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LABORATORY DESIGN CONSIDERATIONS FOR SAFETY.

CAMPUS SAFETY ASSOCIATION, CHICAGO, ILL.
NATIONAL SAFETY COUNCIL, CHICAGO, ILL.

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DESCRIPTORS- *DESIGN, *EQUIPMENT, *SAFETY, *SCIENCE LABORATORIES, *STANDARDS, ACCIDENT PREVENTION, FIRE PROTECTION, LABORATORY SAFETY, LIGHTING, VENTILATION.

THIS SET OF CONSIDERATIONS HAS BEEN PREPARED TO PROVIDE PERSONS WORKING ON THE DESIGN OF NEW OR REMODELED LABORATORY FACILITIES WITH A SUITABLE REFERENCE GUIDE TO DESIGN SAFETY. THERE IS NO DISTINCTION BETWEEN TYPES OF LABORATORY AND THE EMPHASIS IS ON GIVING GUIDES AND ALTERNATIVES RATHER THAN DETAILED SPECIFICATIONS. AREAS COVERED INCLUDE--(1) AUTOMATIC SYSTEMS FOR FIRE AND EXPLOSION PROTECTION, (2) EMERGENCY ALARM SYSTEMS, (3) SPECIAL FACILITIES FOR CHEMICAL STORAGE, HANDLING, AND DISPOSAL, (4) SAFETY EQUIPMENT, (5) FACILITIES FOR INFECTIOUS AGENTS AND ANIMALS, (6) LABORATORY VENTILATION, (7) ILLUMINATION, (8) RADIO ISOTOPES, (9) EGRESS FACILITIES, (10) FIRE RESISTANCE, (11) WATER SUPPLY AND PIPING, AND (12) MISCELLANEOUS DESIGN FEATURES. SPECIAL EMPHASIS IS GIVEN TO LABORATORY VENTILATION, AND A BIBLIOGRAPHY IS PROVIDED ON INFECTIOUS AGENTS AND ANIMALS. (MM)

LABORATORY DESIGN CONSIDERATIONS FOR SAFETY

campus safety association

GREEN CROSS FOR SAFETY
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THE CAMPUS SAFETY ASSOCIATION was formed in 1949 and affiliated with the National Safety Council in 1956. The Association is a division of the Higher Education Section formed in 1957.

OBJECTIVES of the Association are to promote safety on college and university campuses by exchange of information on prevention of accidents to faculty, staff and students.

MEMBERSHIP in the Association is open to any person whose activities are related to college and university safety programs. Membership in the Association automatically provides membership in the Higher Education Section.

MEMBERSHIP APPLICATIONS may be obtained from the Secretary or the Staff Representative; there are no dues. Members are entitled to voting privileges and are eligible to serve as officers or as members of committees.

OFFICERS of the Association are Chairman, Vice Chairman and Secretary, each elected for a term of one year. The Vice Chairman automatically succeeds to the Chairmanship.

STANDING COMMITTEES of the Association are Nominating, Membership, National Campus Safety Conference Planning and Congress Program Planning.

The Association contributes to the College and University Safety Newsletter, official organ of the Section, published five times a year by the Council and available on request.

The primary activity of the Campus Safety Association is an annual National Conference on Campus Safety held in the early summer on the campus of a member college or university. An effort is made to present successive conferences at as wide spaced geographical locations as possible.

The annual conference, of several days duration, is a combination of education, training and discussion of specific problems. The proceedings of the National Conference on Campus Safety are published and copies are available from the National Safety Council.

A mid-year meeting is held each year in conjunction with the National Safety Congress in Chicago. Oftentimes arrangements are made to hold joint meetings with other divisions and sections of the Council.

The Association makes a sincere effort to be of service to the members and others interested in Campus Safety.

Each year a membership roster is published. The roster lists the areas of interest of each of the members and can be used for interchange of ideas and solutions to problems.

LABORATORY DESIGN CONSIDERATIONS FOR SAFETY

These considerations proposed by the Laboratory Safety Committee of the Campus Safety Association received approval at the 13th National Campus Safety Association Conference on June 24, 1966.

CONTENTS

For further information on the Campus Safety Association, please contact Staff Representative, School and College Division, National Safety Council, 425 No. Michigan Avenue, Chicago, Illinois 60611.

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INTRODUCTION

This set of considerations has been prepared from considerable hard-won experience to provide persons working with the designing of new or remodeled laboratory facilities with a suitable reference guide to design safety.

The following items should be used as guides only. These considerations do not spell out the details nor do they cover all of the facets of the many design problems. In most instances, various alternatives are offered and the selection of the method and degree of protection required for your circumstances is left to your judgement. It is suggested that where specialized protective equipment is to be used an engineer or engineering firm be employed with experience with the equipment to be installed. The various state and insurance rating agencies and manufacturers or distributors of equipment will often do preliminary work on specialized equipment without obligation.

The title of these considerations deliberately deletes any reference to the type of laboratory since recent experience has indicated a need for most of the items covered in all laboratory buildings. Reference to existing standards of design or installation are made in the various sections of these guides so that you will be able to acquire the design details. It has been impossible to provide design detail in this set of standards for reasons of desired brevity.

1. AUTOMATIC SYSTEMS FOR FIRE AND EXPLOSION PROTECTION

Automatic fire and explosion detection and/or protection equipment should be installed in those areas of all laboratory buildings which present special hazards. Due to the nature of the work performed in most laboratory facilities and the nature of the chemicals employed, the hazards of fire and explosion are much greater than in other buildings. Even a small fire in laboratory buildings can cause large losses and laboratory fires have destroyed valuable research equipment, products and data.

As research work increases, the concentration of values also increases and the inherent hazard increases. To maintain control of this fast rising spiral of hazard and values, it is suggested that the use of the following types of protective equipment be considered in all new or remodeled laboratory buildings. The decision as to which type of equipment and how complete an installation is desired or necessary is left to the individual designers. Table 1-1 lists several, but not all, potential hazard areas, and Table 1-2 provides, a list of technical design standards for various protective devices.

TABLE 1-1.
Hazardous Areas Needing Automatic Detection and/or Protection Devices

Flammable liquid storage, repackaging or dispensing rooms.
Chemical stockrooms.
Compressed gas cylinder storage or manifold rooms.
General storage, equipment storage and janitor closets.
Radioactive isotope storage or production areas.
Mechanical equipment rooms, boiler rooms, electrical rooms, transformer vaults, air-handling equipment and battery rooms.
Vertical chutes, ducts, pipe chases which pierce more than one floor.

TABLE 1-1 Continued

Horizontal concealed spaces that pass through fire walls.
Laboratories used for handling infectious, carcinogenic or pathogenic agents.
Laboratories below grade level or without windows.
Laboratories used for special hazard experimentation, such as hydrogenation, use of explosives, rocket propellants, highly toxic gases, etc.

In many hazardous areas, it will be desirable to provide more than one type of protection. For example, flammable liquid rooms should have automatic detection, automatic extinguishing and explosion venting equipment.

TABLE 1-2.
Technical Design Standards for Automatic Systems

Installation of Sprinkler Systems, National Fire Protection Association, No. 13.
Carbon Dioxide Extinguishing Systems, NFPA No. 12.
Chemical Extinguishing Systems, NFPA No. 17.
Foam Extinguishing Systems (high expansion foam), NFPA No. 11.
Water Spray Systems for Fire Protection, NFPA No. 15.
Explosion Venting Guide, NFPA No. 68.
Inerting for Fire and Explosion Prevention, NFPA No. 69.
Installation Standpipe and Hose Systems, NFPA No. 14.
Explosion Suppression Systems, NFPA Handbook.
Factory Mutual Laboratories Engineering Manual, NFPA Fire Protection Handbook.

Fire, Smoke and Combustible Gas Detection Equipment should be installed in accordance with its individual listing in the Fire Protection and Hazardous Location Equipment Listings of Underwriters Laboratories, Inc.

2. EMERGENCY ALARM SYSTEMS

Due to the high fire hazards, explosion hazards and possible escape of toxic, radioactive or bacteriological agents, every laboratory building should be equipped with an emergency evacuation alarm system which sounds within the building.

Since quick response by professional fire fighters or other emergency personnel is highly desired to minimize damage and danger to the surrounding area, remote signaling devices connecting the building alarm system to the local fire or police department or campus security department should be given consideration.

The following emergency signaling or reporting equipment should be provided:

A. Remote signaling systems connecting the emergency evacuation alarm, any automatic detection and/or protection devices to a centrally supervised panel at the fire department, police department or campus security office in accordance with the standards of NFPA No. 72, Proprietory, Auxiliary and Local Protective Signaling Systems.

   Where remote signaling systems are impractical, emergency telephones for use by night watchmen, passerby, where they will be accessible when the buildings are closed. The emergency telephones should connect directly to the emergency offices so that there will be no need to dial or locate a telephone number.

B. Consideration should be given to providing outside emergency telephones for use by night watchmen, passerby, or persons who have evacuated the building.

C. Annunciator panels should be provided for all automatic detection, extinguishing and manual alarm systems in a location easily accessible to the fire department to indicate the location of any detection, extinguishing or manual alarm devices which have operated. Such annunciator panels are important for prompt response to sites of emergencies.

D. Building air conditioning fans should be automatically shut down or switched to total exhaust by the operation of any automatic or manual fire or gas detection, protection or alarm device. Laboratory exhaust systems, fume hoods, etc., should continue to operate unless manually shut down by the personnel in charge of the laboratory.

E. Stairway or other firedoors that are normally held open by electromagnetic devices should be released by the action of any automatic detection, extinguishing or manual alarm device.

F. All fume hoods and spot ventilation equipment should be provided with manual shut off devices so that they can be shut off in case of fire, if such action does not cause additional hazards.

NOTE: Automatic shut down is not recommended for this equipment.

3. SPECIAL FACILITIES FOR CHEMICAL STORAGE, HANDLING, AND DISPOSAL

Special provisions should be made for the handling, storage and disposal of flammable liquids, compressed gas cylinders and hazardous chemicals. The more rapid our scientific advances, the more hazardous laboratory operations become. Our new and remodeled laboratory buildings should be designed with the expected increase in hazard in mind.

A. Flammable liquid storage, repackaging or dispensing should be done in separate buildings, separate but adjacent rooms or in special cut-off rooms designed in accordance with NFPA No. 30, Flammable and Combustible Liquids Code or the Factory Mutual Laboratories Engineering Manual. Bulk storage should be in a remote area.

B. Provision should be made for ease distribution of materials to the laboratories so that excessive storage in laboratories can be prevented. Ideally, such facilities should provide for effective security and distribution control.

C. Provision should be made for safe storage within laboratories in ventilated, fire resistive storage cabinets and safety containers.

D. Provision should be made for the collection, disposal and destruction of flammable liquids, hazardous chemicals and biological wastes within each laboratory facility. The nature of this problem is such that individual analysis of the expected problem is required before a solution can be found. In many instances, a system of collection and remote destruction is the most feasible.

NOTE: In some areas, outside firms can be employed to pick up hazardous wastes.

E. Provisions should be made for storing compressed gas cylinders of a flammable and/or toxic nature outside of the building in an area protected from the weather and easily accessible to the freight elevator. See NFPA No. 58, Storage and Handling of Liquefied Petroleum Gases, for a guide in designing storage facilities. Segregated Storage facilities will be needed for certain gases that should not be stored in the same area or enclosure.

NOTE: The increasing use of tank farms and gas manifold systems for the distribution of the primary laboratory gases via a piped system introduces hazards many architects, engineers and university personnel may overlook. Such systems must be carefully engineered to prevent accidental release of explosive or toxic gases in populated areas or buildings. The general guidelines set forth in NFPA Pamphlets 51, 54, 56, 565, 566, 567 and 58 should be used in determining the safety of such installations. Gas masks, self-contained breathing apparatus, proximity suits and special fire extinguishing equipment should be provided in locations where they will be accessible under emergency conditions.

F. Special hazard laboratories should be provided for work which must be unattended at times or which is so inherently hazardous that it cannot be conducted in the normal laboratory. Special hazard labs should be equipped with automatic fire and explosion protection and detection devices. The rooms should be located on the outer perimeter of the building and have a direct means of egress to the outside. Hydrogenation and high pressure autoclave laboratories represent the type of laboratory which needs special consideration. Such laboratories must be carefully designed with attention given to explosion relief, structural integrity, control of entrance and egress and location within the main structure.

G. A special, well ventilated and protected area should be established for the storage of potentially explosive chemicals such as organic peroxide which should not be stored in flammable liquids storage rooms. Such storage should provide for the segregation of potentially explosive chemicals into reasonably small quantities.

4. SAFETY EQUIPMENT

A. Water-type fire extinguishers (Class A) should be provided in accordance with the standards of NFPA No. 10, Installation, Maintenance and Use of Portable Fire Extinguishers.

In addition to the Class A fire extinguishers, Class B:C (carbondioxide or dry chemical) fire extinguishers should be provided for fighting flammable liquid and electrical fires. Multi-purpose, Class AB:C fire extinguishers can be used instead of providing two different types of extinguishing units. There should be at least one 30 lb. Class B:C or AB:C fire extinguisher and one 5 lb. Class B:C or AB;C fire extinguisher on each floor, and one 5 lb. Class B:C or AB:C fire extinguisher in each laboratory.

Special Class D fire extinguishers should be provided where the use of metals or metal hydrides indicates a need for them.

B. Standpipe and fire hose equipped with adjustable fog nozzles should be installed in accordance with NFPA No. 14, Installation of Standpipe and Hose Systems.

C. Consideration should be given to installing two 30 minute, self-contained breathing masks for alternate floor levels for use in emergency rescue operations. The air masks should be set in permanent cabinets. This requirement is in addition to any specific gas masks that may be provided for use within specific hazardous environments. Gas masks which depend upon filtering, etc. are not acceptable for use in oxygen deficient areas or where concentrations of contaminants exceed the listing on the particular mask.

D. Consideration should be given to providing a proximity suit or suits for fire fighting and rescue operations especially where the local fire department is located some distance away or does not have this equipment.

E. At least one safety shower and eyewash fountain or hose should be installed in each laboratory, or near the entrance to each laboratory. There should be no more than a 50 foot travel distance to such devices from any point in the laboratory. Care should be taken to locate these devices and the actuating mechanisms where they will not be blocked.

F. Each laboratory should be equipped with at least one fire blanket.

G. Each laboratory should have access to a first aid kit. The contents of the first aid kit should be determined by the campus physician. Where hospital facilities and emergency transportation is available, it is recommended that only sterile bandages and compresses be provided.

H. Respirators, ventilated hoods, ventilated suits, etc. should be provided for protection of persons entering areas where infectious disease agents or radioactive isotopes may be or are air-borne under normal conditions or due to accidents.

I. Safety bulletin boards should be placed in the building for communication or safety information and regulations.

5. FACILITIES FOR INFECTIOUS AGENTS AND ANIMALS

Animal handling and infectious agent laboratories, and handling or housing areas should be designed with the prevention of human infection in mind. This is especially important in research areas where the level of possible infection is rapidly increasing. All areas of possible contamination should be well segregated from public areas and provided with a separate positive ventilation system which can be equipped with bacteriological filters. Any make up air necessary for the ventilation of contaminated areas should be introduced from the outside. Table 5-1 lists some of the hazards normally encountered and suggested preventive design features. Close cooperation between lab personnel, safety personnel, environmental health personnel and designers is imperative if adequate protection is to be provided.

TABLE 5-1

Hazard	Preventive Design
Air-borne, aerosol, infectious agents as in laboratories or animal housing rooms.	Ultraviolet lights and/or ventilation, e.g. Ventilated animal cages or cabinets, glove boxes.
Surface borne infectious agents from spills or normal contamination.	Ultraviolet lights, where surface is directly exposed, and easily cleanable walls, floors, ceilings and equipment, e.g. Glazed tile, ceramic tile and stainless steel. Floor drains and wall hydrants should be provided.

TABLE 5-1 Continued

Cross contamination	Segregation of high hazard areas by intervening safe areas or decontamination rooms equipped with showers and lockers. Well defined segregation of ordinary hazard areas with change rooms between them and public areas.
Disposal of infectious waste or carcasses.	Autoclaves for sterilization and an incinerator for disposal.
Contaminated equipment	Autoclaves large enough for cages and enough autoclaves to handle all of the equipment and material without removing it from the contamination area and through public areas. After the material has been sterilized, it should be placed in special containers, sealed and incinerated.
General equipment and supplies.	Each area housing animals, used for the handling, introduction or testing of infectious agents should be equipped with autoclaves, a stock of disinfectant, respirators, and ventilated hoods and/or suits. All floor drains in such areas should be segregated from the main drainage and be equipped with sterilization equipment. A sufficient num-

TABLE 5-1 Continued

ber of refrigerators should be provided for infectious agents so that they will not be left on tables or benches.

TABLE 5-2

References

Glassman, H. N. "Surface Active Agents and Their Application in Bacteriology", Bacteriol Rev. 12:105-48, 1948.

Long, E. R. "The Hazard of Acquiring Tuberculosis in the Laboratory", Am. J. Public Health, 41:782-87, 1951.

Miller, O. T.; Schmitt, R. F.; and Phillips, G. B. "Applications of Germidical Ultraviolet in Infectious Disease Laboratories".

I. Sterilization of Small Volumes of Air by Ultraviolet Radiation, Am. J. Public Health, 45:1420-1423, 1955.

Sulkin, S. E. and Pike, R. M. "Survey of Laboratory Acquired Infections", Am. J. Public Health, 41:469-81, 1951.

General Biological, Chemical and Radiological Safety Regulations, U. S. Army Biological Laboratories, Fort Detrick, Frederick, Md., 1963.

Phillips, G. B. "Microbiological Hazards in the Laboratory", J. Chemical Education, 42:A43-A47, A117-A130, 1965.

Design Criteria for Microbiological Facilities: Fort Detrick, Frederick, Md., is available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151.

TABLE 5-2 Continued

NOTE: It should be understood that this material is included only to alert designers to the possibility of such hazards and that a thorough study is necessary to provide safe facilities. The above references are given so that the individuals involved can better acquaint themselves with this highly technical problem area.

6. LABORATORY VENTILATION

In order to meet the needs of both safety and economy, laboratory ventilation systems must effectively remove airborne toxic and flammable materials and at the same time exhaust a minimum volume of air. Make up air should be supplied to laboratories to replace the air removed by exhaust systems so that such systems work properly, and air exhausted from laboratories should not be recirculated.

Laboratory Hoods:

Laboratory hoods are the most commonly used means of removing gases, dusts, mists, vapors and fumes from laboratory operations, preventing toxic exposures and flammable concentrations, but they are often misused and frequently specified when not really needed. Spot ventilation and special enclosures are other means of capturing or containing gases, vapors and particles effectively while exhausting minimum volumes of laboratory air.

To be effective, a laboratory hood and its associated components must confine contaminants within the hood, remove them through ductwork, and disperse them so they do not return to the building through the fresh air supply system.

Storage of chemicals and gas cylinders in laboratory hoods is a common practice which may be both wasteful and dangerous. If chemicals and cylinders are stored in hoods to guard against leaks, then the hoods should operate 24 hours per day to assure constant exhaust. In addition to the expense of such long operation, storage of chemical containers in hoods will restrict performance by reducing work space and by obstructing air flow so that velocities may be too low to retain toxic materials, within the unit.

Special Storage Cabinets:

Hood performance should be assisted by providing ventilated chemical storage cabinets which will require less air flow and which can be exhausted in a separate system 24 hours every day.

Hood Limitations:

Laboratory hoods are not generally designed to contain explosions of a high order, even though laboratory personnel may think so. For general use, laboratory hoods should be constructed of materials to withstand fire which may occur from flammables, solvents and gases; an enclosure should be able to maintain its integrity and confine a fire until the fire can be extinguished.

Successful performance of laboratory hoods depend primarily on the velocity of air moving through the hood which is affected by cross-currents, entrance shapes, thermal loading, mechanical action of particles, exhaust slot design, and obstructions in the hood. Successful performance also depends on corrosion resistance, cleanability if contaminated, and in some cases the collection of contaminants, such as radioisotopes and pathogens.

Design criteria have been established for hoods in radioactive service, including scrubbers and filters with guages to show pressure drop across the filter as it loads up.

Perchloric Acid Hoods:

Hoods in which hot concentrated perchloric acid is to be used should be used only for that service, should have no exposed organic coating, lubricant, or sealing compound, and should be equipped with a special wash down system in the ducts and back. Safe use may also be accomplished by use of a special scrubber unit which effectively removes acid vapors and mists. Because of the hazards of reactions between hot acid vapors and organic materials, gas and oil should not be used for heating perchloric acid. Perchloric acid hoods and ducts should be clearly labeled to prevent confusion.

Hood Face Velocities:

An adequate velocity of air entering a hood at its face is the basic requirement for capture and control of contaminants generated within a hood, and an entering face velocity of 100 lineal feet per minute for normal openings of general units is recommended. Hoods for highly toxic materials may require face velocities ranging from 125 to 200 feet per minute.

Since cross-currents outside a hood can interfere with the operation by counteracting the capturing velocity, it is important to minimize air currents from doors, windows, pedestrian traffic and air supply grilles.

Design of New Hoods:

Design and specification of new hoods should be based on critical analysis of present ventilation needs and an imaginative analysis of future needs, without restricting design requirements to past custom. Some of the questions that can be asked before specifying new hoods include the following:

a.)Should hoods incorporate automatic fire extinguishing systems?
b.)Should hood benches be 36 inches above the floor, or lower to accomodate tall equipment and to be more convenient and safe for short people?
c.)Are there enough hoods to meet present and anticipated needs?
d.)Are hoods specified when other enclosures would do a better job at less cost?

Each laboratory hood should generally have its own exhaust fan, switch and pilot light; multiple hoods in a laboratory should be inter-connected in some manner so that one may not pull air down through a hood not operating. A good practice is to include all portions of hood design, construction and installation in one lump contract so that the effectiveness of the entire system can be judged. Letting individual contracts for hoods, duct work and electrical work weakens your bargaining position.

Enclosures:

The amount of exhaust air needed for laboratory operation is reduced if the operation can be moved from a hood to a partial or complete enclosure such as a glove box, requiring little ventilation, or a vacuum or inert gas box, which requires almost none.

A glove box can be safely ventilated with an air flow of only 50 cubic feet per minute for each square foot of open area.

Improved safety, great flexibility, and economy are advantages offered by glove boxes and other special enclosures. New laboratories should be designed to provide ventilation connections for such enclosures.

Spot Ventilation:

Spot Ventilation -- exhausting contaminants near their point of origin -- can prevent inhalation hazards from laboratory operations not suitable for enclosure because of bulk, access needs or brief use. Ventilation could be provided for every bench in laboratories where ventilation is imperative but adequate hood space cannot be provided.

New laboratories should be designed to provide special local ventilation and exhaust connections for enclosures.

Access for Service:

Fan and duct designs should provide convenient access ports for inspection and cleaning and should be designed with no constricting sharp bends that require excessive fan horsepower for adequate hood performance.

Provision for control of inhalation hazards is one of the most important functions of a laboratory building and design of the building should allow streamlined ductwork and shaftways large enough for future additions of ductwork.

Duct Material:

Material for hood exhaust ducts should resist corrosion by chemicals and moisture to which the ducts will be exposed and fire should not be able to spread from one duct to another.

Duct Velocity:

A minimum duct velocity of 2000 feet per minute is recommended for vapors and gases; a velocity of 2500-3000 feet per minute is suggested to scavenge condensed moisture. Transport velocities for particulate materials will range from 3500-4500 feet per minute. Good practice would be to determine the appropriate velocity from the Industrial Ventilation Manual.

Fan Location and Exhaust Point:

The best location for hood exhaust fans is on the roof of the building to place the duct system under negative pressure, assuring that any leaks which may develop will not allow contaminants to escape into the building.

Consideration should be given to contamination or air pollution problems which could result from direct discharge of hood exhaust to the atmosphere. There is an increasing need to provide filters, collectors, condensers, scrubbers or other air cleaning equipment.

A laboratory ventilation system with the best hoods and best transport system is a failure if the exhaust returns to the laboratory through windows or the fresh air system. Discharge outlets and discharge velocities should be designed so that exhaust is effectively dispersed and nuisance prevented.

Precautions for Shutdown of Air Supply:

If conditioned air from offices, classrooms and corridors of laboratory buildings, and other air generally uncontaminated by laboratory operations is recirculated, two special precautions should be observed to stop recirculation in case of emergency.

The first precaution consists of automatic equipment, fusible link fire dampers on exhaust louvers and smoke detection equipment which can shut down the entire recirculation system to prevent spread of smoke and fire.

The second precaution recommended consists of a readily accessible control for laboratory fresh air supply or recirculation systems so that laboratory personnel can immediately stop the system in case of an emergency such as a spill or release of toxic radioactive, or flammable materials. The emergency control for the ventilation system should be similar to a fire alarm pull station, properly labelled and connected to the evacuation alarm system.

Monitoring Hood Operation:

Monitoring the operational performance of laboratory hoods is desirable. The first thing to know is whether the hood is operating. A pilot light can be provided to show that the exhaust fan motor has been turned on, or a device can be built to assure that the motor is turning, or a gauge can be installed to indicate that the fan has vanes and is drawing air.

If filters are part of the exhaust system or fan vanes are liable to corrode seriously, a manometer which shows the pressure drop across the filters or in the exhaust duct can be used to judge the need for replacement of the filters or the fan.

No Recirculation:

The exhaust from laboratory hoods, enclosures, and spot ventilators should not be recirculated. The continually accelerating pace of research and development activities and technological progress make it impossible to predict what chemical and reactions will be used in laboratories in the future or what demands will be placed on laboratory hoods.

7. ILLUMINATION

Adequate lighting should be provided to conform with recommendations of the Illuminating Engineering Society:

Office and Lecture Rooms	100 footcandles
Laboratories	200 footcandles
Stairways, Washrooms and Other Service Areas	20 footcandles
Shops	100 footcandles
Precision Manual Arc Welding and Extra Fine Bench and Machine Work	1000 footcandles

An emergency power source should be provided so that exit paths and exit signs will be available even if the commercial power source fails. The emergency power source can also supply fire detection, protection or alarm devices, other emergency equipment, exhaust ventilation and special outlets where electrical power loss may lead to disasterous failure.

8. RADIOISOTOPES

A radioisotope laboratory should be designed like any other work area, primarily for convenience, efficiency and safety in normal operations. But in addition to maintaining control of the hazards inherent in planned materials and processes, it is also important that the laboratory be designed to reduce the likehood of accidents and to ameliorate the consequences and promote return to normalcy if an accident does occur.

With the exception of provisions for radiation shielding, the requirements of a radioisotope lab are essentially not different from the requirements of laboratories handling other dangerous materials such as highly toxic chemicals or contagious pathogens. In many ways radioactive materials differ only in DEGREE from other toxic agents in that: (1) Incorporation or radioactivity in normally harmless materials can render them highly toxic, (2) radioactivity never gives warning by virtue of disagreeable taste or odor, (3) radioactivity cannot be destroyed or neutralized, (4) radioactive material, on a weight or volume basis can be many times more toxic than ordinary toxic materials. However, the toxicity hazards are controlled by essentially the same methods of controlling inhalation, ingestion and contact.

A. By promotion of cleanliness and good housekeeping.
   1. Eliminate dust-catchers, e.g. overhead pipes, ledges, grooves, corners.
   2. Provide smooth, non-porous easily cleaned surfaces on equipment, furniture, floors and walls.
   3. Provide a separate change area (for high hazard labs) for exchange of street clothes for laboratory clothing.

B. By control of ventilation and air circulation.
   1. Establish air flow patterns from cold areas to hot areas, i.e. higher level areas, if possible should operate at a slightly negative pressure with respect to lower level areas.
   2. Use hoods or dry-boxes for operations likely to create air-borne contamination.
   3. Place blowers on hood ducts at exit end of duct so as to maintain negative pressure in duct.

4. Place filters, if used, preferably at entrance end of duct.
5. Utilize a common duct and blower when two or more hoods are in one room. If separate ducts and blowers are used, the blowers should be wired to a common switch to insure simultaneous operation (continuous operation is preferred otherwise downdrafts and cross contamination are probable.
6. Design room ventilation supply free of strong drafts - especially near hood faces.
7. Separate exhaust outlets a sufficient distance from ventilation intakes.

C. By control of waste disposal.
1. Select corrosion resistant and break resistant components for sinks and plumbing.
2. Install hold-up tank where necessary.
3. Select waste containers to minimize handling of waste. Choose disposable containers or those with disposable liners.
4. Provide special features or equipment when necessary for handling of animal waste and carcasses in radiobiological laboratories.

D. Shielding may be required for:
1. Work areas.
2. Storage.
3. Hood ducts and filter boxes.
4. Plumbing.
5. Doors and walls common to other areas.

E. Shielding sometimes requires additional structural support incorporated into walls, floors and furniture.

Design of hot labs is a specialized subject on which the available references should be consulted.

9. EGRESS FACILITIES

Each laboratory or other potentially hazardous area should have two exits as remote from each other as possible. Laboratory benches and other equipment should be arranged to facilitate egress and visibility from the corridor with small wired glass panels. Doors from labs to corridors should be at least 36 inches wide, have school type hardware, be openable from lab without a key, and be so designed that they can swing safely in the direction of egress without swinging more than 12 inches into the corridor. Maximum distances to exits should be 75 feet.

10. FIRE RESISTANCE

Walls, doors and windows between laboratories and corridors should have a minimum fire resistance of 3/4 hour, as determined by fire test ratings.

11. WATER SUPPLY AND PIPING

Laboratory water supplies should be suitably designed so that the drinking water supply will not become contaminated. (If there are separate supplies, the potable and non-potable outlets need to be clearly identified.) All plumbing fixtures equipped for hose connections should have anti-siphonage devices installed.

Consideration should be given to providing an emergency water supply where ever pressure failure would create hazards, e.g. condensers, cooling water, eyewashers.

12. MISCELLANEOUS DESIGN FEATURES

Office and individual laboratories should be separated with offices nearer the corridor.

Each laboratory should have one sink supplied with hand washing materials so that persons using the lab can conveniently remove toxic materials before putting on street clothes or going out of the laboratory for drinking coffee, eating or smoking.

The number of researchers working in a single research laboratory space should be limited with a preferable minimum of two and preferable maximum of four.

Laboratory hoods should be equipped with safety glass sash --horizontal sliding panels no wider than 16 inches is preferred. Laboratory benches should be designed so that safety glass shielding is facilitated (Since all reactions under pressure or vacuum should be shielded). (Double lab benches where persons may work opposite each other should be shielded.) Double lab benches where persons may work opposite each other should be provided with safety shielding (safety glass would minimize interference with lighting and would permit observation of reactions which may be temporarily unattended.)

Safety centers where electrical, gas, steam, air and other utilities can be shut off should be located outside the laboratory rooms.

Provisions for hanging coats so that they do not obstruct safety equipment or egress should be made. Hanging coats in halls is not recommended.

Steam outlets on benches should be aimed downward. Valves for gas, steam and air should be of the type that indicates at a glance if the valve is open. One gas outlet in each lab should be fitted with a check valve to prevent oxygen being introduced into gas lines in glass blowing operations. All valves should be consistently color coded and where possible shape coded to reduce confusion in use.

AREAS OF INTEREST listed by current members of the Campus Safety Association include:

- Accident reporting and analysis
- Organization and administration of safety programs
- Agricultural, rural and farm safety
- Aquatics and small watercraft safety
- Safety in athletics, physical education and recreation
- Safety in the design, construction and maintenance of buildings and grounds
- Civil defense and disaster preparedness
- Driver education and traffic safety
- Accident prevention in elementary and secondary schools
- Employee safety programs
- First Aid: instructions, emergencies
- Fire: detection, prevention, etc.
- Firearm safety
- Food service safety
- Housing, home safety
- Health service, hospital safety
- Inspections, fire, general, special
- Industrial and shop safety education
- Industrial shop: machine guarding
- Insurance and Workmen's Compensation
- Junior college safety programs
- Laboratory and chemical safety
- Occupational disease
- Personal protective equipment
- Safety in the handling of radioactive materials
- Safety in research operations
- Safety in student activities
- Traffic: fleet, parking, pedestrian

Completed projects of the Association include cooperation in the development of Off-Campus Housing Standards, co-sponsorship of a National Seminar on Campus Safety, service on a National Committee on Civil Defense on the Campus, publication of a Laboratory Safety Newsletter and stimulation of members to produce monographs on Campus Safety and several surveys on Campus Safety Administration and Management.

Current projects include the publication of a Campus Fire Safety Guide, a system for the reporting of accidents, and planning regional courses on Campus Safety.

You are cordially invited to join with the Association in an effort to improve the safety on the campuses of colleges and universities. Committees of the Campus Safety Association include:

Accident Reporting
Campus Building Design
Campus Fire Safety
Campus Insurance
Campus Vehicle Safety
Conference Site
Contributing Editor - Newsletter
Course Advisory
Course Planning
Disaster Preparedness
Editor, Laboratory Safety Newsletter
Insignia
Laboratory Safety
Annual Conference Exhibits
Annual Conference Host
Annual Conference Program
Nominations and Elections
Personal Protective Equipment
Publications
Radiation Safety
Representative to Gas Cylinder Assoc.
Resolutions
Small Colleges
Student Housing

For further information on the Campus Safety Association, please contact Staff Representative, School and College Division, National Safety Council, 425 No. Michigan Avenue, Chicago, Illinois 60611.