sealed disposable container.

Liquid Radioiodine Waste

a) All liquid radioiodine waste must be stored and transferred in the hood.

b) *0.1N sodium thiosulfate solution must he added to all liquid radioiodine waste.*

c) Liquid radioiodine waste with sodium thiosulfate added must be transferred in the hood to a disposable plastic container (Chemical Storehouse stock # CX12760) which is half-filled with granular absorbent (Hi-Dry Granular Absorbent, General Storehouse inventory # GC20830).

d) When the half-filled container of granular absorbent becomes uniformly moistened with liquid radioiodine waste and sodium thiosulfate solution, do NOT add any further liquid. Fill the remaining half of the container with dry absorbent and place the cover tightly on the container. The sealed container should then be placed in the solid non-combustible radioactive waste container. Do not saturate the absorbent above the 1/2 level of the plastic container. Department of Transportation (DOT) regulations require that a layer of dry absorbent remain on the top of the plastic container to assure that there is no unabsorbed liquid.

e) Do not treat liquid radioiodine with sodium hypochlorite or introduce it into liquid radioactive waste containers which contain chlorinated oxidizing agents such as sodium hypochlorite. Chlorinated oxidizing agents will interact with radioiodine solutions in such a way that volatile radioiodine will be generated and released. Sodium hypochlorite solutions are commonly used to deactivate biohazardous waste materials. A possible substitute which does not present the problem of generating volatile radioiodine is the use of formalin solutions. If it is necessary to use sodium hypochlorite solutions, separate radioactive waste containers must be used and must be clearly labeled to maintain separation of radioiodine and sodium hypochlorite solutions.

If you have any questions regarding the safe use of volatile radioiodine, contact the Radiation Protection Program at 626-6002.

COMMENTS ON CLEANING UP SPILLS OF RADIOACTIVE MATERIALS

If a spill occurs or special problems arise, IMMEDIATELY contact the Radiation Protection Program at 626-6002 for assistance.

1. Confine the spill to as small an area as possible.

2. Restrict access to the spill area. Persons who may have been contaminated should be monitored immediately. Contaminated clothing should be removed and decontaminate or disposed of in the solid radioactive waste container. Skin surfaces should be washed and resurveyed.

3. The spill should be cleaned up as soon as possible. Do not spread the contamination to an area larger than the original spill. Always clean a spill area by starting at the perimeter and proceeding toward the center of the contaminated area. NOTE: Appropriate protective clothing, gloves, shoe covers and respiratory protection are to be worn by personnel who perform spill clean-up.

SPILLS (cont.)

4. If radioiodine compounds are spilled, moisten absorbent pads with 0.1N thiosulfate solution and carefully place the pads over the spill area. NOTE: Appropriate protective clothing, gloves, shoe covers and respiratory protection are to be worn by personnel who perform spill clean-up.

5. Spilled liquids should be absorbed using disposable towels or granular absorbent. The contaminated towels or absorbent should then be placed in the solid radioactive waste container.

6. The spill area must be decontaminated to less than 100 disintegrations per minute per 100 cm^2 above background. A smear survey of the spill area must be performed to verify that the area has been decontaminated.

7. A report of the incident, including the decontamination survey results, must be sent to the Radiation Protection Program.

APPENDIX O

RADIATION PROTECTION INSTRUCTIONS FOR ANIMAL CARETAKERS

1. The door to the animal facility must be posted with a radiation caution sign which lists the name of the approved user and his or her telephone number.

2. The animal cages must be posted with an approved University of Minnesota *"Caution Radioactive Material"* sign, and/or *"Radiation Area"* sign as needed. The name of the approved user, along with the type and quantity of radioisotope administered to the animals must be listed on the caution sign.

3. Laboratory coats, disposable gloves and other required protectiveequipment must be worn when caring for animals and during cage cleaning procedures.

4. Personnel radiation monitors may be required in some animal care situations. The Radiation Protection Program will assess the need for such monitors.

5. The Radiation Protection Program will assess the need for evaluation of external radiation exposure levels in the animal care facility, and will perform this required monitoring.

6. The approved user is required to perform routine contamination smear surveys of the animal care facility. A minimum of one survey per month is required. A copy of these survey results must be forwarded to the Radiation Protection Program with the approved user's quarterly report.

7. Animals that have been irradiated by x-ray or external radiation from sealed sources of gamma rays will not present a radiation hazard.

8. If the radioisotopes will be excreted in the urine or feces, absorbent material in a tray must be provided below or within each cage. The absorbent material must be changed periodically and disposed of as radioactive waste. If dogs or other large animals will excrete radioisotopes in the urine or feces, a metabolic cage must be used, and the excrement must be collected and properly stored prior to pickup as radioactive waste. Appropriate containers must be provided in the animal care facility.

9. Prior to washing animal cages, a contamination smear survey must be made by the approved user to assure that contamination levels are reduced to less than 2200 DPM/100 square centimeters (DPM = CPM/fractional efficiency). After reducing contamination below this level, the cages may be washed in a sink designated and labeled for washing items that have low-level contamination. If cages are to be washed in a cage washing facility, the Radiation Protection Program must be contacted (626-6002) and specific wash procedures will be outlined.

10. Animals or portions of animal carcasses containing radioisotopes must be properly disposed of in accordance with the requirements of the Radiation Protection Program. Radioactive animals or portions of animal carcasses must be NOT be placed in radioactive waste containers in the laboratory. This type of waste may need to be refrigerated or frozen depending on lab location and size of animal. The following procedures must be used in packaging and disposal of radioactive animals: (over)

Animal Disposal (cont.)

- Place the animal(s) and/or parts of the carcass in sealed transparent or translucent plastic bags (double bag), seal the bags and label with radiation caution tape. Do not use colored plastic bags because this prevents easy inspection of the contents. A label must indicate the radioisotope(s), the activity of each radioisotope in millicuries, and the number and type of animals contained in the bag.

- DO NOT PLACE PADS, TOWELING, ETC. IN THE BAG WITH THE ANIMAL. Do not individually bag or wrap small animal carcasses when more than one animal is placed in the disposal bag. Collect animal bedding, disposable toweling, gauze, pads, etc. in a separate transparent plastic bag and place in the solid radioactive waste can.

- Absorb and remove free-standing blood present in larger animals by using absorbent pads, gauze, etc. and dispose in a sealed bag in the solid radioactive waste can.

- In areas in which same-day pickup from the laboratory cannot be provided, it will be necessary for the approved user to temporarily store the waste in a laboratory freezer to prevent biodegradation.

- Animals which contain ^{14}C and/or ^{3}H must be collected and packaged separately from other radioactive animal waste.

- Animals which contain ^{131}I, ^{125}I, ^{331}P, ^{51}Cr, or other radioisotopes with a half-life of 60 days or less must be packaged separately by isotope.

- Vials or test tubes which contain small amounts of tissue or blood products require special packaging and preparation prior to disposal. Contact the Radiation Protection Program at 626-6002 for instructions.

- For disposal of the animals, call the Radiation Protection Program at 626-6819 between the hours of 9:00-10:30 a.m., or 1:30-3:00 p.m. to request pickup from the laboratory. Be prepared to provide the location of the waste, the weight of the waste, and the isotopes and activity present in the waste.

11. In case of radiation emergencies such as spillage of contaminated waste, contact the Radiation Protection Program in the Department of Environmental Health and Safety (626-6002).

APPENDIX U

SOME COMMONLY USED RADIOISOTOPES AND THEIR RELATIVE RADIOTOXICITIES

I. Low Hazard Radioisotopes. (The level of intermediate activity for laboratory use in this group is 1-30 millicuries.)

Radioisotope	Half-Life	Type of Ionizing Radiation Emitted	Energy of Radiation
1. H-3 (tritium)	12 years	beta	0.014 MeV
2. C-14	5730 years	beta	0.15 MeV

II. Medium Hazard Radioisotopes. (The level of intermediate activity for laboratory use in this group is 100 microcuries - 3 millicuries.)

Radioisotope	Half-Life	Type of Ionizing Radiation Emitted	Energy of Radiation	mR/hr-mCi at 1 meter
1. Na-22	15 hours	beta gamma	1.39 MeV 2.75 MeV	1.84
2. K-42	12.4 hours	beta gamma	3.5 MeV 1.5 MeV	0.15
3. Hg-197	64 hours	gamma	0.19 MeV	0.04
4. P-32	14.3 days	beta	1.7 MeV	
5. S-35	87 days	beta	0.167 MeV	
6. Cl-36	3 x 10^{5}years	beta	0.714 MeV	
7. Fe-59	45 days	beta gamma	0.46 MeV 1.10 MeV	0.64
8. Rb-86	18.6 days	beta gamma	1.78 MeV 1.08 MeV	0.05
9. Sr-89	50 days	beta	1.46 MeV	
10. Au-198	2.7 days	beta gamma	0.96 MeV 0.41 MeV	0.23
11. Hg-203	46 days	beta gamma	0.21 MeV 0.28 MeV	0.13
12. Cr-51	27.8 days	gamma	0.32 MeV	0.018
13. P-33	25.2 days	beta	0.248 MeV	

III. High Hazard Radioisotopes. (The level of intermediate activity for laboratory use in this group is 10 microcuries - 300 microcuries.)

Radioisotope	Half-Life	Type of Ionizing Radiation Emitted	Enernv of Radiation	mR/hr-mCi at 1 meter
1. Na-22	2.6 years	positron gamma	0.54 MeV 1.27 MeV	1.20
2. Ca-45	164 days	beta	0.254 MeV	
3. Co-60	5.24 years	beta gamma	0.312 MeV 1.17, 1.33 MeV	1.32
4. Sr-90	28.4 years	beta	0.545 MeV	
5. I-131	8 days	beta gamma	0.6 MeV 0.364 MeV	0.22
6. I-125	60 days	gamma	0.035 MeV	0.07
7. Cs-137	30 years	beta gamma	0.514 MeV 0.667 MeV	0.33

IV. Very High Hazard Radioisotopes (Intermediate laboratory level - 1-10 microcuries).

Radioisotope	Half-Life	Type of Ionizing Radiation Emitted	Energy of Radiation	mR/hr-mCi at 1 meter
1. Pb-210	22 years	beta gamma	0.017 MeV 0.0465 MeV	
2. Po-210	138 days	alpha	5.3 MeV	
3. Ra-226	1620 years	alpha	4.7 MeV	0.825

Toxic, Reactive, Carcinogenic, and Teratogenic Chemicals

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Laboratory Safety

A. Toxicology Background

1. Modes of Entry
2. Dose
3. Exposure Time
4. Chronic/Acute effects

B. Regulatory Agencies

OSHA
EPA

C. MSDS

D. Classification of Chemicals/Hazards

E. Fume Hoods

I. GENERAL PRINCIPLES

Every laboratory worker should observe the following rules:

1. Know the safety rules and procedures that apply to the work that is being done. Determine the potential hazards (e.g., physical, chemical, biological) and appropriate safety precautions before beginning any new operation.

2. Know the location of and how to use the emergency equipment in your area, as well as how to obtain additional help in an emergency, and be familar with emergency procedures.

3. Know the types of protective equipment available and use the proper type for each job.

4. Be alert to unsafe conditions and actions and call attention to them so that corrections can be made as soon as possible. Someone else's accident can be as dangerous to you as any you might have.

5. Avoid consuming food or beverages or smoking in areas where chemicals are being used or stored.

6. Avoid hazards to the environment by following accepted waste disposal procedures. Chemical reactions may require traps or scrubbing devices to prevent the escape of toxic. substances.

7. Be certain all chemicals are correctly and clearly labeled. Post warning signs when unusual hazards, such as radiation, laser operations, flammable materials, biological hazards, or other special problems exist.

8. Remain out of the area of a fire or personal injury unless it is your responsibility to help meet the emergency. Curious bystanders interfere with rescue and emergency personnel and endanger themselves.

9. Avoid distracting or startling any other worker. Practical jokes or horseplay cannot be tolerated at any time.

10. Use equipment only for its designed purpose.

11. Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in appropriate order, and avoid adding solids to hot liquids.

12. Think, act, and encourage safety until it becomes a habit.

II. Health and Hygiene

Laboratory workers should observe the following health practices:

1. Wear appropriate eye protection at all times.

2. Use protective apparel, including face shields, gloves, and other special clothing or foot wear as needed.

3. Confine long hair and loose clothing when in the laboratory

4. Do not use mouth suction to pipet chemicals or to start a siphon; a pipet bulb or an aspirator should be used to provide vacuum.

5. Avoid exposure to gases, vapors, and aerosols. Use appropriate safety equipment whenever such exposure is likely.

6. Wash well before leaving the laboratory area. However, avoid the use of solvents for washing the skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent might facilitate absorption of a toxic material.

III. FOOD HANDLING

Contamination of food, drink, and smoking materials is a potential route for exposure to toxic substances. Food should be stored, handled, and consumed in an area free of hazardous substances.

1. Well-defined areas should be established for storage and consumption of food and beverages. No food should be stored or consumed outside of this area.

2. Areas where food is permitted should be prominently marked and a warning sign (e.g., EATING AREA -- NO CHEMICALS) posted. No chemicals or chemical equipment should be allowed in such areas.

3. Consumption of food or beverages and smoking should not be permitted in areas where laboratory operations are being carried out.

4. Glassware or utensils that have been used for laboratory operations should never be used to prepare or consume food or beverages. Laboratory refrigerators, ice chests, cold rooms, and such should not be used for food storage; separate equipment should be dedicated to that use and prominently labeled.

IV. HOUSEKEEPING

There is a definite relationship between safety performance and orderliness in the laboratory. When housekeeping standards fall, safety performance inevitably deteriorates. The work area should be kept clean, and chemicals and equipment should be properly labeled and stored.

1. Work areas should be kept clean and free from obstructions. Cleanup should follow the completion of any operation or at the end of each day.

2. Waste should be deposited in appropriate receptacles.

3. Spilled chemicals should be cleaned up immediately and disposed of properly. Disposal procedures should be established and all laboratory personnel should be informed of them; the effects of other laboratory accidents should also be cleaned up promptly.

4. Unlabeled containers and chemical wastes should be disposed of promptly, by using appropriate procedures. Such materials, as well as chemicals that are no longer needed, should not accumulate in the laboratory.

5. Floors should be cleaned regularly; accumulated dust, chromatography adsorbents, and other assorted chemicals pose respiratory hazards.

6. Stairways and hallways should not be used as storage areas.

7. Access to exits, emergency equipment, controls, and such should never be blocked.

8. Equipment and chemicals should be stored proplery; clutter should be minimized.

Infectious Agents

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Introduction

Research involving biological agents capable of causing disease in man has been conducted throughout the past century. In the last few decades, research with known or potentially hazardous agents has been greatly intensified. This intensification is primarily due to rapid advancements in disciplines such as Genetics, Cell Biology, Immunology, Biochemistry, Virology, Medicine (especially transplantation), and Animal and Plant Parasitology. During this century of research, there has been only a few incidents of spread of disease outside of the laboratory and the number of laboratory-acquired diseases have been relatively few. Unfortunately, such a record is not comforting for those suffering disease complications or death. This is especially true when one considered that the factors responsible for these disease incidents, were, in most situations, controllable.

Today's presentation will examine biohazard containment, or in other words, controls which prevent the spread of biohazardous agents. The implementation of such controls necessitates an understanding of the Infectious Disease Process.

Infectious Disease Process

The Infectious Disease Process can be defined in simple terms as the interreactions between the biological agents, the environment and the host. This interreaction has six essential components. These components are depicted as a circular linked chain (see handout) and are labeled as follows:

Etiological Agent (causitive agent)
Reservoir (typical habitat of agent: man, animal, soil, etc.)
Escape from Reservoir (typical mode(s) by which agents escape from reservoir
Transmission (typical mode(s) of transmission between reservoir and host)
Entry into Host (typical mode(s) of entry into host)
Host Susceptibility (host prediliction to agents disease capacities)

The disease process depends on the continuity of the chain. If even one of the links is broken, the disease process is interrupted. To understand how the disease process works, some specific examples will be examined.

Smallpox (variola major, minor, etc.)
Hepatitis Type B
Salmonella
L.D.B.

One of the best controls against biohazardous agents is by decreasing the host susceptibility through vaccination. However, this type of control is only possible for a handfull of agents. Physical controls are also used to interrupt the disease process.

Physical Controls

Physical controls are directed at the escape and transmission component of the disease process. They separate the agent from the host by a physical barrier. Secondary physical barriers separate the laboratory environment from the outside environment. Certain laboratory design criteria for such control depends on the risk classification of the agent.

High Containment Facility
Special Design Facility

A more important type of physical control is known as primary physical barriers. These barriers separate the agent from the person during the actual work. Such barriers include:

BSC
LFBSC
Safety blender
Safety trunnion cup for centrifugation
Gloves and gowns
Etc.

Microbiological Technique

Another type of control, and in my opinion, the most important, is what is referred to as good microbiological technique. Without such good techniques, the other controls are practically useless, The laboratory techniques, which include good personnel hygiene practices, are as follows:

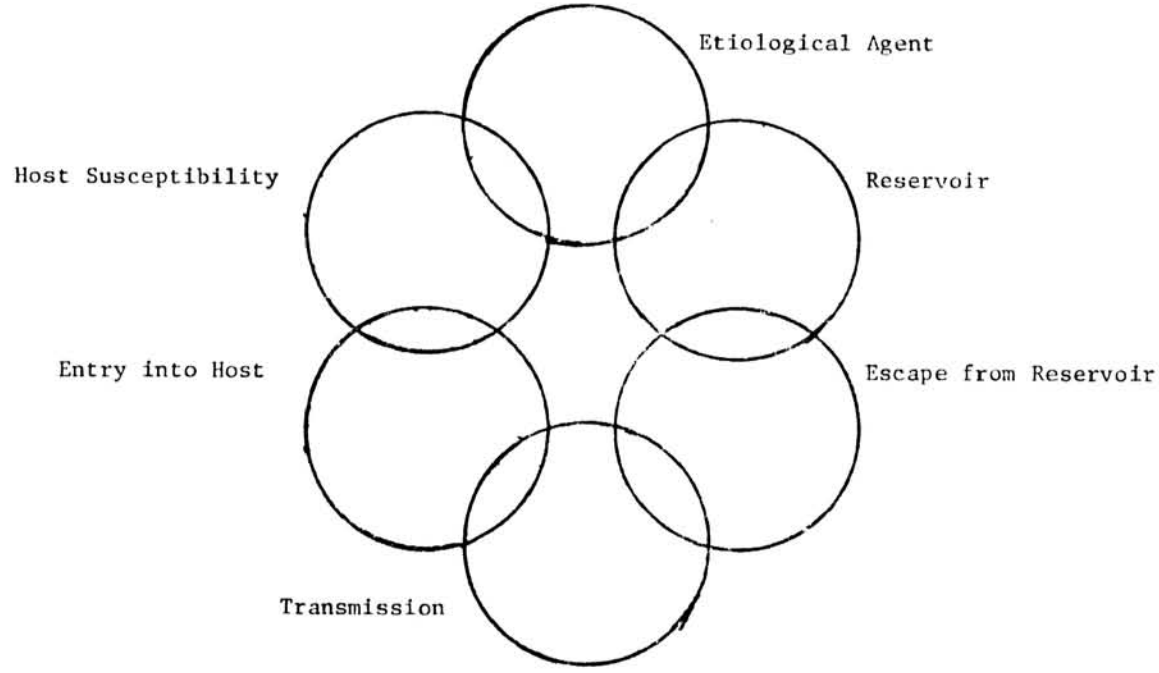
Use pipetting aids
The appropriate use of gloves and gowns
Avoid the use of syringes and needles
Good handwashing practices are essentiail
Hand habits
Flaming and transfer techniques
Smoking and the storage or consumption of food or beverages must be prohibited
Etc.

Case Studies Emphasizing the Importance of Controls

1. Hepatitis Type B in Hospital
2. Smallpox in England

SCHEMATIC OF THE INFECTIOUS DISEASE PROCESS:

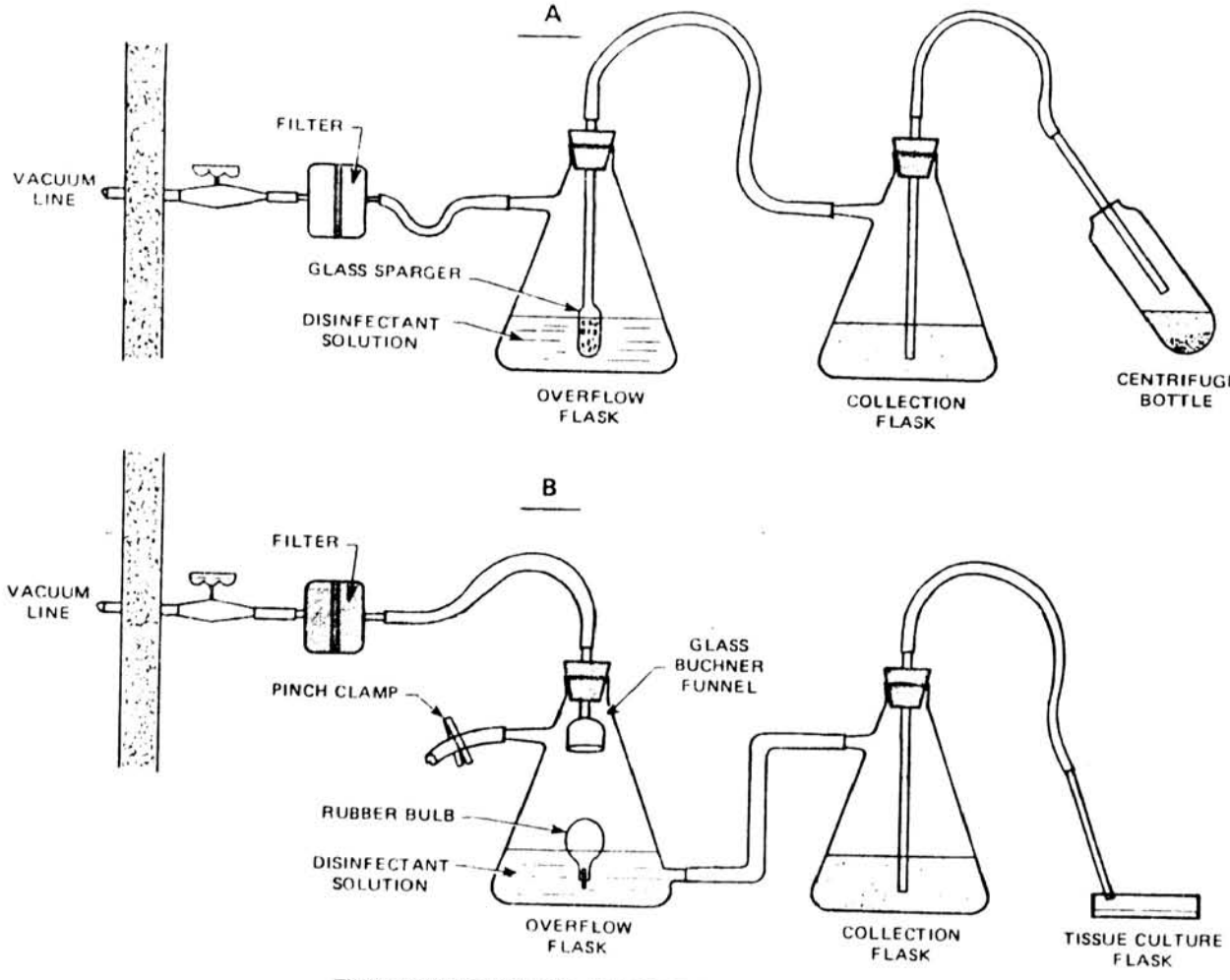
The Six Essential Components of the Infectious Disease Process



Controls Used to Interrupt the

Infectious Disease Process

Controls	Conditions and/or Equipment Involved	Percent Effectiveness of Control
I. Physical Containment A. Primary	I. A. 1. Biological safety cabinet 2. Laminar flow biological safety cabinet 3. Safety blender (Waring AS-1) 4. Safety centrifuge trunnion cup 5. Vacuum system 6. Water baths 7. Non-breakable leak-proof containers with covers 8. Appropriate glass ware	I. A. 10
B. Secondary	I. B. 1. Special Design Facility 2. High Containment Facility	I. B. 1
II. Biological Containment	II. Special condition related to recombinant DNA research Host-Vector System (HV) HV - 1 HV - 2	II. The % effectiveness of this control is extremely high. However, it must be noted that this is based on a number of assumed conditions.
III. Microbiological Techniques Laboratory practices including personnel hygiene	III. 1. Mouth pipetting (pipetting aids) 2. Gloves 3. Gowns 4. Flaming of loops 5. Transfer technique 6. Syringes and needles 7. Handwashing 8. Smoking and the storage or consumption of food or beverage 9. Hand habits	III. 90



TWO TECHNIQUES FOR PROTECTING VACUUM SYSTEM FROM CONTAMINATION

CLEAN-UP OF BIOHAZARDOUS SPILLS

I. Biohazard Spill in a Laminar Flow Biological Safety Cabinet*

In the LFBSC, chemical decontamination procedures should be initiated once while the cabinet continues to operate to prevent escape of contaminants from the cabinet.

A. Spray or wipe walls, work surfaces, and equipment with 2% Wescodyne** (or other appropriate disinfectant detergent). A disinfectant detergent has the advantage of detergent activity which is important because extraneous organic substances frequently interfere with the reaction between a microbe and microbiocidal agent. Operator should wear gloves during this procedure.

B. Flood top tray, drain pans, and catch basins below work surface with disinfectant and allow to stand 10–15 minutes.

C. Dump excess disinfectant from tray and drain pans into cabinet base. Lift out tray and removable exhaust grille work. Wipe off top and bottom (underside) surfaces with disinfectant sponge or cloth. Replace in position. Gloves, cloth or sponge should be discarded in an autoclave pan and autoclaved.

D. Drain disinfectant from cabinet base into appropriate container and autoclave according to standard procedures.

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* Procedure adapted from "Laminar Flow Biological Safety Cabinets," A Training Manual for Biomedical Investigators, National Cancer Institute.

** West Chemical Products, Inc. 16–42 West Street, Long Island City, New York. 11101

II. Biohazard Spill Outside a Laninar Flow Biological Safety Cabinet

A. Holding your breath, leave the room immediately and close the door.

B. Warn others not to enter the contaminated area.

C. Remove and containerize contaminated garments for autoclaving and thoroughly wash hands and face.

D. Wait 30 minutes to allow dissipation of aerosals created by the spill.

E. Don a long-sleeve gown, mask, and rubber gloves before reentering the room. (For a high risk agent, a jumpsuit with tight-fitting wrists and use of a respirator should be considered.)

F. Pour a germicidal solution (5% Wescodyne or 5% Hypochlorite are recommended) around the spill and allow to flow into the spill. Paper towels soaked with the germicide may be used to cover the area. To minimize reaerosolization, avoid pouring the germicidal solution directly onto the spill.

G. Let stand 20 minutes to allow adequate disinfectant contact time.

H. Using an autoclavable dust pan and squeegee, transfer all contaminated materials (paper towels, glass, liquid, gloves, etc.) into a deep autoclave pan. Cover the pan with aluminum foil or other suitable cover and autoclave according to standard directions.

I. The dust pan and squeegee should be placed in an autoclavable bag and autoclaved according to standard directions. Contact of reusable items with non-autoclavable plastic bags should be avoided--separation of the plastic after autoclaving can be very difficult.

III. Radioactive biohazard Spill Outside a Laminar Flow Biological Safety Cabinet

In the unlikely event that a biohazardous spill also involves a radiation hazard, the clean–up procedure may have to be modified, depending on an evaluation of the risk assessment of relative biological and radiological hazard.

Laboratories handling radioactive substances must have the services of a designated radiation protection officer available for consultation.

The following procedure indicates suggested variations from the biohazard spill procedure (above) that should be considered when a radioactive biohazard spill occurs outside a safety cabinet.*

A. Holding your breath, leave the room immediately and close the door.

B. Warn others not to enter the contaminated area.

C. Remove and containerize contaminated garments for autoclaving and thoroughly wash hands and face.

*Personnel should be surveyed for radiation hazard before and after clothing change and wash–up.

D. Wait thirty minutes to allow dissipation of aerosols created by the spill.

*Before clean–up procedures begin, a radiation protection officer should survey the spill for external radiation hazard to determine the relative degree of risk.

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* Changes in procedure have been starred and underlined.

E. Don a long-sleeve gown, mask, and rubber gloves before reentering the room. (For a high risk agent, a jumpsuit with tight-fitting sleeves and use of a respirator should be considered.)

F. Pour a germicidal solution (5% Wescodyne or 5% Hypochlorite are recommended) around the spill and allow to flow into the spill. Paper towels soaked with the germicide may be used to cover the area. To minimize reaerosolization, avoid pouring the germicidal solution directly onto the spill.

G. Let stand 20 minutes to allow adequate disinfectant contact tine.

H. *In most cases, the spill will involve ^{14}C or ^{3}H, which present no external hazard. However, if more energetic beta or gamma emitters are involved, care must be taken to prevent hand and body radiation exposure. The radiation protection officer must make this determination before the clean-up operation is begun.

If the radiation protection officer approves, the biohazard handling procedure may begin: Using an autoclavable dust pan and squeegee, transfer all contaminated materials (paper towels, glass, liquid, gloves, etc.) into a deep autoclave pan. Cover the pan with aluminum foil or other suitable cover and autoclave according to standard directions.

*If the radiation protection officer determines that the radiation hazard is too great, the material must not be autoclaved. In that case, sufficient germicidal solution to immerse the contents should be added to the waste container. The cover should be sealed

with waterproof tape, and the container stored and handled for disposal as radioactive waste. Radioactive and biohazard warning symbols should be affixed to the waste container.

I. If autoclaving has been approved, the dust pan and squeegee should be placed in an autoclavable bag and autoclaved according to standard directions. Contact of reusable items with plastic bags should be avoided--separation of the plastic after autoclaving can be difficult.

*A final radioactive survey should be made of the spill area, dust pan, and squeegee with a Geiger counter, or a smear should be taken and counted in a liquid scintillation counter. Twice (2X) background count indicates the need for further decontamination.

Fire and Physical Hazards

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Laboratory Fire Safety

I. The Fire Problem of Laboratories

   A. Factors of Origin

   B. Factors of Spread

   C. General Concepts

II. Methods of Fire Control

   A. Hazard Classification

   B. Physical Design and Construction

   C. Fire Protection and Alarm

   D. Laboratory Ventilation and Fume Hoods

   E. Flammable and Combustible Liquids Control

   F. Compressed Gas and Fixed Piping Systems

III. Laboratory Operations

   A. Assign Responsible Individual

   B. Assess Operation and Apparatus

   C. Provide Hazard Identification

Italic = New or Revised January 1,1987

Safety Guidelines
Department of Environmental Health and Safety

Design and Construction of Laboratories Using Chemicals

I. Laboratories must be designed to conform with one of the following National Fire Protection Association (NFPA) standards.

A. NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals

B. NFPA 99, Chapter 7 – Laboratories in Health Related Institutions

II. Laboratories must also conform with NFPA 101, Code for Safety to Life From Fire In Buildings and Structures. Depending upon the building in which the laboratory will be located and the nature of the work performed in the laboratory, a laboratory will be considered to be within one of the following occupancies:

A. Business

B. Health Care

C. Industrial

III. Compartmentation of each laboratory unit must be achieved by providing it with at least:

A. One-hour fire separation from adjacent laboratories, or Other areas.

B. Self-closing fire doors with at least 3/4 hour ratinq (NFPA 101, 6-2.2.5)

C. Class A interior finishes

D. Class I floor finishes

IV. Access to two or more exits must be provided within each laboratory. Aisles servinq a single work area must be a minimum of 36" wide. Double aisles must be a minimum of 60" wide. Avoid aisles longer than 20 feet. Arrange furniture for easy access to an exit from any point in the laboratory.

V. Doors in laboratories where hazardous materials are used must swing in the direction of exit.

VI. Faucets must be provided with vacuum breakers, or a special laboratory water supply must be provided as required by the stat? plumbing code.

VII. In a lab equipped with a fume hood, a safety shower and an eyewash must be provided. In other laboratories using chemicals at least an eyewash will be required. *If it is feasible, water supply should be controlled to a temperature between 60º and 95º.* Refer to the Department of Environmental and Safety Recommended Practices for the Installation of Emergency Eyewashes and Safety Showers.

VIII. The laboratory user must be consulted to determine the quantities of flammable and combustible liquids which will be present in the laboratory. These materials must be stored according to the University of Minnesota Standard for the Quantity of Flammable and Combustible Liquids in University of Minnesota Laboratories and NFPA 30, the Flammable and Combustible Liquids Code.

IX. Storage and supply systems for compressed and liquified gases shall comply with requirements of the NFPA and ANSI. Standards which should be consulted include:

(a) NFPA 50, Standard for Bulk Oxygen Systems at Consumer Sites

(b) NFPA 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites

(c) NFPA 50B, Liquefied Hydrogen Systems at Consumer Sites

(d) NFPA 51, Design and Installation of Oxygen–Fuel Gas Systems for Cutting and Welding

(e) NFPA 56F, Standard for Nonflammable Medical Gas Systems

(f) NFPA 54, National Fuel Gas Code

(g) NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases

(h) NFPA 99, Standard for Health Care Facilities
Chapter 3 – Use of Inhalation Anesthetics (flammable and non-flammable)
Chapter 4 – Use of Inhalation Anesthetics in Ambulatory Care Facilities
Chapter 5 – Respiratory Therapy

(i) ANSI B31.1.0, Power Piping (including Addenda B31.1.0a, B31.1.1.0c, and B31.1.1.0d)

(j) ANSI B31.2, Fuel Gas Piping

(k) ANSI B31.3, Petroleum Refinery Piping

X. Systems for other gases shall comply with manufacturers designs and specifications. The Handbook of Compressed Gases by the Compressed Gas Association and the Matheson Gas Data Book by Matheson Gas Products may be consulted.

XI. When a central supply of flammable, combustible or oxidizing gases is provided, shut-off valves in accessible locations must be provided; they must be outside of the areas in which the gases are used. These shut-offs are in addition to those at the points of supply and use. *They may be located in either a distant area of the lab or in the corridor if security is not a problem.*

XII. Controls for air, gas and other utilities must be color coded and labeled (different control handle configurations are desirable).

XIII. Fire extinguishers must be provided to meet the requirements of NFPA 10. A five-pound multipurpose dry chemical fire extinguisher must be provided for each laboratory unit. The extinguisher must be mounted near an exit from the unit.

XIV. Laboratories using chemicals must be under negative pressure, with respect to adjacent areas. No recirculation of exhaust air from laboratories is permitted.

XV. Laboratory fume hoods must meet the Department of Environmental Hood Design Criteria.

XVI. Electrical systems must meet the requirements of NFPA 70, the National Electric Code. Outlets must be provided for fixed appliances and one duplex must be provided per each 3 to 5 feet of bench length.

The following items are preferred design criteria for chemical laboratories and may be required when appropriate:

1. Metal laboratory furniture with stainless or synthetic stone benchtop.

2. Wall cabinets with a continuous enclosed front plane to the ceiling.

3. Glass waste lines.

4. A glassware cleaning sink at least 12" deep

5. An emergency equipment room, cabinet or kit, including an air supply mask, chemical neutralizer, liquid absorbents and protective clothing at a minimum.

Italics=New or Revised January 1, 1987

Safety Standard
Department of Environmental Health and Safety

General Purpose Fume Hoods and Additional Requirements For Radioisotope and Perchloric Acid Hoods

General purpose fume hoods are provided for operations using flammables or toxic chemicals. A multipurpose hood design which will provide adequate safety for changes in use that may occur during the useful life of the hood is required. Compliance with the following design criteria will support user safety. These criteria are supplemental to SAMA Standard LF 10-1980, University of Minnesota Construction Standards, and to more specific material and equipment specifications.

Fume Hood Construction and Design

1. Non–combustible construction is required.

2. It shall be of air foil design with the bottom foil raised to provide a one–inch clear opening between the foil and the work top.

3. Provide a vertical sliding safety glass sash *operable with one hand from any point on the bottom.*

4. *On 14' and larger hoods, 15" wide horizontal sliding safety shield shall be provided, supported to resist pressure displacement. It shall be suspended on bearings or slide in an easily cleanable channel.*

5. An air by-pass designed to prevent hood face velocity from exceeding 200 feet per minute shall be provided.

6. Electrical outlets shall be located outside of the fume hood interior.

7. Utility (gas, water, vacuum, etc.) controls must be located on the exterior of the hood with utility outlets mounted on the interior side wall. Controls shall be identified.

8. A liquid-tight work surface to contain at least *3/8"* liquid depth shall be identified.

9. A baffle system that allows air to be drawn evenly to the top, middle, bottom of the hood and so arranged that is possible to adjust the flow of the air but not shut it down completely shall be provided. * *The top baffle must have a opening width limited to no more than 3/4 inch.*

10. One fume hood base cabinet per laboratory (two cabinets are acceptable in large laboratories) may be used as a storage cabinet for flammable liquids. Cabinet top, bottom, sides and doors shall not be less than 18 gauge steel, double-walled construction with a 1 1/2" air space between the walls. * *The doors shall be equipped with a 3 point latch system.* All joints shall be welded or screwed to provide rigid enclosures. A liquid tight pan capable of containing a 2" depth of liquid shall be provided. The cabinet shall be ventilated at a minimum rate of **5** CFM with a stainless steel duct penetrating behind the baffle at least 1" above the work surface. Flame arrestors shall be provided on cabinet vents. Make up air supply for the cabinet shall be taken from the pipe space behind the cabinet; supply vents shall not be placed on the front or side of the cabinet. The exterior exposed surfaces of the storage cabinet shall be painted with yellow paint and must be labeled with at least 1" high black letters with 0.25" stroke "FLAMMABLE STORAGE" or "FLAMMABLE LIQUIDS"

11. Acid storage base cabinets shall be constructed to resist corrosion. Ventilation shall be provided in the cabinet at the rate of 5 CFM. Vent pipes shall extend above the work surface and behind the baffle in the same manner as with flammable storage cabinets although flame arrestors are not required. Vents may be provided in the cabinet door. Cabinets shall be provided with a liquid tight pan, capable of holding a 2" depth of liquid. Cabinets shall be labeled in at at least 1" letters with 0.25" stroke "ACID STORAGE."

12. Drying base cabinets shall not be installed under fume hoods.

13. Interior lighting shall be vapor sealed and covered with a safety glass lens. Illumination levels at the working surface shall be at least 80 foot-candles.

14. *Fume hoods shall, whenever feasible, be located in the distal corners of a lab and away from high traffic areas. This is to avoid locations in a traffic pattern which will cause conflicting convection currents and to avoid blocking an exit if there is fume hood fire.*

Filter Enclosures*

15. When a HEPA filter enclosure is provided, it must provide for easy bag-in, bag-out of filters so there is no exposure to maintenance staff. The filter enclosure shall be located in such a position as to allow easy installation and removal of the filters.

16. On hoods with filter enclosures, an airflow indicator shall be provided in a clearly visible location to indicate pressure drop across the filter.

17. Filter enclosure:

a. The filter enclosure shall be of stainless steel construction.
b. It shall be designed to provide a tight seal between the enclosure and the filter frame (use levered cams on four corners of filter frame and gasketed filter frames to prevent air leakage).
c. The filter enclosure must provide for installatioin of a 11 1/2" X 24" X 24 or 5 3/4" x 24" X 24" HEPA filter, and a 2" x 24" x 24" pre-filter.
d. The filter access door(s) shall be gasketed to prevent air leakage.
e. The duct between the hood and the filter shall be of stainless steel construction.

18. If the hood is installed with a HEPA filter enclosure, the open face velocity shall be 150 fpm to allow for filter loading. If the hood is not installed with a filter, the face velocity shall be 100 fpm but reserve capacity for a filter must be engineered into the fan design.

* Note: Enclosure must be equal to Mine Safety Equipment Company Ultra-Lok Series U.

Exhaust and Ductwork Requirements

19. Systems shall generally be installed in accordance with the requirements of NFPA 91-1983, Standard for the Installation of Blower and Exhaust Systems.

20. The fire rating of laboratory units and other building fire compartments must be protected. Stainless steel and sheet metal ductwork will usually be considered to provide one hour fire separation. When more than one hour separation or the use of other ductwork materials are proposed, construction of 3 suitable fire rating must also be proposed to protect the system.

21. *General purpose* fume hoods shall be individually ducted – except that up to four hoods, located in the same room, may be connected to a common exhaust duct leading from that room to an exhaust fan. *If more than one hood is connected to an exhaust duct, a balanced undampered drop must be engineered. Fume hoods provided with HEPA filters enclosures shall always be individually ducted*

22. Fire dampers or other restrictions shall not be placed in any chemical fume exhaust duct.

23. *Fume hood exhaust systems shall function independently of the general building HVAC system. Fume hood exhaust volumes shall not be modulated or controlled to balance air requirements for air conditioning or heating*

24. *Associated equipment in the same room, such as flammable liquid storage cabinets, biological safety cabinets and atomic absorption units, should be provided with an independant exhaust system. However, after review by the Department of Environmental Health and Safety, associated equipment might be permitted to be ducted into the fume hood. On hoods with HEPA filter enclosures, associated equipment must be connected between the hood and the enclosure.*

25. *Clearly visible airflow indicators shall be installed on new laboratory hoods or on existing fume hoods when they are modified*

26. Fume hood exhaust ductwork shall be operated with negative static pressure in the ductwork through all spaces within the building. Fume hood exhaust fans shall be located on the roof of the building or In a ventilated equipment room just below the roof of the building.

Fan discharge ducts shall discharge vertically through the roof and terminate at least seven feet above the roof. Seal the discharge duct airtight.

27. Stack design and discharge velocity shall distribute contaminants outside the eddy current envelope of the building. *On structures with roof areas at more that none level, discharge ducts within 30 feet of a higher level shall terminate at a point at least seven feet above the elevation of the higher level.*

28. Air velocity on the suction of the fan *shall* be a minimum of 1,000 fpm and should not exceed 2,000 fpm under any conditions. High duct velocity results in high noise levels, excessive leakage and high power consumption. An optimum velocity of 1,200 fpm is recommended. *Ductwork should be round to assure uniform air flow, rectangular ductwork will be acceptable only when condition require its use.*

Fume Hood Operation

29. Fume hoods shall run continuously. On–off control to be by Physical Plant only.

30. Open–face velocity average shall be 100 fpm + or – 10 fpm. Individual face velocities shall not exceed 20% of the open-face velocity average when readings are taken in the center of several square grids measured in the plane of the face opening *(see SAMA Standard LF 10-1980 for the recommended sampling grid! Open-face" for two-speed fume hoods shall be the maximum possible opening while the "open-face" for reduced capacity fume hood shall be the 18" sash lock level (see number 32.b below).*

31. When calculating exhaust volumes required for a fume hood, the 15" wide horizontal sliding safety shield shall not be taken into consideration for any hood less than 4 feet wide because they are often removed by users: On a reduced volume fume hood, the safety shield shall not be taken into consideration for any hood less than 6 feet wide. This standard may result in higher face velocities.

32. To conserve energy, fume hoods may be provided with two-speed fans of a reduced capacity fume hood exhaust system.

a. Two-speed system

1) Two-speed fans, when provided, shall function at low speed when the sash is closed or within 2" of the working surface. Activation device shall be fail-safe so that if the device fails the fan will operate at high speed.

2) High speed and low speed signal lights shall be provided and labeled to indicate their function.

3) Provide an easily readable sign: "Conserve Energy, Close Hood Sash When Possible to Activate Lower Fan Speed."

b. Reduced capacity fume hood exhaust system

1) The vertical sliding safety glass sash shall have a positive steel mechanical latch to prevent opening above 18" without operator intervention. Latch shall be operable with one hand and allow unobstructed closing of sash from any position.

2) A flashing red warning light shall be installed to operate whenever vertical sash is above 18". The warning light shall be adjacent to latch control and be observable by hood operator.

3) An easily readable sign shall be provided adjacent to the sash height warning light: "Caution: Face Velocity Reduced - Position Sash Below 18" for Continued Use".

Supply Air Requirements

33. *Auxiliary air supply hoods are not desirable under usual circumstances at the University. Before proposing an auxiliary air supply hood, contact the Department of Environmental Health and Safety*

34. *Room cross drafts shall be avoided. Whenever possible air should be provide in a diffuse manner from behind an operator.*

Additional Requirements for a Radioisotope Fume Hood

1. A raised cup sink shall be provided. It shall be raised (1/4-5/16") above the work surface but shall be lower by (1/16") than the raised margins of the work surface. *The front lip of the work surface shall be raised at least 1/2 inch.*

2. The interior lining and baffles of the fume hood shall be constructed of stainless steel.

3. The work surface shall be capable of supporting up to 200 pounds/foot^2 of shielding material.

4. Corners shall be *smooth and* seamless and radiused 1/2" except at the top.

5. *An absolute filter enclosure may be required Contact the Department of Environmental Health and Safety for licensure requirements.*

Additional Requirements for a Perchloric Acid Fume Hoods

1. *Hoods and exhaust duct work shall be constructed of acid resistant, non-reactive, impervious materials:*

2. *Duct work shall take the shortest and straightest path to the outside Positive drainage shall be provided back to the hood.*

3. A water spray system shall be provided to wash down the entire exhaust system from the hood interior behind the baffle, through the fan, up to the roof line. The hood work surface shall be watertight with a minimum depression of 1/2" at the front and sides. An integral trough shall be provided at the rear of the hood to collect wash down water. The baffle shall be removable for cleaning.

4. Washdown must be easily initiated by the user. Initiation of the washdown cycle must start a minimum 1/2 hour washdown. Since the washdown of a contaminated hood requires up to 24 hours of continuous washing, manual control of the cycles' duration must also be possible.

5. Provide an easily readable placard stating "Washdown after use, do not use perchloric acid with incompatible materials -- e.g., acetic acid, bismuth and its alloys, alcohol, paper, wood, grease or oils".

Italics=New or Revised January 1, 1987

Safety Standard
Department of Environmental Health and Safety

Installation of Emergency Eyewashes and Safety Showers

These recommendations apply to the installation of eyewashes and safety showers in new buildings or renovation projects at the University of Minnesota. Eyewashes and safety showers are effective means of flushing corrosive materials out of the eyes or off the body. Safety showers can also be used to extinguish clothing fires.

General Considerations

1. Emergency eyewashes and safety showers are not a substitute for proper protective devices. To protect against flying particles and splashing injurious liquids, persons shall wear eye and face protection and protective clothing.

2. Eyewashes and safety showers shall be located in areas where the eyes or body may be exposed to corrosive chemicals, e.g. laboratories, battery operations, corrosive dip tanks.

3. Eyewashes and safety showers shall be located so that the maximum distance from the hazard does not exceed 100 feet and so that they can be reached within 10 seconds.

4. Eyewashes and safety showers should be located in the normal path of egress. For example, in a laboratory, the location should be near a corridor door.

5. Water supplied to eyewashes and safety showers should be tempered. A temperature of 60º-95º is considered optimum.

6. Only potable water shall be used to supply eyewashes and safety showers.

7. The activation devices of eyewashes and safety showers must be uniform throughout a building.

8. All eyewashes and safety showers must be uniformly marked throughout a building.

Eyewash/Face Washes

1. Eyewashes should be of a type that provide a curtain of water over the entire facial area. Streams of water should be simultaneously released from two sides to clean foreign particles or liquids from both the eyes and facial area.

2. Eyewashes shall have a flow rate of at least 3 gallons per minute at a pressure of 30 psi supply to fixture.

3. The eyewash control should be of the paddle type with dimensions of approximately 4 x 4". The control should require no more than 10 ounces of force for activation. The valve should be designed to remain activated until intentionally shut off.

4. The recommended distance from the floor to the eyewash jets is 33-45 inches.

5. All eyewash fixtures are required by the State Plumbing Code to be drained to sewer.

Safety Showers

1. Safety showers shall be of deluge type with a continuous flow valve. Such a valve would require a second pull of the cord or ring, for example, to deactivate the shower. The valve shall remain activated until intentionally shut off.

2. Safety showers may be ceiling or wall mounted, and they may be installed in combination with an eyewash fixture. The supply lines and connections of combination units shall not create a contact hazard for persons using the eyewash.

3. Safety showers should provide a head discharge of at least 30 gallons per minute at a pressure of 30 psi.

4. The recommended distance from the floor to the shower is 82-96"

5. Activation of the shower may be by wall cord, ring and chain or pull bar. The location of the activating device should be designed so that it will not be in the way of normal operations. This is to prevent accidental discharge.

6. The provision of a floor drain is a desirable option for a safety shower.

QUANTITY OF FLAMMABLE AND COMBUSTIBLE LIQUIDS IN UNIVERSITY OF MINNESOTA LABORATORIES

October 12, 1983

This standard shall apply to University laboratory facilities including instructional, research, health care and general purpose, to regulate the quantity of flammable and combustible liquids within the laboratory. It addresses quantities in use as well as those in storage in approved storage cabinets. It does not address storage in specifically constructed flammable liquids storage rooms.

For use within this standard, the following definitions shall apply.

Flammable Liquid: A liquid having a flashpoint below 100ºF and having a vapor pressure not exceeding 40 pounds per square inch at 100ºF shall be known as a Class I liquid. Class I liquids shall be sub-divided as follows:

Class IA shall include those having flashpoints below 73ºF and having a boiling point below 100ºF.

Class IB shall include those having flashpoints below 73ºF and having boiling point at or above 100°F.

Class IC shall include those having flashpoints at or above 73ºF and below 100ºF.

Combustible Liquid: A liquid having a flashpoint at or above 100ºF. Combustible liquids shall be sub-divided as follows:

Class II shall include those having flashpoints at or above 100º F and below 140ºF.

Class IIIA liquids shall include those having flashpoints at or above 140ºF and below 200°F.

Class IIIB liquids shall include those having flashpoints at or above 200°F.

Laboratory Unit: A enclosed space used for experiments or tests. Laboratory units may or may not include offices, laboratories, and other contiguous rooms maintained for or used by laboratory personnel, and corridors within the unit. It may contain one or more separate laboratory work areas. It may be an entire building. It must, however, be separated from other building areas by appropriate fire resistive construction having at least a one hour fire resistive rating.

Requirements

1. Maximum quantities of flammable and combustible liquids in research and general purpose laboratory units shall be in accordance with the following table.

Maximum Quantities of Flammable and Combustible Liquids in Laboratory Units Outside of Approved Flammable Liquid Storage Rooms

Excluding Quantities in Storage Cabinets and Safety Cans

Liquid Class	Maximum Quantity per 100 sq. ft. of Lab Unit	Maximum Quantity per*** Lab Unit
I*	2 gallons	75 gallons
I, II and IIIA**	4 gallons	100 gallons

Including Quantities in Storage Cabinets and Storage Cans

I*	4 gallons	150 gallons
I, II and IIIA**	8 gallons	200 gallons

Notes: *Class I liquid **maximum** shall be inclusive of Class IA, IB and IC collectively.

**The Maximum quantities of Class I liquids shall not exceed the quantities specified for Class I liquids alone.

***The more restrictive quantity, based on either the Maximum quantity per 100 sq. ft. of Lab Unit or Maximum Quantity per Lab Unit, shall apply in all cases.

2. Maximum quantities of flammable and combustible liquids in instructional laboratory units shall not exceed 50% of that allowable in research and general purpose laboratories.

3. Maximum quantities of flammable and combustible liquids in use, outside of approved storage cabinets in health care laboratories, shall not exceed 2 gallons per 1,000 square feet of laboratory unit. The total capacity of all storage cabinets, within health care laboratories, shall not exceed 12 gallons per 1,000 square feet of laboratory unit.

4. Maximum allowable container size for use in all laboratories shall be in accordance with the following table.

Maximum Allowable Container Size for Use in Laboratories Using Chemicals

	Flammable Liquids			Combustible Liquids	
Container Type	1A	1B	1C	II	IIIA
Glass	1 pt*	1 qt*	1 gal	1 gal	5 gal
Metal (other than DOT Drums) or Approved Plastic	1 gal	5gal**	5 gal**	5 gal**	5 gal
Safety Cans	2 gal	5 gal**	5 gal**	5 gal**	5 gal

Notes: *Glass containers, as large as one gallon, may be use if needed, and if the required purity would be adversely affected by storage in a metal or an approved plastic container, or if the liquid would cause excessive corrosion, or degradation of metal or approved plastic container.

**In instruction laboratory work areas, no container for Class I or Class II liquids shall exceed a capacity of one gallon, except that safety cans may be of two-gallon capacity.

5. Flammable or combustible liquids shall not be stored in ordinary refrigerators. Storage of flammable or combustible liquids in well-sealed containers is permissible in approved flammable materials storage refrigerators or in refrigerators approved for Class I, Division I, Group C and D. The outside of doors to laboratory refrigerators shall be labeled to denote whether or not they are acceptable for storage of flammable or combustible liquids.

6. Incompatible materials shall be segregated to prevent accidental contact with one another.

7. Flammable and combustible liquids stored in the open in the laboratory work area shall be kept to the minimum necessary for the work being conducted.

8. All containers used for storage of flammable and combustible liquids shall be labeled as to content in accordance with good laboratory practice.

Use and Storage of Compressed Gas Cylinders in University of Minnesota Buildings

This Standard applies to all compressed gas cylinders in University buildings. Special uses such as administration of combustible anesthetics, are the responsibility of persons associated with such applications.

Requirements

1. Cylinders shall have the name of the chemical appearing in legible form on the cylinder. A color code is not satisfactory designation.
2. Cylinders shall be securely held in an upright position. String, wire or similar makeshift materials are not acceptable.
3. Cylinders shall be located so they are not exposed to direct flame or heat in excess of 125 degrees Fahrenheit.
4. Cylinders not in use shall have the valve protective cop securely in place. (Lecture bottles are an exception.)
5. Cylinders shall be moved only in suitable hand carts.
6. Cylinders containing flammable gas shall be used and stored in a ventilated area. (10 air changes par hour, minimum.) No other gases or chemicals shall be stored in the same area.
7. Cylinders containing toxic or corrosive gases shall be used and stored in well-ventilated areas.
8. Cylinders containing corrosive gas shall be returned to the supplier no later than six months from time of first use. Cylinder and regulator valves shall be opened and closed frequently during the period of use.
9. Cylinders discharging into liquids or closed systems containing other chemicals shall have a trap, check valve, of vacuum breaker between cylinder and system or liquid.
10. Systems mixing two or more gases shall be provided with necessary control or check valves to prevent contamination of the separate gas sources.
11. Closed systems, or any arrangement that might accidentally become a closed system to which a cylinder is attached, shall have a safety relief valve set at a relief pressure that will prevent damage to any part of the equipment.
12. Cylinder valves and regulators shall have outlets and inlets respectively for the specific gas as designated in the American Standard of Compressed Gas Association Pamphlet V-1 or for flush–type cylinder valves according to Compressed Gaa Association Pamphlet V-1.
13. Use of adaptors between cylinder valve and regulator should be discouraged, but if used, they should be only a type listed in Appendix of Compressed Gas Association Pamphlet V-1.
14. Emergency plans shall be developed to insure control or safe removal of leaking cylinders. Properly maintained protective clothing and equipment for safe entry into an area, contaminated by compressed gases in use, shall be available in the immediate area.

Extension Cords in University Buildings
(Revision–2) April 1980

Extension Cord Construction

1. The flexible cord shall contain a ground wire and shall be type S, hard usage cord; for cords used with heating appliances, type HS cord is required.
2. Plugs and connectors shall be the grounding type, single–service (multiple outlet cube connectors or adaptors not allowed), allow for inspection of wire connections and have a device to prevent tension transfer to terminal connections.
3. The wire in the flexible cord servicing a current draw of over 7 amps shall be No. 14 or larger wire.

Extension Cord Use and Maintenance

1. Extension cords shall not be used as a substitute for permanent wiring. Multiple strip outlets, fused for wire size of connecting cord are allowed on a temporary basis until permanent wiring is installed.
2. Extension cords shall not be used on fixed or semi–fixed equipment (refrigerators, centrifuges, etc.) or equipment drawing more than 15 amps.
3. Extension cords shall not run through, behind or in walls, ceilings or floors; or run in or through ventilation or other ducts; or suspended over pipes, fixtures or other metal objects. They cannot be used as a substitute for permanent wiring.
4. Extension cords shall not be placed under carpets, under doors, or other locations that subject the cord to wear, abrasion or other damage.
5. Extension cords with broken wires or damaged insulation must be removed from service; splicing or taping is not allowed.
6. Extension cords shall not be used where hazardous atmospheres exist or may exist due to presence of flammable gases or vapors or explosive dusts.
7. Extension cords shall not be placed across aisles or corridor floors or located so as to produce a tripping hazard.
8. The combined length of the appliance cord and extension cord used on very portable equipment such as floor scrubbers, projectors and tools shall not exceed 105 feet.
9. Long cords shall not be left in a coiled or semi-coiled condition when in use.

General Considerations

1. Replacing a very short appliance cord with a longer one is generally more desirable than using an extension cord.
2. Consider the proximity of electrical outlets when locating furniture.
3. Select a cord with proper insulating materials if there will be exposures to moisture, oil or other chemicals.
4. Check frequently for damaged insulation and poor connections at the plug and connector.

Building: _____ Department _____

Room : _____ Principal Investigator _____

I General

1. Maintenance and Repair
2. Housekeeping and sanitation
   Benches__ Cabinets__ Storage__
   Hoods__ Adj. Corridor__ Aisles__
   Smoking and eating__
3. All chemicals and gases labeled
4. Flammable liquids
   Amount on hand__ Amount needed__
   Protected storage__ Proper amount__
5. Compressed Gases
   Supported
   Proper Hose, gauge and controls
   Toxic and flammable gases vented
   Separate oxygen from flammable gases
   Corrosive gases 6 month shelf life
6. Separate storage for acids, caustics, oxidizing agents
7. Limited amounts of high hazard chemicals
   Perchloric acid__ Peroxys__ Ether__
   Picric acid__ Dated__
8. Refrigerators, etc. modified__ labeled__
9. Hoods
   FPM__ Separate Duct__ Fan at roof__
   Electrical outlets outside
   Radioisotope__ Perchloric Acid__

II Waste

1. Old or unneeded chemicals removed
2. Containers for: Combustible__
   Non-Combustible__
   Special containers for:
   Radioactive (4 types)__ Biohazards__
   Flammable liquids __ Cellulose nitrate
   Oily rags __ tubes__
3. Hazardous waste labeled, packaged and periodically picked up

III Special Procedures

1. Flammables
   In hood or explosion proof area
   Electric mantle or steam heat
   Stirring by safe method
2. Toxic materials
   Used in hood
3. Mercury, protected
   Container to catch spills
4. Acid Glass cleaning
   Commercial cleaner
   Safe container in sink
   Prevent contact with organics, alcohol or acetic acid
5. Paper chromatography
   Vented__ drying cabinet__
6. Biohazards (what precautions are taken)
   Oral pipetting
   Work surface covered by disinfectant towel
   Use equipment in disinfectant
   Cool loop or disposable wood
   Lock-type needle
   Culture in 15X150MM tubes
7. Electrophoresis Apparatus
   Interlocked__ fail safe__ grounded__
8. Centrifuge shielded
9. Cold Room
   Vented__ Explosion-proof__
   Emergency escape
10. Cryogenic materials
   Safe dry ice storage
   Vented__ System purged__
   Protected from damage
   Plastic tubes, etc. prohibited

IV Personal Protective Equipment

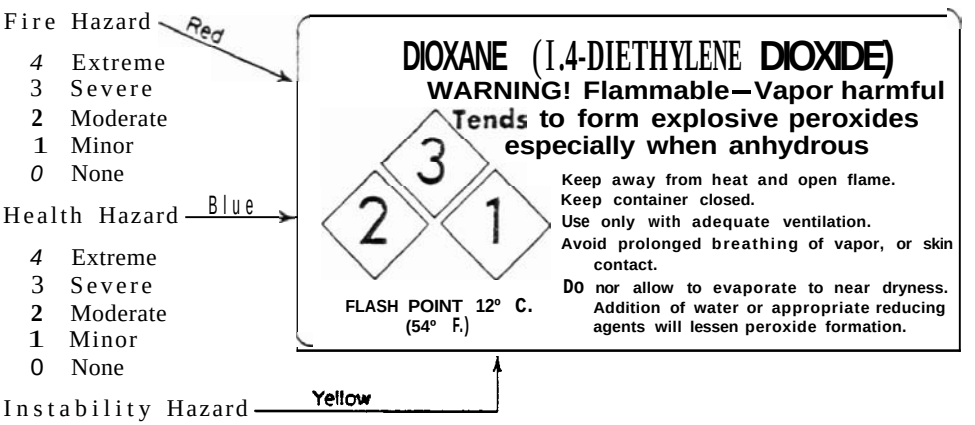
1. Fire extinguisher 5# dry chemical
2. Safety shower__ eyewash fountain__
3. Gloves__ aprons__
4. Eye protection-face shields-contacts prohibited
5. Rescue equipment available
6. Egress route adequate
7. Emergency procedures available
8. Telephone emergency decal
9. Name and telephone of principal investigator

Other _____

Items checked above indicate an injury control need. Related written recommendations will be forwarded to principal investigator and department chairman.

Chemical Label Hazard Signals

Chemicals packaged by Chemical Storehouse and several departments have new color-coded labels to help laboratory and service personnel see at a glance the hazards to health and safety if the chemical is spilled or mishandled.



4	Extreme	Readily explosive under normal conditions.
3	Severe	Explosive if strongly initiated, heated, or water added.
2	Moderate	Normally unstable, or violently reactive with water.
1	Minor	Unstable at elevated temperatures, or reacts with water.
0	None	Normally stable.

Special Precautions

Transportation and handling of chemicals in hazard grades 3 and 4 require special precautions to prevent breakage, spills, or exposure to fire. Ventilation and fire-protected storage are required for safe use.

Spills of grade 3 or 4 chemicals require prompt action. Keep people out of the danger area and take action to neutralize, absorb, emulsify or ventilate the spill. Prevent fire by keeping flames, sparks and other ignition sources away from flammable vapors and gases.

Flash points are shown for flammable chemicals--flash point is the lowest temperature at which the chemical will give off enough vapor for ignition to cause a flash fire or explosion.

Chemicals which are highly flammable or only slightly soluble in water are marked "Do Not Dispose of in Building Drains." Such chemicals should be disposed of by calling Plant Services at 273-3625 for free weekly pickup.

Departments that are interested in applying this hazard labeling system to reagent and other chemicals may purchase Pamphlet 325M of the National Fire Protection Association or contact the University Health Service, Division of Environmental Health and Safety.