The following paragraphs describe the architectural and engineering design criteria that are important in planning a laboratory building. For specific room requirements refer to section E, Room Data Sheets.

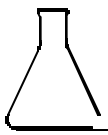
D.1 Equivalent Linear Measurement

ELM is the minimum quantity of work space which is required to safely conduct biomedical research. Based on a survey of 37 existing laboratory branches at the NIH (approximately 20,000 m^2), minimum guidelines were established for the length of the laboratory bench, laboratory equipment (including storage), desk space, chemical fume hoods, and BSCs. The following criteria provide minimum guidelines for the required ELM per laboratory occupant:

Bench and Equipment (including storage)	6500 mm ELM
Chemical Fume Hood and BSC	750 mm ELM
Desk Space	2000 mm ELM
Total: Per Lab Occupant	9250 mm ELM

The primary occupants of the laboratory are considered to be researchers who spend more than 50% of their time in the laboratory. These may be scientists, lab technicians, visiting fellows, or students.

These values are only guidelines and are not absolute. Specific user programming is required to verify actual requirements.

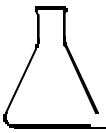


D.2 Area Allowances

Gross Area Allowance: The gross building area, which includes circulation, building core, wall thickness, and utility space, will exceed the net assignable area by a grossing factor. A grossing factor of 1.7 to 2.0 is typical for research laboratories depending on internal circulation patterns and utility distribution choices. By taking the net assignable area and multiplying by the grossing factor, a projected gross area is established. This gross area must be verified when actual plans are developed.

Net Area

Net Assignable

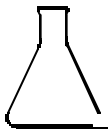


D.3 The Laboratory Module

After extensive discussions with researchers and analysis of existing laboratories at the NIH, it was determined that an appropriate laboratory module width of 3,350 mm will accommodate bench, equipment, and aisle widths needed for research. The size of the aisle is the critical factor in the determination of module width.

The depth of the laboratory module is determined by the ELM of work space, circulation space, chemical fume hood quantity and location, door recesses, office locations, desk locations, secondary exits, and the structural systems. The result of the NIH's analysis in this regard has determined that a multiple of 3,350 mm (3,350 mm, 6,700 mm, 10,050 mm) is the appropriate depth for its future laboratory modules.

Floor-to-floor heights will be driven by the utilities distribution scheme (vertical chase, service corridors, interstitial levels, etc.), selected for the specific building. Typical dimensions are 4,600 mm to 5,200 mm for floor-to-floor heights and up to 6,400 mm where interstitial levels are used.



D.4 Laboratory Furniture and Equipment

D.4.1 Casework

Metal casework systems shall be utilized in the NIH's laboratories. Casework will conform to NIH Standard Specification #12347. Built-in casework shall be minimized. Shelving height is not to exceed 2,200 mm. Casework shall be sealed to walls and floors during installation. Racked equipment, mobile casework on "wheels," or other options which minimize costs and maximize flexibility shall be considered due to the tremendous changes in research requirements.

Countertop materials will vary depending upon usage (refer to NIH Standard Details for dimensions). Typically chemical-resistant, plastic laminates will be used. Epoxy resin will apply for most applications where corrosive chemicals are used or where sinks or heavy water usage occurs. Stainless steel shall be used for radioisotopes, perchloric acid, glassware washing, cold rooms, and solvent usage.

D.4.2 Chemical Fume Hoods and Biological Safety Cabinets

Chemical fume hoods may be constant-volume or variable-volume exhaust hoods depending on user and facility management considerations of function, first cost, and life cycle cost issues. All containment devices must be located in the laboratory to avoid entrapment, blocking of egress, or safety hazard to the lab occupant. For correct positioning of the Laboratory hood, the designer must follow the design methodologies to evaluate the likely hood containment performance detailed in NIH publication "Methodology for Optimization of Laboratory Hood Containment".

Chemical fume hoods will operate continuously and must achieve a face velocity of 0.51+/-0.10 m/s with a uniform face velocity profile of +/-10% of the average velocity with the sash fully open. Both constant volume and variable volume Fume Hoods are acceptable The bypass shall be designed so face velocity does not exceed the maximum as the sash is lowered in variable volume hood. Variable Volume Fume Hood protocol of a 1800 or 1200 mm shall be tested in accordance with modified ASHRAE 110 Test

for minimum base line requirements for the successful fume hood control system at the manufacturer's state of the art test facility meeting the requirements of SAMA standards LF10-1980 or latest on his cost for acceptance by NIH prior to delivery of hoods for installation. The minimum of 50% installed hoods at site will be again offered for testing on site by the contractor after installation and building balance prior to occupancy. Contractor shall arrange to conduct these testing by an NIH approved independent testing contractor.

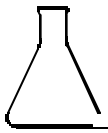
Chemical fume hoods must have a pressure-independent flow-monitoring device connected to a local audio alarm within the laboratory. Investigators shall be consulted regarding sash preference. A combination sash provides energy efficiency with the advantages of a vertical sash hood. Special hoods, such as canopy hoods, shall be coordinated with the NIH Division of Safety.

Except for exhaust from special hoods such as those for perchloric acid and radioisotope, chemical fume hood exhaust shall be combined with general laboratory exhaust.

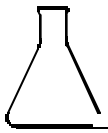
BSCs are available in several classifications. Class II, Type A, and Class II, Type B1 or B2, will typically be government-furnished equipment, supplied by the NIH. Class II, Type A, typically used at the NIH, is suitable for work with microbiological research in absence of volatile or toxic chemicals and is designed to recirculate high-efficiency particulate air (HEPA)-filtered air back into the laboratory. Class II, Type B1, exhausts most of the air to the exterior. Class II, Type B2, exhausts all of the contaminated air to the exterior. This type of BSC is not typically used at the NIH. NSF 49 and NIH Criteria and Standard Details regarding BSCs shall be used.

D.4.3 Equipment

A wide variety of laboratory equipment is used in NIH laboratories. The goal is to create adaptability in laboratory space so that instruments can be relocated within the laboratory without altering the space, or its attendant utility systems, or without compromising the operation of the instruments or safety of the users.



Some instrumentation rooms, electron microscopy suites, MRI spectroscopy suites, X-ray crystallography suites, and mass spectrometry rooms require special utilities and environmental controls.



D.5 Architectural Finishes and Materials

Materials selected for the construction of laboratories must be durable and cleanable, and contribute to the creation of a comfortable, productive, and safe work environment. Design features shall promote cleaning, maintenance, and better storage while minimizing pest access. Selection of materials and penetrations through walls and floors shall be coordinated with the NIH Division of Safety. For additional criteria see Section D.14, Fire Safety.

D.5.1 Floors

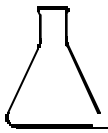
Floor materials must be nonabsorbent, skidproof, resistant to wear, and resistant to the adverse effects of acids, solvents, and detergents. Materials may be monolithic (sheet flooring) or have a minimal number of joints such as vinyl composition tile (VCT) or rubber tile. The base may be a 100 mm vinyl or rubber material (if readily cleanable) with an integral cove base when sheet vinyl flooring is used.

D.5.2 Walls

Wall surfaces shall be free from cracks, unsealed penetrations, and imperfect junctions with ceiling and floors. Materials must be capable of withstanding washing with strong detergents and disinfectants and be capable of withstanding the impact of normal traffic. Corner guards and bumper rails shall be provided to protect wall surfaces in high traffic/impact areas.

D.5.3 Ceilings

Ceilings such as washable lay-in acoustical tiles shall be provided for most laboratory spaces. Ceiling heights shall be 2,900 mm in laboratory and laboratory support spaces and a minimum of 2,440 mm in administrative spaces. Gypsum board with epoxy paint and equipped with access panels will be provided in glassware washing and autoclave rooms, where the potential for high moisture exists.



D.5.4 Windows and Window Treatment

Windows shall be nonoperable and must be sealed and caulked. Treatments shall meet all functional and aesthetic needs and standards. All selections shall be coordinated with other interior finishes. Light-tight treatments will be provided in conference rooms, laboratories, and other spaces that may need to be darkened. Window systems shall use energy-efficient glass. Consistent visual appearance on the exterior of the building shall be maintained by the type of window treatment selected.

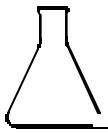
D.5.5 Doors

Doors into laboratories along a service corridor shall be 1,200 mm wide with 900 mm active leaf and 300 mm inactive leaf. The door along the personnel corridor shall be a single-leaf 900 mm door. In the event no service corridor is planned, a double-leaf door along the personnel corridor is desirable. Doors shall be at least 2,100 mm high. In laboratories where the use of larger equipment is anticipated, wider/higher doors or removable transoms shall be considered. Laboratory doors shall be recessed and swing outward in the direction of egress. They shall be provided with locks and closers for security/safety. Doors assemblies shall comply with all appropriate codes.

D.5.6 Door Hardware

Laboratory doors, keys, kickplates, hardware, hinges, etc. shall comply with NIH guidelines and standard details. Vision panels shall be provided in the active leaf of laboratory doors.

The key system design shall be reviewed through the NIH Division of Security Operations, Crime Prevention Branch, Locksmith Unit. Such coordination is to be completed prior to submitting the hardware schedule to the Contracting Officer. The key and lock system shall be based on several levels of master keys. Grand masters and great-grand masters shall be provided for functional zones and modules. Master keys shall not be capable of opening computer areas.



Room door-lock keys and day-lock combinations, where applicable, are special keys and shall not be mastered.

Doors to the exterior of the building that are also used as part of a means of egress (exit) will be readily operable from the inside of the building. When security devices are to be provided on egress doors, they are normally designed to unlatch upon loss of power (fail safe). In some buildings at the NIH, it is desirable to have the latching device remain in place upon a power failure (fail secure). In either case, the determination of whether the device will be fail safe or fail secure will be made by the NIH Division of Security Operations and the NIH Division of Safety, Fire Prevention Section with input from the users.

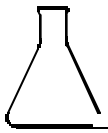
Any plan or specification for each new or modified door must be submitted to the following:

Division of Security Operations, Crime Prevention Branch
Room B3Bl6, Building 31
Phone (301) 496-9818

and

Division of Safety, EMB, Fire Prevention Section,
Building 15G-2
Phone (301) 496-0487

Keys are to be turned over to the Project Officer, who will give them to the Locksmith Shop.



D.6 Structural

D.6.1 Vibration

An analysis of vibration response of the structure shall be made. Consideration must be given to vibration of floor-framing systems caused by mechanical and electrical equipment such as pumps, chillers, fans, emergency generators, and transformers and other sources such as foot traffic, parking garage traffic, and movement of heavy equipment.

Because vibration can interfere significantly with sensitive laboratory instruments, designers must take every opportunity to control vibration and to locate vibration sources away from activities sensitive to vibration. Specific vibration recommendations shall be made by an experienced vibration consultant. Steel structures shall not be precluded for use in structural design relative to vibration without analysis.

To control vibration transmitted into laboratory space, the Architect/Engineer shall consider the following items during the early design phases.

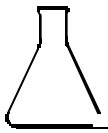
- The structural system shall be relatively stiff so that any vibration that is transmitted occurs at high frequencies. Vibrations occurring at higher frequencies are more easily dampened with instrumentation vibration dampening systems and isolation tables than vibrations occurring at lower frequencies

- The structural system shall have relatively short column spacing

- Laboratory spaces shall be isolated from sources of vibration

- Vibration-sensitive equipment shall be located on grade-supported slabs

- On framed floors, vibration-sensitive equipment shall be located near columns



- On framed floors, the combining of corridors and laboratory spans in the same structural bay shall be avoided

D.6.2 Module/Bay Size

The dimension of the structural bay, both vertical and horizontal, must be carefully evaluated with respect to the laboratory planning module, mechanical distribution, and future expansion plans. Due to the importance of the laboratory-planning module to functional and safety issues, the laboratory planning module shall be considered as the primary building module in multiuse facilities.

The horizontal dimension of the structural bay must be a multiple of the laboratory-planning module dimension to provide for maximum flexibility and regular fenestration, and to allow uniform points of connection for laboratory services with respect to the laboratory planning module.

Columns must not fall within the laboratory-planning module to prevent interference with laboratory layouts and cause inefficient use of valuable laboratory space.

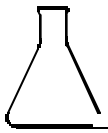
Close coordination between structural and mechanical disciplines is critical to minimize interference of piping and ventilating systems with the structural framing.

D.6.3 Floor Slab Depressions

Floor depressions and/or topping slabs will be evaluated for use in special-finish areas or areas exposed to materials that may deteriorate the structural floor slab. Floor depressions shall be reviewed for equipment requirements to allow for ease of movement of equipment.

D.6.4 Equipment Pathway

The potential routing or pathway for the addition or relocation of heavy equipment shall be reviewed and identified during the design phase.



D.7 Heating, Ventilation, and Air Conditioning

HVAC systems must be responsive to research laboratory demands. Temperature and humidity must be carefully controlled. Systems must have adequate ventilation capacity to control fumes, odors, and airborne contaminants, permit safe operation of fume hoods, and cool the significant heat loads which can be generated in the lab.

HVAC systems must be both reliable and redundant and operate without interruption. There shall be no exceptions. Fume hoods will operate continuously. HVAC systems must be designed to maintain relative pressure differentials between spaces and must be efficient to operate, both in terms of energy consumption and from a maintenance perspective. Federal energy standards must be achieved. An energy monitoring control system shall be provided. Studies shall be conducted during the design phase to determine the feasibility of utilizing heat-recovery systems in research laboratory buildings.

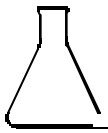
Laboratory noise, much of it generated by HVAC systems, shall be maintained at a NC between 40-45 dB.

D.7.1 Building Design Considerations

The Project Engineer shall include at the completion of the schematic design phase a Basis of Design report. The report shall be a bound presentation with documentation sufficiently complete to justify the complete design concept of the architect/engineer. Detailed building design criteria, computations, schematic system diagrams, economic analysis, and life cycle costing comparisons shall be included as a part of the Basis of Design report. For specific requirements see the Reference Materials, Section I, A/E Checklist.

D.7.2 Energy Conservation

The International Energy Conservation Code shall be utilized to regulate the design and construction of the exterior envelopes and the selection of HVAC, service water heating, electrical distribution, lighting systems, and equipment required for the purpose of effective use of energy, and shall govern all buildings and structures erected for human occupancy. When requirements of the energy conservation code cannot be satisfied because of program requirements, the NIH Project Officer shall be notified.



At the completion of the design development phase, a plan review record as defined in the International Energy Conservation Code shall be submitted stamped and signed by a licensed professional engineer showing full compliance with the code.

Minimum system insulation thicknesses shall be as required by the energy conservation code and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommendations. The minimum thickness in all applications shall be sufficient to prevent condensation.

The quality of the building environment shall be supportive of the health and safety of building occupants. Opportunities for conserving energy resources shall not compromise health and safety issues nor hinder continuous research functions.

Effective energy management requires close, consistent control of all energy-consuming systems and components. Evaluations of heat reclamation alternatives shall be compared to systems employing no heat recovery or energy conversation components. The capital cost, energy cost, maintenance cost, and payback period of the heat reclamation systems shall be evaluated for use at the NIH.

D.7.3 Systems Economic Analysis

The purpose of the economic analysis is to determine the comparative life cycle costs of various HVAC system alternatives. The analysis shall provide sufficient data to indicate the most economical and energy-efficient system and to permit a comprehensive review of all computations. The analysis shall include and compare the total initial capital cost, energy cost, operating cost, system reliability, flexibility, and adaptability for each alternative. Each system alternative considered shall satisfy completely the program requirements as to flexibility, redundancy, reliability, and ease of maintenance. The total capital cost to provide the program requirements for each alternative shall be included as part of the life cycle cost.

D.7.4 Outdoor Design Conditions for the NIH, Bethesda

For facilities whose purpose is laboratory research and for HVAC systems requiring 100% outside air, outdoor design conditions shall be as follows:

Summer: 35 ^{o}C dry-bulb and 25.7 ^{o}C wet-bulb, 12 km/h wind
Winter: Minus 11.6 ^{o}C dry-bulb, 10.8 km/h wind
Latitude: 39 N, daily temperature range: -8 ^{o}C

All other facilities such as office buildings, administrative facilities, and noncritical HVAC systems not requiring 100% outdoor air will use the values recommended by current ASHRAE *Handbook of Fundamentals* to conform with the following:

Summer: 1% design dry-bulb
1% design wet-bulb

Winter: 99% design dry-bulb

The design wet-bulb temperature for sizing cooling towers shall be 1^{o} higher than the ASHRAE 1% outdoor design wet-bulb temperature.

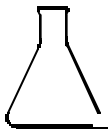
All outdoor air-cooled condensing equipment shall be designed and selected based on a 41 ^{o}C ambient temperature.

D.7.5 Indoor Design Conditions

The following indoor design conditions shall be used in the design of research laboratories except as explained below. Laboratory areas shall be maintained at the design conditions at all times.

Summer: Temperature 23 ^{o}C +/- 1 ^{o}C
% Humidity 50% +/- 5% relative humidity

Winter: Temperature 23 ^{o}C +/- 1 ^{o}C
% Humidity 40% +/- 10% relative humidity



In some special cases, there are NIH laboratories that require special temperature and humidity control. The Design Engineer

shall review and check the Program of Requirements for each laboratory room with the NIH Project Officer and the researchers prior to the initial design. The A/E shall design the systems and select the equipment to include all the requirements.

D.7.6 Air Quality

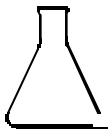
HVAC systems must maintain a safe and comfortable working environment and be capable of adapting to new research initiatives. In addition, they must be easy to maintain, energy efficient, and reliable to minimize lost research time.

Adequate access shall be provided for periodic maintenance and cleaning of coils, humidifiers, and drain pans. Drain pans shall be designed and installed for proper and immediate drainage of condensed water. A proper hydraulic head shall be provided for drains within positive and negative air plenums to insure drainage and prevent overflow. Condensate drain piping shall have a minimum slope of 21 mmper metal and be minimum 20 mm in size.

The floor of outdoor air areaways shall be sloped approximately 8% to ensure prompt drainage of rain and snow.

Outdoor air intakes shall be located as far as practical (on directionally different exposures) but not less than 9.0 m from exhaust outlets of combustion equipment stacks, cooling towers, ventilation exhaust outlets from the building or adjoining buildings, vacuum systems, plumbing vent stacks, or from areas that may collect vehicular exhaust and other noxious fumes. The bottom of outdoor air intakes serving central systems shall be located as high as practical but not less than 1.8m above ground level, or if installed above the roof, 1.0 m above the roof level.

Exhaust outlets shall be located a minimum of 3.0 m above ground, away from occupied areas or from doors and operable windows. The preferred location for exhaust discharge is above roof level. Care must be taken in locating highly contaminated exhausts and discharges from engines, fume hoods, BSCs, kitchen hoods, and paint booths. Prevailing winds, adjacent buildings, and discharge velocities must be taken into account to insure that discharge is not entrained within an outdoor airstream.

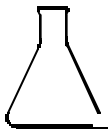


Laboratories containing harmful substances shall be designed and field balanced so that air flows into the laboratory from adjacent (clean) spaces, offices, and corridors. This requirement for directional airflow into the laboratory is to contain odors and toxic chemicals, i.e., negative pressurization. Air supplied to the corridor and adjacent clean spaces must be exhausted through the laboratory to achieve effective negative pressurization. Laboratory HVAC systems shall utilize 100% outdoor air, conditioned by central station air-handling systems to offset exhaust air requirements. Laboratory supply air shall not be recirculated or reused for other ventilation needs.

The use of exposed fiberglass or any fibrous material that allows fibers to break off into the airstream for interior lining or insulation is prohibited for ductwork and air-handling units. Sound attenuators with suitable linings or other approved means of noise control shall be used where required. Insulation and vaporseal insulation shall be installed on the outside of ductwork to prevent condensation.

Building HVAC systems shall be designed to provide a purge cycle during building start-up and when future renovations occur. The purge cycle employs 100% outdoor air to ventilate away fumes and odors generated by construction materials, furnishing, and finishes. The A/E shall develop in the design phase a formal start-up and commissioning procedure that addresses indoor air quality requirements.

The filtration necessary for supply air depends on the activity in the laboratory. Conventional chemistry and physics laboratories commonly have 85% efficient filters, based on ASHRAE Standard 52-76 Test Method. Biomedical laboratories usually require 85% to 95% efficient filters. HEPA filters shall be provided in special laboratories where research materials are particularly susceptible to contamination from external sources. HEPA filtration of the supply air is considered necessary in only the most critical applications, such as environmental studies, dust-sensitive work, and electronic assemblies. In many instances, BSCs (which are HEPA filtered), rather than HEPA filtration for the entire room, are satisfactory. HEPA filtration shall be provided as required by the Program of Requirements for individual applications.



Supply air for all laboratory systems shall be filtered on the upstream side of fans with 30% efficient prefilters and 95% efficient afterfilters.

Exhaust air, in general, does not require filtration or scrubbing. However, in special laboratories using radioisotopes, or certain hazardous chemicals or in biocontainment laboratories, exhaust air may require special scrubbing or filtration before entering the combined laboratory exhaust system or discharging to the atmosphere. The A/E shall consult with the NIH Division of Safety, Radiation Safety Branch, for specific requirements.

D.7.7 Air Distribution

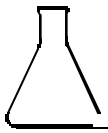
Air supplied to a laboratory space must keep temperature gradients and air turbulence to a minimum, especially near the face of the laboratory fume hoods and BSCs. Air outlets must not discharge into the face of fume hoods. Also, cross-flows that impinge on the side of a hood more seriously alter airflow than do cross-flows in front of the hood. Large quantities of supply air can best be introduced through perforated plate air outlets or diffusers designed for large air volumes. The air supply shall not discharge on a smoke detector, as this slows its response.

D.7.8 Relative Pressurization

Laboratories must remain at a negative air pressure in relation to the corridors and other nonlaboratory spaces. Laboratory air shall flow from low-hazard to high-hazard use areas. In general, laboratories shall be maintained at 47 L/s per module negative relative to nonlaboratory spaces. Administrative areas in laboratory building must always be positive with respect to corridors and laboratories.

Corridor supply air distribution shall be sized to offset transfer air to laboratories while maintaining an overall positive building pressure. Loading and receiving docks must be maintained as positive to prevent the entrance of vehicle fumes.

Some laboratories, such as biohazard containment laboratories and tissue culture laboratories, require control of relative pressurization. The HVAC system must be capable of achieving



these special relative pressure requirements, which are discussed in the CDC/NIH publication *Biosafety in Microbiological and Biomedical Laboratories*.

D.7.9 Air Balance

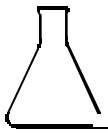
Control of airflow direction in research laboratories controls the spread of airborne contaminants, protects personnel from toxic and hazardous substances, and protects the integrity of experiments. In these facilities, the once-through principle of airflow is applied based on (1) exhausting 100% of the supplied air; (2) maintaining the required airflow with all exhaust units operating at capacity; and (3) providing directional flow of air from areas of least contamination to those of greatest contamination. Determinants for air pattern control are (1) the type of research materials handled or generated in each space; (2) the type, size, and number of laboratory fume hood, BSCs, and auxiliary exhaust equipment in each space; and (3) permissibility of air transfer into or out of spaces.

For critical air-balance conditions, a personnel entry or exit airlock provides a positive means of air control. An airlock is an anteroom with airtight doors between a controlled and uncontrolled space. The air pattern in the airlock suits the foregoing laboratory space air-balance requirements.

Supply air quantities are not fully established by the room-cooling requirements and load characteristics. Additional supply air required to make up the differences between room exhaust requirements and primary supply may be designated (1) infiltrated supply, if induced indirectly from the corridors and other spaces or (2) secondary supply, if conducted directly to the room.

D.7.10 Ventilation Rates

The ventilation rate for laboratory HVAC systems is driven by three factors: fume hood demand, cooling loads, and removal of fumes and odors from the general laboratory work area. The minimum air-change rate for laboratory space is six air changes per hour regardless of space cooling load. Some laboratories may require significantly higher rates to support fume hood demand or to cool high instrument heat loads in equipment laboratories.



Implementation of a recirculative-type HVAC system for administrative areas may be utilized for energy conservation. Recirculating air systems shall provide ventilation conforming to ASHRAE Standards and must not affect the pressurization and balance between laboratory and administrative zones. Recirculating systems shall be completely separate from 100% outdoor air laboratory systems.

In the design of HVAC systems for laboratory areas and the use of recirculating systems for administrative areas, the question of future flexibility becomes an ever increasing and important question. It is imperative that the design A/E do in-depth programming and planning and that the research personnel be informed that administrative areas do not have flexibility for conversion into soft lab space unless this is a planned function and the area is designed accordingly.

D.7.11 Heating and Cooling Load Calculations

Complete design load calculations and a moisture control study shall be prepared for each space within a design program and presented in a similar format to that outlined in the latest ASHRAE *Handbook of Fundamentals.* Heating and cooling load calculations are required for all projects to facilitate review and provide a reference for system modifications. Individual room calculations shall be generated and summarized on a system basis and presented with a block load to define the peak system load. Load summary sheets shall indicate individual rooms with area, design air quantity, L/s per m^2, air changes per hour, and corresponding return or exhaust air quantity. Calculations shall include but not be limited to indoor and outdoor design parameters, heat gains and heat losses, supply and exhaust requirements for central systems and for each area of the facility, humidification and dehumidification requirements, and heat recovery. As a reference, calculations for assessing heating and cooling loads may include but are not limited to the following:

<u>Sensible Heat Loads</u>:
Walls, external, external chases
Roofs and skylights
Floors, when above unconditioned spaces
Ceilings, when below unconditioned spaces

Partition, when next to unconditioned spaces
People, sensible
Animals, sensible
Lights, room, and task
Internal equipment and personal computers
Supply, return, and exhaust fan heat
Infiltration
Makeup and ventilation air requirements
Auxiliary air requirement

Latent Heat Loads:
People, animals, internal equipment infiltration
Makeup and ventilation air requirements
Auxiliary air requirements

All heating and cooling load calculations shall include a predetermined safety factor to compensate for load inaccuracies, future flexibility, infiltration, and air leakage. Safety factors shall be clearly defined in the Basis of Design report.

D.7.12 Building Solar and Conduction Loads

The Design Engineer shall provide a thorough review of all building construction components to accurately calculate the resultant R and U values for the various construction conditions. Calculations shall include a sketch of the construction condition and a written description of where the condition exists. Component R values used shall be referenced as to their source and, where possible, tied to project specification. R and U values, shading coefficients, vapor transmission values, transmittance, doors, windows, and skylights shall be selected by the A/E and accurately defined in the project specification.

D.7.13 Lighting Loads

The HVAC system shall provide as a minimum capacity the following heat loads generated by room and task lighting:

Laboratories:
Task lighting: 250 W/person
Room lighting: 32 W/nm^2

Offices:
Task lighting: 250 W/person
Room lighting: 32 W/nm^2

Corridors: 11 W/nm^2

D.7.14 Occupancy Loads

In the absence of more specific program requirements, the following occupancy loads shall be used as a general guide for HVAC calculations during the facility design. The A/E shall review the actual occupancy load and these general loads with the NIH Project Officer prior to starting the HVAC design work.

Offices: 7 nm^2 per full-time employee (FTE)

Laboratories: 10 nm^2/FTE

Laboratory support areas, constant temperature rooms, autoclave rooms, glassware washing rooms: 22 nm^2/FTE

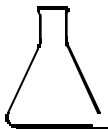
D.7.15 Ventilation Load

Laboratory/laboratory support: 6 air changes per hour minimum

Office/administrator support: 9 L/s per person minimum

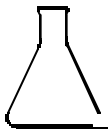
D.7.16 Laboratory Equipment Cooling Loads

The central HVAC system shall provide as a minimum cooling for 1,892 W of laboratory equipment per lab module or cooling for the actual calculated load, whichever is greater. NIH experience has shown that for a typical 22 nm^2 laboratory module, the equipment load is usually 1,892 W (sensible heat) or 86 W per nm^2. The Design Engineer shall make a detailed and complete inventory of all laboratory equipment scheduled for installation in each design space, and using estimated utilization factors, determine the projected equipment load requirement. Equipment utilization factors shall be indicated in the Basis of Design report.



The Designer shall carefully evaluate the following rooms used for laboratory support, which often have higher than normal cooling loads, as well as evaluate the use of supplemental units to remove excessive sensible loads affecting these areas while maintaining minimum ventilation requirements.

Common equipment rooms
Autoclave rooms
Glassware washing rooms
Cage and rack washing rooms
Darkrooms



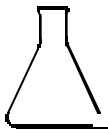
D.8 Plumbing, Waste, and Fire Protection

The plumbing systems shall be coordinated with the laboratory planning module. A piping distribution method, including mains, risers, and branch lines, shall be designed to accommodate easy service isolation and system maintenance while minimizing disruption to laboratory functions. Emergency isolation valves must be conveniently located on branch lines so that segments can be taken off line quickly in the advent of failures.

Piping systems shall be designed for flexibility and have redundant components to provide reliable and continuous operation. Adequate fluid temperature, pressure, and volume must be delivered to required laboratory functions through conservatively sized pipe mains. Future capacity allowances need to be considered in building designs.

Floor penetrations in laboratory areas shall be avoided. All required penetrations shall use raised sleeved openings sealed and caulked to prevent leakage and maintain the fire rating of the slab.

Building services such as centralized bottled gases, compressed air, etc., that are needed by the researcher shall be considered in the design for modular systems and services for the facility. Manifolding of gases and the decentralization of some services can be evaluated.



D.9 Electrical

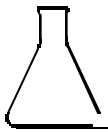
D.9.1 Normal Power

The following load figures in voltamperes per square meter shall be used in calculating and sizing the overall building load. These figures are connected load and shall be used in the early design stages. Actual design loads shall be used in the later part of the design. The range provided allows for varying intensity of usage. The mechanical loads do not include chilled water or steam generation, which are produced centrally on the NIH campus. The engineer shall use sound judgment in applying these numbers.

Load	VA/m^2
Lighting	27 - 38
Receptacle	48 - 215
HVAC	97 - 108
Lab Equipment	43 - 86
Elevators	11 - 16
Miscellaneous	11 - 22
Total Range	237 - 485

Laboratories shall have a surface metal raceway mounted above all benches and as otherwise required in the room. The power duct shall have a continuous 60 A, 120/208 V**,** 3 phase, 4 wire plus ground circuit installed. Twenty ampere taps as needed shall serve receptacles via 20 A single pole circuit breakers mounted in the raceway. Receptacles connected to this circuit shall be ivory in color. Receptacles shall be mounted 600 mm on center in a continuous raceway above laboratory benches. Receptacles mounted within 1m of water dispensing shall be ground fault interrupter (GFI) type. One 60 A 3 phase, 4 wire circuit minimum shall serve a 3350 mm by 6700 mm laboratory module.

Two 20 A circuits per lab module for computers with a maximum of three duplex receptacles each. These computer receptacles shall be gray in color. One 20 A circuit per lab module for printers with a maximum of two duplex receptacles. The printer receptacles shall be blue in color.



D.9.2 Emergency Power

The following load figures in watts per square meter shall be used in sizing the generator. These figures are connected load and shall be used in the early design stages. Actual design loads shall be used in the later part of the design. The range allows for varying intensity of usage. The Engineer shall use sound judgement in applying these numbers.

Load	W/m^2
Lighting	1 - 5
Receptacles	1 - 2
HVAC	1 - 32
Lab equipment	20 - 43
Elevators*	2 - 2
Total Range	25 - 84

*Minimum: One elevator per bank of elevators

The following loads are required to be connected to emergency power. These loads are in addition to any code-required emergency loads:

- A 20 A, 120 V circuit in a junction box mounted to the structural ceiling of each lab module
- One light fixture per module with one light switch per lab
- BSCs
- Supply and exhaust fans for BL3 and BL4 labs
- Ventilated animal cages and cage systems
- Lab equipment alarm-monitoring system
- Fume hood exhaust fans
- High-value specimen refrigerators, freezers, cold rooms, warm rooms, etc.

The following loads may be connected to emergency power:

- Incubators

D.9.3 Lighting

The lighting levels listed below in lux shall be used for design purposes. The values listed are average maintained illuminance levels using a total maintenance factor of 75%. The numbers listed are target values and shall be adjusted to meet the research requirements.

Function/Space	lx
Laboratories	800 - 1,100
Offices	525 - 800
Corridors	325 - 525
Stairwells	200 - 325
General storage	200 - 325
Lab equipment rooms	325 - 525
Mechanical/electrical rooms	200 - 425

Areas not identified above shall use the Illuminating Engineering Society of North America (IESNA) *Lighting Handbook* for recommended values.

Undershelf-mounted, fluorescent task-lighting fixtures are optional. Where utilized, under-shelf fluorescent fixtures shall have lenses over the lamps. Industrial type fluorescent lighting fixtures shall have wire guards.

D.9.4 Fire Alarm

Corridors shall be equipped with ionization-type smoke detectors if the building is not fully sprinkler protected or if the width of the corridor is greater than 1,500 m. For additional fire alarm requirements see section D.14, Fire Safety.

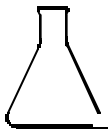
D.9.5 Monitoring

Lab equipment, such as freezers, which need to be monitored for alarm conditions may be monitored by the NIH. If equipment in renovation work requires monitoring, the user or the Designer must receive approval from the Maintenance Engineering Section of the NIH Division of Engineering Services (DES). If approval is granted, wiring and conduit shall be installed in accordance with DES requirements.

New buildings or wholesale renovation of existing buildings shall have empty conduit with pull lines installed for monitoring of lab equipment. A distribution system of raceways shall start at the building engineer's office or another central location. The raceway shall connect with each lab module's service corridor and other locations likely to have lab equipment requiring monitoring.

D.9.6 Telecommunications/LAN

Voice, data, and video are important systems needed in the laboratory and shall be prewired using accessible cable trays and conduit as required. The location and number of telecommunications/LAN closets in research buildings must be carefully considered during the design phase. Telecommunications/LAN rooms require adequate space for circulation around the equipment for repair and maintenance. Consideration shall be given to alternatives to surface-mounted raceways since they can harbor pests. Refer to the Reference Materials, section E.10, for specific criteria.



D.10 General Health and Safety

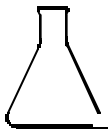
The NIH, through the Division of Safety, has developed a comprehensive Occupational Safety and Health program to protect the safety and health of all employees on the campus. Safety and health regulations and guidelines require the use of engineering controls for worker protection, wherever possible, to minimize the potential for occupational exposure to hazards in the workplace. To be most effective, engineering controls for protecting occupational safety and health must be designed into facilities for both new construction and renovated space. This proactive approach can minimize numerous common potential health and safety concerns in laboratory facilities.

These health and safety guidelines are to be incorporated, as appropriate, in facility-specific construction documents by the Architect/Engineer to ensure that health and safety protection is engineered in at the time of construction of the facilities.

While many of the requirements for health and safety engineering are incorporated in these guidelines, it is impossible to cover all possible concerns. The Architectural/Engineering firm shall, whenever possible, have a health and safety specialist on staff and shall always consult with Division of Safety personnel with regard to specific health and safety engineering requirements in the design of new construction and renovation projects.

D.10.1 Fume Hoods

Hoods shall be tested in accordance with ANSI/ASHRAE Standard 110-1985, as specified in the NIH Fume Hood Specification, after installation but before acceptance by the construction project manager. See the illustrations of various hood types and configurations illustrated in the American Conference of Governmental Industrial Hygienists (ACGIH) publication *Industrial Ventilation, A Manual of Recommended Practice*. In general, the hoods shall be tied into the laboratory area exhaust system with no separate exhaust stack. However in some instances such a configuration is not appropriate. Architects/Engineers shall consult with Health and Safety personnel regarding specific exhaust configurations for laboratory fume hoods.



D.10.2 Biological Safety Cabinets

BSCs are not to be confused with chemical fume hoods. These safety devices have specific criteria for installation, decontamination, and certification that must be followed. See the section D.11.6 under Biological Hazard Safety.

D.10.3 Vacuum Systems

Vacuum pump systems will have hydrophobic (water-resistant) filters on the suction side, with the exhaust to outside of the facility and not into mechanical spaces. Filter housing shall be designed for easy replacement of the filter, with maximum protection of maintenance employee from possible contamination.

D.10.4 Emergency Shower/Eyewash Equipment

There shall be one emergency shower (conforming with ANSI Standard Z 358.1) available to each laboratory space containing a chemical fume hood. This shower shall be tapped to the laboratory water supply.

Eyewash stations (conforming with ANSI Standard Z 358.1) shall be available to each laboratory space. Eyewashes must be no more than 22 m from any point in a laboratory. Eyewashes shall be tapped to the laboratory water source.

D.10.5 Physical Hazards

Furniture and cabinets/counters shall be designed to be as vertically flush as possible. Kneehole space shall be provided for waste containers. Both these approaches allow for better movement in the laboratory and reduce trips and bumps.

D.10.6 Electrical

Refer to the electrical design considerations for shunt trip breakers for labs with high-voltage electrical equipment.

D.10.7 Flammables

Consideration shall be given to incorporating flammable storage cabinets in all laboratories.

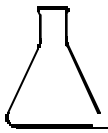
D.10.8 Gas Cylinders

Where appropriate and possible, individual gas cylinders used in the laboratory space will be secured in a service corridor on the opposite side of the laboratory from the entrance to the travel hallway. The gases will be piped into the laboratory through permanent piping fittings placed in the common wall. All applicable warning gauges and valves with protective fusible links or equivalent shall be included in the design. Note: Some gases (flammable gases) may not be stored outside of the laboratory. The Architect/Engineer shall consult with safety personnel regarding placement requirements for specific gases.

If cylinders are to be placed in the lab, they shall be properly secured to a vertical surface or counter out of the way of traffic in the space. Appropriate space for such cylinders shall be provided within the laboratory to minimize potential hazards associated with the use of these cylinders and to maximize usable laboratory space.

D.10.9 Waste Storage

At the laboratory space level, waste boxes must be located near the service corridor and be easily accessible. Space must be allocated in each laboratory for waste box storage.



D.11 Biological Hazard Safety

Work performed at the NIH involves the potential for occupational exposure to biohazardous materials. Biohazardous materials are defined as "infectious agents, or materials produced by living organisms that may cause disease in other living organisms." While, generally speaking, the laboratory procedures identified as good microbiological techniques are helpful in minimizing potential occupational exposure to biohazardous materials, containment of these agents through the use of good facility design is also extremely important.

The intent of this section is to provide Architects/Engineers and design and construction contractors with a working knowledge of the facility design parameters required for the construction of facilities which must provide for containment of biological hazards.

D.11.1 Background

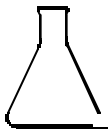
The CDC/NIH guideline, *Biological Safety in Microbiological and Biomedical Laboratories*, provides guidance in the appropriate containment of biohazardous work. Biological safety levels 1-4 have been designated, with BL1 being the least hazardous. The biological safety levels are based on the probability of occupationally acquired infections resulting from the handling of specific agents in the laboratory. Containment facility design and laboratory practices have been developed for each biological safety level to minimize the potential for personnel exposure and release to the environment.

D.11.2 Biological Safety Level 1

BL1 is the lowest level of safety for biological hazards. No BL1 laboratories will be built at the NIH.

D.11.3 Biological Safety Level 2

Containment Requirements: BL2 laboratories are similar to all other laboratories. For ultimate flexibility, a general laboratory shall minimally be designed to conform to BL2 containment requirements.



Directional Airflow: Air shall be supplied, in the laboratories, at

0.25 m/s maximum at 1.8 m above the floor. All laboratories shall have single-pass air. The airflow shall be directed from clean areas to potentially contaminated areas and from low-hazard to high-hazard areas. Air supply diffusers must be supplied with diffusers to direct flow away from fume hoods and BSCs in order to minimize potential disruptive air currents.

Ceilings: The requirements for cleaning and decontamination of BL2 laboratory space require that exposed surfaces be smooth and cleanable. Dropped ceilings with cleanable tiles (mylar face with smooth surface or equivalent) are recommended for BL2 laboratories.

Open ceilings are acceptable provided minimal ducting and piping are present and all exposed surfaces are smooth and cleanable.

Architects/Engineers shall consult with safety personnel in establishing the final design criteria for ceiling finish in any renovation or new construction project.

Flooring: Due to the potential for spills of biological materials in BL2 laboratories, flooring materials must be installed in such a way as to allow for decontamination with liquid disinfectants and to minimize the potential spread of spills.

Laboratory Furniture: BL2 laboratory furniture shall be appropriate for the work to be performed in the laboratory. Furniture shall be easily cleanable, and finishes must be compatible with materials used for cleaning and disinfection.

Caulking/Splash Guards/Coves: The seams between the cabinet and floor or wall are always a difficult area to decontaminate in case of a spill. Caulking of the seams of laboratory furniture, countertops, floors, etc. shall be done to ensure a smooth finish for ease of cleanability. Architects/Engineers shall also review caulking and sealing requirements for pest management when designing BL2 facilities.

Decontamination Requirements: The Occupational Safety and Health Administration requires the use of "EPA registered tuberculocidal hospital disinfectants" for the decontamination of biohazardous spills. These disinfectants may include halogen-

containing compounds (hypochlorite, iodine), phenols, alcohols, aldehydes, and quaternary ammonium compounds. Selection of a specific disinfectant depends on a number of criteria which could be different for different laboratories. Personnel must choose appropriate disinfectants that are compatible with the surfaces on which the spill may have occurred.

Materials for laboratory finishes shall be as resistant as possible to the caustic chemical activity of disinfectants and other chemicals used in the laboratory.

Medical Pathological Waste (MPW) Storage Areas**:** Sufficient kneehole space must be provided in each laboratory module to accommodate the in-use MPW boxes as well as other in-use waste receptacles. Design consideration must be made for accommodation of these boxes.

There must be space provided in the area of the loading dock for the collection and storage of MPW. A cold box capable of holding a minimum of 30 MPW boxes overnight must be supplied in close proximity to the loading dock.

Space must also be provided for MPW collection stations on each floor of laboratory buildings.

Autoclaves**:** For maximum flexibility, autoclave space shall be provided on each floor where microbiological research is performed. Actual installation of autoclaves and their use is an operational decision. Since quality control considerations may require separate autoclaves for clean and dirty procedures, space must be considered for both "clean" autoclaves (for sterilization of microbiological media and clean instruments, etc.) and "dirty" autoclaves (for decontamination purposes). Architects/Engineers shall review the requirements of the building personnel when designing and specifying autoclave space.

Autoclave space must be of sufficient size to accommodate carts and other equipment necessary for the handling of materials to be sterilized and of disposables.

Autoclave space shall be finished with epoxy coatings and shall not have a suspended, acoustical ceiling. This area must be

thoroughly caulked and sealed to promote cleaning and reduce pest harborage.

The space must have adequate exhaust capacity to remove heat, steam, and odors generated by the use of the autoclave(s). A canopy hood shall be provided over the door of the autoclave.

The autoclave space must operate at negative pressure to the surrounding areas.

Vacuum Systems**:** Vacuum systems must be protected with appropriate filtration (0.2 micron hydrophobic filter or equivalent) to minimize the potential contamination of vacuum pumps. Filters must be located as close as possible to the laboratory in order to minimize potential contamination of vacuum lines. Some mechanism for the decontamination of filters must be incorporated in the design of the vacuum system. NIH Division of Safety personnel must be consulted with regard to the suitability of the decontamination mechanism design and must approve of the system prior to finalization of design.

Vacuum system exhaust must be vented to the outside of the building and not recirculated to the mechanical room. A sampling port may be needed to sample exhaust.

The design of the vacuum system shall be reviewed by safety personnel prior to finalization**.**

Maintenance**:** Facilities must be designed for ease of maintenance. This is particularly important with regard to the specific containment devices (i.e., high-efficiency particulate air (HEPA) filter housings, HVAC systems, vacuum systems, etc.) designed for the facility. Safety personnel shall be consulted regarding the appropriate design for maintenance of containment devices and facilities.

D.11.4 Biological Safety Level 3

BL3 Space vs. BL2 Space: BL2 laboratory space is normally not easily convertible to BL3 containment space due to specific requirements for limiting access, air-locks, HVAC filter decontamination processes, autoclave space, etc. Design

considerations shall be made for designating a given amount of space in each facility as BL3 laboratory space or potential BL3 space. The space so designated shall be constructed using appropriate BL3 criteria. This space could be used as BL2 and easily upgraded or converted to BL3 as necessary.

Containment Requirements: BL3 laboratories require all of the design considerations for BL2 laboratories plus specific requirements for the additional containment of those biohazardous materials used in the laboratory. No compromise of the integrity of the containment of the BL3 laboratory is allowed.

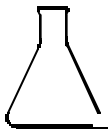
Restricted Access: BL3 laboratories must be separated from areas with unrestricted traffic flow by passage through two sets of "self-closing" doors. There must be a ventilated airlock designed to separate the common corridor(s) from the BL3 containment laboratory.

The purpose of a BL3 laboratory facility is to ensure containment of agents used in this laboratory. It is recommended that airlock doors be interlocked to prevent simultaneous opening of doors between the outside corridor and containment areas. Interlocks, when present, shall be provided with a manual override for use in case of emergency. Final determination on the design of airlocks for these facilities shall be made in consultation with safety personnel.

Sinks: A sink for hand-washing is to be located near the exit door in each BL3 laboratory (not in the airlock). Sink faucets must be foot, elbow, or automatically operated.

Interior Surfaces: Interior surfaces of walls, floors, and ceilings must be water resistant (i.e., epoxy paint, caulking, etc.), gas tight (i.e., capable of containing decontamination gas during decontamination process), and easily cleanable.

Ceilings: All BL3 facilities must have a ceiling with a smooth, sealed finish. In all new construction, all access to critical mechanical equipment (ventilation ducts, fans, piping, etc.) must be provided outside of the containment facility. (See HVAC Systems/Mechanical Equipment below).



HVAC/Airflow: Ventilation must be single-pass air, and all BL3 space must be kept negative with respect to outside corridors and laboratories. Exhaust ducts must be under negative pressure until the air is discharged outside the building.

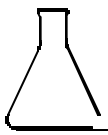
Note: HEPA filtration of BL3 space may, in some cases, be required. (See HEPA Filtration of BL3 Facility Exhaust).
If the BSC cabinet exhaust system is connected to the building exhaust, it must be connected in such a manner as to maintain the air balance of the cabinets and the building exhaust system. (See section D.11.6.)

Continuous-flow centrifuges and other aerosol-producing equipment must be contained in devices that exhaust air through HEPA filters prior to discharge into the laboratory. Where possible, such containment devices shall be discharged to the outside through the cabinet exhaust system.

HVAC System/Mechanical Equipment: Supply and exhaust ducts for BL3 laboratories must be supplied with gas-tight dampers to ensure the capability of gas decontamination of the laboratory without compromising the rest of the building. Ductwork between the laboratory and the damper must also be gas tight.

When retrofitting existing laboratory space as BL3 containment, it may not be possible to keep access to critical mechanical equipment outside of the laboratory space. In these cases, an access panel must be supplied inside the laboratory to allow access to such mechanical equipment. The access panel must be hinged (piano-type hinge) and gasketed with gas-tight gaskets to ensure an appropriate seal for both containment and decontamination procedures.

Penetrations and Joints: All penetrations in walls, floors, and ceilings must be sealed (with a smooth finish) to facilitate decontamination and cleaning. All joints between fixed cabinetry (i.e., shelves, cabinets, plumbing fixtures, etc.) and the floor or wall must be smooth coved and sealed to ensure maximum cleanability.



All light fixtures and supply and exhaust ducts must be gasketed or sealed at the point of penetration into the laboratory to ensure

containment and to ensure the capability of gas decontamination. Light fixtures in BL3 laboratories shall be surface mounted.

Laboratory Furniture: Laboratory furniture must be designed and installed in such a way as to facilitate cleaning around and under the furniture. Movable furniture with minimal wall and floor connections shall be considered for installation in BL3 laboratories. Such cabinetry lends itself to ease of cleanability and decontamination of the entire laboratory space.

Windows: BL3 laboratories shall be designed without windows. However, laboratory windows, where present, must be designed not to open. All interior windowsills must be sloped, and the seams around the windows must be sealed as are other seams in the laboratory.

Autoclaves: Decontamination equipment (preferably autoclave) shall be available in the BL3 laboratory. Autoclave space shall meet specifications as provided in the section C.4.1 of this document.

Vacuum Systems: Vacuum systems in BL3 laboratories must be protected by filtration. (See D.10.3)

Alarms: BL3 facilities must be designed to ensure notification of inappropriate directional airflow. Both visual (gauges) and audible local alarms are acceptable. In addition, alarms indicating the potential failure of BL3 containment shall be tied to a central system at the Building Engineer's office, where possible. Notification devices shall indicate the failure to maintain a negative pressure differential from a noncontaminated area to potentially contaminated areas. All designs shall meet CDC/NIH guidelines.

All alarm systems must be validated prior to occupancy of the containment space by research personnel.

Filtration of Laboratory Exhaust: While HEPA filtration of room exhaust from BL3 laboratories is seldom necessary, an evaluation of the need for specific filtration shall be performed during the initial planning and design stages of the project. The need for HEPA filtration shall be determined on a case-by-case basis in consultation with NIH Division of Safety personnel and shall be

based on a hazard assessment of the materials in use and the procedures to be performed.

Autoclave Exhaust Filtration: The exhaust from an autoclave contains a significant amount of moisture. Filtration of this exhaust, when necessary (as determined above in Filtration of Laboratory Exhaust), must be through a moisture-resistant (hydrophobic) filter such as a Pall 0.2 micron filter or equivalent. Filtration of moist exhaust through a cold filter housing containing a paper HEPA filter will result in the destruction of the HEPA filter and a break in integrity.

HEPA Filter Housings: When installed, HEPA filter exhaust housings must be constructed in such a manner as to allow for appropriate particulate testing (i.e., DOP or equivalent) and must be capable of being isolated from the ventilation system for gas decontamination and testing (i.e., gas-tight dampers and housings). NIH Division of Safety personnel must be consulted with regard to the suitability of the decontamination mechanism design and approve of the system prior to the finalization of the design.

D.11.5 Biological Safety Level 4

BL4 is required for work with exotic agents which pose a high individual risk of aerosol-transmitted laboratory infection and life-threatening disease. Construction of BL4 laboratory facilities requires careful planning and unique design features. This type of containment laboratory must be designed and constructed to specific containment requirements in order to minimize the potential for personnel exposure and to prevent dissemination of BL4 organisms to the environment.

Specific requirements for the design and construction of BL4 containment labs will be provided by the NIH Division of Safety, and no design or construction of such labs may proceed until the Division of Safety has been contacted and approval given.

D.11.6 Biological Safety Cabinets

BSCs are safety devices that are used for primary containment of biohazardous materials. These units are uniquely different from other types of laboratory hoods, and installation involves specific design consideration. BSCs are classified as Class I, II, or III. Class I cabinets are no longer being manufactured on a regular basis.

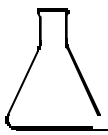
Where BSCs are needed, Class II cabinets are being installed in new and renovated laboratories. Class II cabinets include both Type A and Type B cabinets. The Type A cabinet recirculates 70% of the air in the cabinet and exhausts 30% to the room. Type B cabinets are further classified as Type B1 (exhausts 70% of the air of the cabinet directly out through the building exhaust system), B2 (exhausts 100% of the air of the cabinet), and B3 (essentially a modified Type A which exhausts 30% of the air of the cabinet). Each type of cabinet has unique properties and specific uses.

Class III BSCs are totally enclosed gloveboxes primarily used in BL4 laboratories but may also be used for work with hazardous chemicals. Note that Class III BSCs are negative-pressure cabinets and are not to be confused with positive-pressure gloveboxes, which may, if they leak, release hazardous materials to the laboratory.

Modern BSCs are designed to minimize personnel, product (research), and environmental exposure to biohazardous agents and other particulate matter. In addition to specific requirements for placing and installation of BSCs, absolute attention to procedural details by the user is necessary to ensure that these cabinets perform in the manner intended.

BSCs are certified according to NSF Standard 49. This standard establishes the stringent cabinet performance requirements for both personnel and product protection.

Class II, Type A Cabinets: Type A cabinets are suitable for routine microbiological research in the absence of volatile chemicals. These cabinets vent to the room in which they are housed. Although the exhaust is HEPA filtered, there is some small possibility of release of agents to the room if the filter shall be damaged. Volatile chemicals shall not be used in these cabinets



since the recirculation of the air would result in concentration of the volatile chemical in the cabinet with potentially hazardous consequences. In addition, when these cabinets are vented to the laboratory, volatile chemicals would be released to the room with the potential for significant exposure to personnel in the laboratory and in the building.

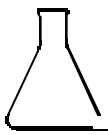
It shall be noted that Type A cabinets have a contaminated positive pressure plenum. A pressure test of this plenum to ensure that no leakage is occurring shall be performed on all new or relocated cabinets. Such tests shall also be performed following maintenance involving the removal of panels used to form the positive pressure plenum.

Note: At the NIH, Class II, Type A cabinets may not be exhausted to the outside through the building ventilation system.

If recirculation of exhaust to the laboratory space from an installed cabinet is not acceptable, a Class II, Type B1 cabinet, hard-duct exhausted to the outside, must be considered. The final decision on the appropriate cabinet must be made by personnel from the NIH Division of Safety.

Class II, Type B1 Cabinets: Type B1 cabinets are also used for routine microbiological research and for tissue cultures. Although these cabinets are recirculating (70% exhaust and 30% recirculating), it has been shown that small volumes of volatile chemicals may be used in them provided the work is performed past the middle of the work surface, towards the back of the cabinet. The exhaust from the work surface in Type B1 cabinets is to the back of the cabinet, and this exhaust is not recirculated in the cabinet. The HEPA-filtered exhaust from these cabinets is hard ducted through the facility ventilation system. All contaminated areas of these cabinets are under negative pressure. Potentially contaminated air from the work surface that is exhausted through the front vent of the cabinet is HEPA filtered below the work surface and then recirculated to the work surface.

Type B1 cabinets are the most versatile of all the BSCs and their installation results in more flexible laboratory space. However, since these cabinets require that they be hard ducted to the building exhaust system and such ducting is not always possible in retrofit



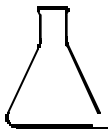
projects, Class II, Type A or B3 cabinets may be substituted when appropriate. Again, the final decision on the type of cabinet to be used shall be provided by the personnel of the NIH Division of Safety.

Class II, Type B2 Cabinets: Type B2 (total exhaust) cabinets are useful when working with both biological and hazardous chemical materials, including volatile chemicals and carcinogens. The exhaust of these cabinets is HEPA-filtered, and additional filters may be added for special purposes (i.e., charcoal filters for radioactivity or volatile organics). Filters other than the HEPA filters shall be located downstream of the HEPA filter whenever possible since infectious agents could be present in the exhaust airstream and would be deposited in the HEPA filter without contaminating the extra filter.

Installation of Class II, Type B2 cabinets requires special ventilation engineering considerations. Type B2 cabinets are total exhaust cabinets which exhaust over 22.7 m^3/min of air. This air must be supplied either from the room or from outside of the facility. At least 8.50 m^3/min must be supplied from the room to satisfy the inflow air velocity across the front grill of the cabinet and to ensure containment of materials in the cabinet. It is important to evaluate the ventilation of the laboratory to ensure that sufficient air is supplied to the room to prevent robbing adjacent areas of air. Failure to adequately supply such cabinets could result in the failure of other containment devices (i.e., fume hoods, BSCs, etc.) in adjacent laboratories.

Class II, Type B3 Cabinets: Type B3 cabinets function in a manner similar to Type A cabinets but have been redesigned to provide a negative-pressure zone around all positive-pressure contaminated plenums. They have the same limitations as the Type A cabinets.

Requirements for BSC Installation: All BSCs to be installed at the NIH must meet NSF Standard 49 requirements and be approved for purchase by the NIH Division of Safety personnel. Selection of cabinets is to be based on the evaluation of the work to be performed and the specific safety requirements necessary to protect personnel, research, and the environment.

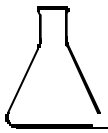


Air supply diffusers, or exhaust vents, shall not be placed directly over or in front of BSCs where the movement of air can affect the airflow of the cabinet.

The safe operation of BSCs depends upon the air curtain formed by incoming and downflow air in the cabinet. Disruption of the air curtain will result in potential compromise of the operation of the cabinet and possible contamination of personnel or work. Personnel traffic results in air pattern disruption in BSCs. Therefore, these cabinets must be placed towards the rear of the laboratory module and out of the direct traffic pattern of the laboratory.

A gas-tight roll-valve (Baker Company; Sanford, ME; Martin/ Peterson; Kenosha, WI, or the equivalent) must be provided on the Class II, Type B1 cabinet exhaust. This valve is required in order to facilitate decontamination and testing of the cabinets.

The design of the HVAC systems must allow for the maximum exhaust capacity for all BSCs which may be required in the facility.



D.12 Radiation Safety

Work performed at the NIH laboratories involves the potential for occupational exposure to radioactive materials and other sources of ionizing and nonionizing radiation. While, generally speaking, the laboratory procedures identified as good radiation safety (HP) practices and techniques are essential to minimize potential exposure to radiation, the security, containment, and shielding of this material and equipment through the use of good facility design are other extremely important elements.

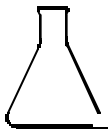
The intent of this section is to provide Architects/Engineers and construction contractors with a working knowledge of the facility design parameters required for the construction of facilities which must provide for the control and containment of these radiation hazards.

Not all sources of ionizing radiation are covered by NRC licensing. The nonlicensed sources are, however, controlled by regulations issued by the NIH Radiation Safety Committee upon recommendation by the Radiation Safety Officer. Nonlicensed sources include X-ray machines, high-voltage accelerators, electron microscopes, and radioactive materials from sources other than reactor by-products.

In addition to the protection of occupationally exposed workers, the NIH Division of Safety, *Radiation Safety Branch*, has to ensure that the general public and surrounding environs are also provided with an adequate and similar degree of protection.

D.12.1 Background

The NIH *Radiation Safety Guide* provides guidance and technical information concerning the use of radioactive materials as well as policies and procedures for radiation-producing machines and areas. Radiation safety control, containment, and shielding design and laboratory practices have been developed to minimize the potential for radiation exposure to workers as well as release to the environment.



D.12.2 Specific Areas of Concern

The following key radiation issues were identified relative to laboratory activities:

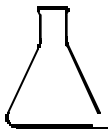
- Radiation safety requirements for laboratories using radionuclides
- Radioactive airborne and liquid effluent sampling
- Radiation safety requirements for devices used in medical research, such as X-rays, accelerators, and irradiators
- Radiation safety requirements for nonionizing radiation (only including MRI and high-intensity lasers (e.g., CO_2)
- Security of radioactive materials

All radioactive materials stored at any NIH facility shall be secured; i.e., unattended laboratories in which radionuclides are in use or stored must be locked or radioactive materials must be locked in containers, refrigerators, or freezers. In addition, besides locked doors, other security options may be implemented, such as card key access, etc.

D.12.3 Radioactive Waste Storage

On-Campus Buildings: Laboratory buildings on the NIH campus shall be designed with a separate area for the temporary staging of hazardous and radioactive waste. Mixed waste (hazardous waste that is also radioactive) shall be treated as radioactive waste in this temporary staging area. These staging areas are discussed in detail in the Hazardous Waste Storage section of these guidelines. Only the specific issues which are directly related to radioactive waste are discussed here. Information on the carts and equipment for the transfer of radioactive waste currently in use can be obtained from the NIH Division of Safety, *Radiation Safety Branch*.

The staging area shall be large enough to provide for temporary storage of the radioactive waste and capacity for storage of specialized carts used to transport the radioactive waste from the laboratories. The staging area shall be designed to contain any spills of radioactive waste that may occur due to handling of the



waste materials. It is anticipated that this will be accomplished using specialized carts; however, the Designer may propose alternate means for spill containment.

Special consideration must be given to this area in the fire protection design as indicated in NRC Information Notice 90-09, which specifies the description of the fire protection and suppression system to minimize the likelihood and extent of fire.

Coolers and/or walk-in freezers used to store MPW will also be used to store animal carcasses, tissues, and bedding contaminated with radioactive materials. Coolers and/or walk-in freezers shall be located in each building for laboratories conducting biomedical research with radioactive materials.

Off-Campus Facilities: Laboratory facilities not located on the NIH campus shall be designed with a room for the processing and staging of hazardous and radioactive waste. Mixed waste shall be treated as radioactive waste in this room. These areas are discussed in detail in section D.13.4 of these specifications. Only the specific issues which are directly related to radioactive waste are discussed here.

A 2-hour rated wall shall be designed to separate the radioactive waste and the hazardous waste storage areas.

The waste will be transported to the NIH campus for additional processing and shipping to the long-term radioactive waste storage facility. Since this waste will be transported over public roads, this room shall be used to prepare the radioactive waste for shipment. Processing conducted in this room shall include bulking of waste into large containers, lab packing of individual waste containers, and labeling and manifesting the containers for shipment. There will be a need for a bulking hood to perform these activities.

Consideration shall also be given to requiring a service elevator on the premises which can be used to transport the radioactive waste to the appropriate marshaling area in the building. If a service elevator is not available, the use of a passenger elevator may be appropriate; however, dedicated times will be required to transport the radioactive waste.

The staging room shall be divided into two separate areas. The first

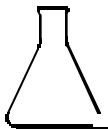
part shall be large enough to provide for temporary storage of the radioactive waste as it is received from the laboratories and after it is packed for shipment. The second part shall be used for bulking and packaging the waste. Sufficient space must also be provided for the storage of specialized carts used to transport the radioactive waste from the laboratory.

The staging room shall be designed to contain any spills of radioactive waste that may occur due to handling of the waste materials. Spill containment in the bulking and packaging area may be accomplished with a curb around the area, secondary containment bins, or a combination thereof. Spill containment in the staging area may be accomplished with a curb around the area, secondary containment bins, shelving designed to contain spills, or a combination thereof. These areas shall be thoroughly caulked and sealed to minimize pest harborage and exclude pests.

It is important to note that prior to contracting for leased space, which will require remodeling, renovation or other extensive architectural or engineering work, the NIH Division of Safety shall be informed and provide the necessary technical assistance concerning this leased space.

Laboratory Module Requirements: All laboratory modules shall be designed for the safe storage of radioactive waste. The volume of radioactive waste generated by a laboratory is a function of the type of work being performed in the laboratory. Thus, the Designer needs to consider the function of the laboratory to determine the space necessary for radioactive waste storage. The Designer must also recognize that some types of radioactive waste will require segregation from other types and design the radioactive waste storage area to accommodate multiple containers.

All laboratories shall be designed to fit the appropriate low-level radioactive waste (LLRW) storage receptacles and/or containers. The Radiation Safety Branch shall be contacted for specifications on these containers. Five LLRW streams have been identified for laboratories from the *NIH Waste Disposal Calendar*, as amended in 1995.



- Liquids

  - aqueous waste
  - solvents/other hazardous chemical constituents (mixed waste)

- Dry or solid waste (dry active waste)

  - disposable labware
  - sharps (can also be categorized as MPW)

- Liquid scintillation vials and/or bulk liquid scintillation media

- Animal carcasses and/or tissues

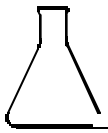
- Animal bedding and/or solid excreta

The size of the space dedicated to these of the containers shall be based upon the volume of radioactive materials generated and/or research activities performed in this laboratory. Standard-sized containers are available from the *Radiation Safety Branch* and the radioactive waste contractor and shall be considered in the design.

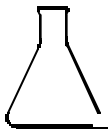
The location of the radioactive waste storage in laboratories shall be standardized to assist emergency response personnel. It is recommended that this storage be located near the laboratory door for convenient access by the technician collecting the radioactive waste. For laboratory modules with a service corridor, it is recommended that this storage be located near the service entrance rather than the hall entrance. This will avoid the need for moving radioactive waste through the main corridors of the laboratory building.

The configuration of the radioactive waste storage area in the laboratory shall be designed to facilitate radioactive material spill clean-up and decontamination. Interior surfaces of the storage area shall be readily cleanable for ease in decontamination.

The Designer shall also include the following considerations in the design:



- All laboratories must have the ability to be locked against unauthorized access
- All radioactive materials in laboratories shall be secured when unattended
- The space required for shielding the waste containers shall be considered
- Laboratories and marshaling areas shall be sized appropriately to reduce accumulation
- Appropriate spill containment shall be included in all storage areas
- Potential shielding requirements shall be considered between adjoining or adjacent lab bench areas for high-energy beta emitter radionuclides
- If the laboratory is to be used for high-energy gamma emitter radionuclides, then the design of the countertops and hoods shall take into account and compensate for the additional weight required for the appropriate lead shielding
- Secure equipment alcoves shall be considered for storage of radioactive materials and/or irradiator equipment
- If there is a need to store radioactive materials in refrigerators and/or freezers, the design specifications shall include security provisions, e.g., locks as part of the integrated system, to secure this equipment
- Corridors and public space shall not be designated and used for storage, and equipment such as refrigerators and freezers shall not be designated to store this material in these areas.



D.12.4 Module Requirements

Beta barriers for shielding energetic beta emitters (P-32), often transparent plastic (lucite) sheets, 0.95 to 1.27 cm thick, shall be considered to protect personnel working in adjacent and close work areas.

D.12.5 Clearance for Renovation/Remodeling

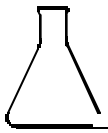
The NIH Division of Safety, *Radiation Safety Branch,* shall be notified prior to any renovation or remodeling in laboratories using radioactive material. The laboratory shall be surveyed by the Principal Investigator or authorized users, and the Radiation Safety Branch will conduct additional confirmation or clearance surveys prior to release of the laboratory for unrestricted use, if necessary. Ventilation systems used for controlling airborne radioactive discharges require design considerations. Laboratory exhausts shall be manifolded into the regular building exhaust. Hoods used for bulking RAM shall have the capability for sampling. In addition, the design shall accommodate space in the mechanical room to provide for any future additional filtration capability.

If the facility requires additional hoods, specifically for the use of iodination techniques, then the exhaust from these installations shall be equipped with the capability for HEPA or charcoal filtration. A distinct installation shall be considered separate from the main exhaust system.

D.12.6 Radioactive Airborne and Liquid Effluent Discharges

NIH Design Policy and Guidelines prohibits discharge of radioactive material into laboratory sinks. Provision shall be made for installation of appropriate sampling probes for sampling capability to assess airborne and liquid effluent discharge streams, including main exhaust systems, sufficient to demonstrate compliance with the requirements of 10 CFR 20.1302.

Liquid effluent monitoring can be accomplished by batch, composite, or continuous sampling prior to discharge into the sanitary sewer system.



The design and construction considerations for airborne radioactive effluent monitoring shall also include the following:

- All systems for use with radioactive materials shall have the capacity to sample the airborne effluent being discharged, primarily gases and vapors

- Sufficient capacity shall be provided for sampling the combined discharge, specifically gases and vapors, at a common point located inside the mechanical room downstream of the filters and fans

- Where iodination is performed in specific laboratories, those hoods shall be equipped to accept appropriate HEPA and charcoal filters

- Airborne radioactive effluent monitoring systems shall be designed in accordance with ANSI Standard N13.1, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities* (1969), specifically Appendix A, *Guides for Sampling from Ducts and Stacks*

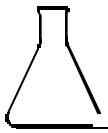
- A single-nozzle sample probe shall be designed inside the airstream for gas and vapors sampling, as specified in ANSI Standard N13.1**.**

Laboratory design considerations shall also include state-of-the-art design considerations, as specified by ANSI and other acceptable industry standards, such as the following:

- National Council on Radiation Protection and Measurements, (NCRP), Report No. 59, *Operational Radiation Safety Program*, Chapter 3, November 1, 1980

- Hanson and Blatz, *Radiation Hygiene Handbook*, section 9, Facility Design, 1959

- Epoxy coatings, laminates, floor coverings, and protective coatings shall be utilized for ease of decontamination and to provide a protective coating which can be readily removed without extensive damage to the existing facility and surfaces



- Sinks shall be either plastic composite or coated with epoxy or the equivalent to ease the decontamination of surfaces

- Stainless steel is also an option for sinks; however, soapstone shall not be used

- Air filtration systems (activated charcoal/HEPA filtration) shall be installed and tested in accordance with ANSI/ America Society of Mechanical Engineers Standard N510-1980, Testing of Nuclear Air Cleaning Systems.

The activated charcoal and HEPA filters shall be tested with current state-of-the-art methods and techniques for filter efficiency and compliance with technical specifications at the factory and postinstallation at NIH facilities.

Chemical fume hoods for radionuclide use shall be designed in accordance with the following industry criteria and technical specifications:

- Landis and GYR Powers, Inc., *Laboratory Control and Safety Solutions Application Guide*, 1993

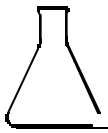
- ACGIH, *Industrial Ventilation: A Manual of Recommended Practice*, (current edition)

- Hoods shall have a minimum face velocity of 100 m/s

A typical chemical fume hood designed for hazardous materials is acceptable as a radioisotope fume hood. The hood design shall include smooth, nonporous surfaces for ease of decontamination. In addition, the fume hood shall be constructed of materials that will not generate mixed waste if the surfaces and the construction materials interact with the radioactive materials.

D.12.7 Vacuum Systems

Vacuum systems shall be protected with appropriate filtration (0.3 micron hydrophobic filter or the equivalent) to minimize the potential for contamination of vacuum pumps. Filters shall be on the suction side of the pumps, with exhaust to the outside of the facility and not recirculated into the mechanical spaces.



Filters shall be located as close as possible to the laboratory in order to minimize the potential contamination of vacuum lines and to preclude and minimize decontamination and decommissioning costs.

Filter housings shall be designed for easy filter replacement in order to minimize the possibility of maintenance worker contamination and to provide for easy disposal.

D.12.8 Irradiators Utilized in Medical Research

Irradiators are designed to contain significant amounts of radioactive material, and therefore are designed with engineering controls as well as adequate shielding to perform the necessary functions utilized in medical research. However, the following facility design parameters are required for the construction to adequately house this equipment:

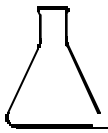
- Floor loads must be assessed to ensure structural integrity given the amount of shielding, and associated weight, of this equipment

- Consideration shall be given to the available means for moving this equipment to its location (e.g., loads on elevators)

- Because of the shielding requirements, this equipment is usually located on the lower floors of a facility (e.g., ground floor, basement, or subbasement)

- The NIH Division of Safety, *Radiation Safety Branch,* shall be contacted when the design and installation of an irradiator is considered

- The room or facility housing the irradiator must be secured or have the capability to be secured (locked).



D.12.9 Radiation-Producing Equipment and/or Machines

In accordance with the NIH *Radiation Safety Guide*, the NIH Division of Safety, *Radiation Safety Branch*, must be notified when there is any change in the setup of radiation-producing equipment or machines. This includes purchase and installation of new equipment, changes in shielding, changes in the output of the radiation, or changes in usage of the unit.

With respect to the use of radiation-producing equipment and/or machines, the following design guidance shall be used:

- *National Council on Radiation Protection and Measurements (NCRP), Report No. 102, "Medical X-Ray, Electron Beam and Gama- Ray Protection For Energies up to 50Mev (Equipment Design, Performance and Use) (1989)"*

- NCRP, Report No. 49, *Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV*, September 15, 1976.

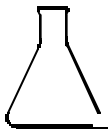
The documents referenced above shall be used by the Radiation Safety Branch to

- implement an "As Low As Reasonably Achieve able" (ALARA) program to minimize radiation exposure to occupationally exposed individuals and the general public

- provide the appropriate design criteria as they relate to radiation producing equipment and/or machines

- provide structural shielding requirements for any new installations or installations undergoing renovations or changes

The following factors, such as W (workload), U (use factor) and T (occupancy factor), as defined in the appropriate NCRP handbooks, shall be utilized to calculate and design the necessary shielding requirements. The dose equivalent limit for design purposes shall be 10 mRem public exposure and 500 mRem occupational exposure.



D.12.10 Non-Ionizing Radiation

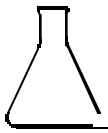
This section applies only to MRI and high-power intensity lasers.

With respect to the use of MRI devices the following regulations and design considerations apply:

- U.S. Food and Drug Administration (FDA) regulations 21 CFR 892.1000, Magnetic Resonance Imaging
- security requirements for housing and enclosing the equipment
- warning placards, signs and postings, which may also include barriers
- warning requirements for cardiac pacemakers as well as other prosthetic devices and/or equipment
- shielding requirements to minimize radiation exposure to electric and magnetic fields
- posting concerning electrical hazards

With respect to the use of lasers, specifically high-power intensity lasers, the following regulations and design considerations apply:

- FDA regulations 21 CFR 1040, Performance Standards for Lightemitting Products
- ANSI Standard for the Use of Lasers, ANSI Standard 2136.1, 1986
- *Conference of Radiation Control Program Directors Frankfort, KY. Suggested State Regulations for Control of Radiation, Volume II: Non-Ionizing Radiation* (Latest Edition).
- security requirements for housing and enclosing the equipment
- warning placards, signs, and postings, which may also



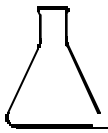
include barriers

- appropriate personal protective equipment warnings prior to entering and/or working with the equipment to mitigate and prevent eye and skin exposure

A Class III laser system is a medium-pulse system requiring control measures to prevent viewing of the direct beam. Design and control measurers emphasize preventing direct access to the primary or reflected beam. Safety eyewear is necessary and required with this class of laser.

High-power intensity lasers (e.g., CO_2 lasers) are classified as Class IV lasers in 21 CFR 1040. These lasers produce radiation so powerful that they can cause injury with a direct or reflected exposure, even when the beam is scattered or diffused by a rough surface or smoke scenes. Class IV radiation lasers emit more than one-half watt continuous output.

Laser facilities shall be designed to minimize the use of reflective/ refractive surfaces to provide additional protection to occupational personnel.



D.13 Environmental Management

This section describes the general requirements and specific goals for managing environmental issues on the NIH campus. Specific issues that are addressed in this section include

- Hazardous materials storage and handling
- Hazardous waste storage and handling
- Bulk storage facilities
- Wastewater discharges
- Solid waste management and recycling

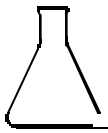
Attention to environmental management issues and proper waste handling is a key portion of the NIH's overall goals of ensuring the health and well-being of NIH employees, visitors, and neighbors and maintaining the NIH campus atmosphere.

D.13.1 Background

These guidelines regarding environmental management on the NIH campus encompass the current Federal and State of Maryland regulations regarding environmental management issues. They also include the requirements of local governments and agencies such as the Washington Suburban Sanitary Commission (WSSC) and Montgomery County, Maryland.

Federal laws applicable to environmental management on the NIH campus include

- The Resource Conservation and Recovery Act
- The Clean Water Act
- The Safe Drinking Water Act
- The Clean Air Act
- The Hazardous Materials Transportation Act



Certain environmental issues have been purposely excluded from this section of the Guidelines because they are fully addressed in section G, Site/Civil, of the Reference Materials. These issues include stormwater management and sediment control, erosion control wetlands and use of fertilizers and pesticides in landscaping and groundskeeping.

The requirements contained in this section upgrade the previous NIH design policy and guidelines, which contained little discussion of environmental protection issues.

D.13.2 Hazardous Substance Storage and Handling

All NIH laboratory facilities shall be designed to minimize the use of hazardous substances. Alternative nonhazardous or nontoxic materials shall be preferred in all new construction and renovations. The Designer shall develop a plan for eliminating the use of hazardous substances. Where hazardous substance use is unavoidable, the Designer shall demonstrate that alternate nonhazardous substances are either not available, inferior to the hazardous substance, or cost prohibitive. Examples of hazardous substances that shall be avoided include, but are not limited to, oil-based paints and caulks; hazardous cleaning, surface preparation, and paint-stripping solvents; and petroleum-based contact adhesives.

In general, most new construction will result in the release (off-gassing) of odors that can affect occupant comfort. If hazardous substances are avoided in the construction, these odors will generally be nonhazardous; however, they can still have a detrimental effect on indoor air quality. Examples of nonhazardous substances that can affect indoor air quality include systems furniture, carpets, and latex paints.

New facilities shall be allowed to off-gas prior to occupancy. Ventilation systems on new construction shall be operated for at least 1 month before the building is occupied. For renovations, where it is not feasible to isolate the NIH employees from the off-gassing, materials which are going to off-gas and affect indoor air quality shall be allowed to air out and off-gas in a warehouse or well-ventilated, unoccupied area before they are installed.

Insecticidal dusts, such as boric acid, shall not be applied in wall

void and/or chase areas as part of the facility construction or renovation.

D.13.3 Hazardous Substances Storage

Receiving Areas: Hazardous substances used at the NIH fall into two categories. They are either substances used in the facility directly by the research activity, or they are substances used in support of the facility. An example of the hazardous substances used directly by the research activity would be laboratory chemicals used for the analysis. As example of the hazardous substances used in support of the research facility would be chemicals used for washing of glassware or neutralization of wastewater discharges.

Hazardous substances that will be used in a laboratory are delivered directly to the end user laboratory. Therefore, a staging and temporary storage area will not be required in the receiving area for these materials.

Materials that will be used in support of a facility must be placed in a hazardous substance storage area. In general, these materials are received in 220 L drums or larger. Storage capability shall exist in areas for up to 10 drums. Some neutralization materials may be stored in bulk containers up to 1,600 L.

Each building utilizing these hazardous substances shall be designed with a receiving and storage area. This area shall be located at or near the point of use of the materials and will be used for long-term storage of hazardous materials.

Hazardous substance storage areas shall be out of the normal flow of personnel traffic. There shall be convenient access from the storage area to the freight elevator and/or the loading dock without having to traverse heavily traveled corridors.

The staging area shall be large enough to provide storage of the hazardous substances and room for loading and unloading the drums or containers. If multiple substances will be stored, the design shall allow for incompatible materials to remain segregated while in storage.

The storage area shall be designed to contain any spills of

hazardous substances that may occur due to handling. Spill containment may be accomplished with a curb around the area, secondary containment bins, shelving designed to contain spills, or a combination thereof. A chemical-resistant coating shall be applied to the walls and floor in this area to make it easier to clean up spills. These areas shall be thoroughly caulked and sealed to minimize pest harborage and exclude pests.

Safety equipment shall be provided for each staging area. This safety equipment shall consist of an emergency eyewash and an emergency shower. Special consideration must be given to this area in the fire protection design if flammable materials will be stored.

Modules: All laboratory modules shall be designed for the safe storage of hazardous substances while discouraging the storage of excessive amounts of hazardous substances. Thus, the Designer needs to consider the function of the laboratory and the potential use of hazardous substances to fulfill this function.

All laboratories shall contain an approved flammable materials storage cabinet. The size of this cabinet shall be based upon the volume of flammable materials used in the laboratory. The location of the storage cabinet shall be standardized in the laboratories to assist emergency response personnel. Flammable materials substance storage cabinets shall be placed to allow the cabinet to be ventilated, if needed. Ideally, this would place the cabinets near the fume hood.

An additional storage area for nonflammable hazardous substances shall also be provided. This storage area shall have at least two physically separated sections to allow segregation of incompatible materials. Each section of the storage area shall be designed to contain a spill of at least 1 gallon of liquid. The configuration of the storage area shall be designed to facilitate spill cleanup. Interior surfaces of the storage area shall be cleanable, corrosion resistant, and nonreactive.

D.13.4 Hazardous Waste Storage and Handling

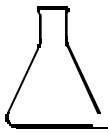
On-Campus Buildings: Laboratory buildings on the NIH campus shall be designed with a room for temporary storage of hazardous waste and radioactive wastes. Mixed waste (hazardous waste that is also radioactive) shall be treated as radioactive waste in this temporary storage area. Hazardous waste is generally stored in this room for several hours, although it may be stored overnight.

The room shall consist of two individual segments: one for the hazardous waste and one for the radioactive wastes. The storage room shall be large enough to provide for temporary storage of the hazardous waste and radioactive waste and room for storage of specialized carts to transport the hazardous waste from the laboratories. The hazardous waste storage segment shall be at least 2.5 m by 3.5 m. The radioactive waste storage segment shall be at least 0.75 m by 1.5 m. Facilities which generate larger amounts of hazardous or radioactive waste will need larger spaces.

There shall be at least three 2 m high storage cabinets in each room to provide segregated storage of incompatible materials. There shall be sufficient open floor space in the storage room to accommodate one 1 m long waste cart while allowing a person to access the storage cabinets and shelving.

The storage room shall be designed to contain any spills of hazardous waste that may occur due to handling or mishandling of the waste materials. The waste materials will normally be transported using specialized carts which will provide spill containment. The Designer may propose alternate means for spill containment within the storage room. Options may include a spill containment curb around the room and shelving or bins designed to contain spilled materials. A chemical-resistant coating shall be applied to the walls and floor in this area to make it easier to clean up spills.

The storage room shall be located near the loading dock for easy access to the trucks that will be used to transport the waste to Building 21 for processing. Personnel shall be prohibited from any processing of the hazardous wastes, such as bulking or lab packing, in this storage room.



There shall be convenient access from the storage room to the freight elevator without having to traverse heavily traveled corridors. This will allow the contractor collecting the waste to bring the waste down from the laboratories to the storage room while minimizing the risks to the building occupants.

A separate ventilation system shall be installed for the storage room. Exhaust shall be directed away from the building and surrounding buildings air intake. This ventilation system shall be connected to the building's emergency power system. Standard illumination requirements exist for this room. The room shall be designed to fire protection Hazard Group 2.

Safety equipment shall be provided for each storage room. This safety equipment shall consist of an emergency eyewash and an emergency shower.

The NIH Division of Safety shall review and provide the final approval of the design of all hazardous waste storage rooms.

Off-Campus Buildings: Laboratory buildings located in Montgomery County, Maryland, but not located on the NIH campus shall be designed with two rooms for processing and storage of hazardous waste and radioactive waste. Mixed waste (hazardous waste that is also radioactive) shall be treated as radioactive wastes. The design of the radioactive waste room is discussed in section D.12, Radiation Safety. Hazardous waste may be stored in these rooms for up to 90 days, although 60 days is more typical.

The storage room shall be located near the loading dock for easy access to the trucks that will be used to transport the waste to the NIH campus for additional processing. Since this waste will be transported over pubic roads, this room shall be used to prepare the hazardous waste for shipment. Processing conducted in this room shall include bulking of waste into larger containers, lab packing of individual waste containers, and labeling and manifesting the containers for shipment.

There shall be convenient access from the storage room to the freight elevator without having to traverse heavily traveled corridors. Given the fact that these laboratories are typically leased

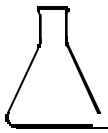
space, it may be difficult to meet these criteria. If this is the case, consideration shall be given to alternate uses of this leased space that will not generate hazardous wastes.

The storage room shall be divided into two parts. The first part shall be large enough to provide for temporary storage of the hazardous waste as it is received from the laboratories and after it has been packed for shipment. The second part shall be used for bulking and packaging the waste. Space must also be provided for preparing manifests and other documentation. This may be provided in the storage area or in an additional space outside the room. Sufficient space must also be provided for storage of specialized carts used to transport the hazardous waste from the laboratories.

Both parts of the storage room shall be designed to contain any spills of hazardous waste that may occur due to handling or mishandling of the waste materials. Spill containment in the bulking and packaging area may be accomplished with a curb around the area, secondary containment bins, or a combination thereof. Spill containment in the storage area may be accomplished with a curb around the area, secondary containment bins, shelving designed to contain spills, or a combination thereof. A chemically-resistant coating shall be applied to the walls and floor in this area to make it easier to clean up spills. These areas shall be thoroughly caulked and sealed to minimize pest harborage and exclude pests.

A separate ventilation system shall be installed for the storage room. Exhaust shall be directed away from the building and surrounding buildings air intakes. This ventilation system shall be connected to the building's emergency power system. The ventilation system shall be sparkproof. The ventilation system shall be designed to allow easy access for routine or emergency maintenance from outside of the containment area.

Safety equipment shall be provided for each storage room. This safety equipment shall consist of an emergency eyewash and an emergency shower. A telephone to be used to contact emergency response personnel shall be located either in the room or within 10 m of the room.



A walk-in fume hood is necessary in the bulking and packaging area where exposure to harmful fumes is possible. An explosion panel designed to dissipate the impact of an explosion is required in the storage room. Explosion-proof lighting shall be provided in both areas. Walls of the storage room shall have a 2-hour fire rating.

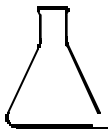
The NIH Division of Safety shall review and provide final approval of the design of all hazardous waste storage rooms.

Modules: All laboratory modules shall be designed for the safe storage of hazardous waste generated by the laboratory activities. The volume of hazardous waste generated by a laboratory is a function of the type of work being performed in the laboratory. Thus, the Designer needs to consider the function of the laboratory to determine the space necessary for hazardous waste storage. At a minimum, a 0.75 m by 0.75 m area will be required.

The Designer must also recognize that some types of hazardous waste may be incompatible with other types and design the hazardous waste storage area to accommodate multiple containers. The Designer shall investigate the possibility of stacked containers that will provide sufficient storage space while minimizing the footprint in the laboratory. Each storage container shall be designed to provide secondary containment of the hazardous wastes.

The location of the hazardous waste storage area in the laboratories shall be standardized to assist emergency response personnel. It is recommended that this storage area be located near the laboratory door for convenient access by the technician collecting the hazardous waste. For laboratory modules with a service corridor, it is recommended that this storage area be located near the service entrance rather than the hall entrance. This will avoid the need for moving hazardous waste through the main corridors of the laboratory building.

The hazardous waste storage area shall have at least two distinct segments to allow segregation of incompatible materials. Some laboratories may require three segments depending upon the types of hazardous waste that will be generated. Each segment of the storage area shall be designed to contain a spill of at least 1 gallon



of hazardous waste. The configuration of the storage area shall be designed to facilitate spill cleanup. Interior surfaces of the storage area shall be cleanable, corrosion resistant, and nonreactive.

D.13.5 Bulk Storage Facilities

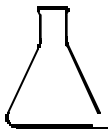
Above-Ground Storage Tanks: Wherever possible, the Designer shall consider the use of clean burning fuels such as natural gas or liquid propane. If storage of these fuels is required, for example, a day tank to ensure uninterrupted availability of fuel, it shall be in above-ground storage tanks installed in accordance with State of Maryland and Montgomery County, Maryland, requirements.

All above-ground storage tanks shall be double walled, be provided with secondary spill containment, and meet the requirements of the American Petroleum Institute and the National Fire Protection Association (NFPA). The tanks shall also be consistent with the NIH Spill Prevention, Control, and Countermeasures plan.

Design considerations regarding the above-ground storage tanks include the location of the tanks to provide access for delivery trucks. At the same time, the tanks shall be sufficiently isolated and protected from traffic flow to minimize the risk of accident. The tanks shall also be placed in a location to minimize the aesthetic impact of the tank on the surroundings. This would include the use of berms and landscaping to block the view of the tanks.

Spill Control: All bulk storage facilities and above-ground storage tanks shall be equipped with secondary containment to prevent discharge of the material in the event of a spill or a leak. For single storage tanks, the secondary containment shall be large enough to contain the volume of the tank and rainfall from the 10-year, 24-hour storm. For multiple storage tanks, the secondary containment shall be large enough to contain the volume of the largest tank and rainfall from the 10-year, 24-hour storm.

Materials used to provide the secondary containment shall be impervious to the substance contained in the storage tank. The containments shall be equipped with a normally closed valve to prevent accidental discharge of the substance from the containment. This valve can be manually opened to discharge accumulated rainwater after it has been determined that the water



is not contaminated.

The other potential spill areas for hazardous substances on the campus are the loading docks. Spills can occur at the loading docks during the loading and unloading of hazardous substances or hazardous wastes.

Loading docks shall be designed to contain spills of hazardous substances and minimize the contamination of stormwater runoff. One option that would accomplish this objective would consist of a loading dock with a grate drain at the base that would accumulate any spilled substances. This drain would be equipped with a normally closed valve to prevent accidental discharge of spilled substances. Uncontaminated runoff would be diverted from this drain by a second grate drain and a small berm. An overhang would divert direct rainfall from the base of the loading dock to the uncontaminated runoff drain. Alternative designs which meet this objective may be proposed by the Designer.

Control of stormwater runoff and water quality around the NIH campus are discussed in section G, Site/Civil, Reference Materials. To ensure proper water quality, all drainage systems which collect runoff from the parking areas shall be equipped with oil water separators.

D.13.6 Wastewater

Wastewater Discharge: Only uncontaminated stormwater runoff shall be discharged from the NIH campus to the receiving stream. All wastewaters generated on the NIH campus shall be discharged to the sanitary sewer. Wastewaters generated on the NIH campus include domestic sewage from the lavatory facilities, nonhazardous waste discharged from laboratory or research area sinks, waters used for cage washing and animal care, waters used in cafeteria operations, and all floor drains.

Wastewater Sampling: The NIH campus is connected to the WSSC sanitary sewer system. The NIH is permitted to discharge wastewater to the WSSC system through a Discharge Authorization Permit. Under the terms of this permit, the NIH must sample its wastewater four times every 6 months and submit an Industrial User Effluent Compliance Permit report to WSSC twice

per year.

The wastewater sampling is conducted at the two locations where the NIH sewers connect to the WSSC system. However, for new laboratory facility construction, the sanitary system shall be designed to allow for sampling at the discharge point from the individual building. This will allow for testing and troubleshooting of individual building wastewater streams.

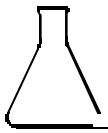
The sampling point shall be designed to allow for installation of a continuous pH monitor, installation of a programmable sampler, and personnel access for grab sampling. Cage-washing facilities shall be provided with a continuous pH monitor and recorder.

Wastewater Treatment: Since the NIH utilizes the WSSC system, it is normally not necessary to perform wastewater treatment on campus. However, it may be necessary to provide neutralization and equalization of wastewater streams from some laboratory buildings to comply with WSSC requirements.

To allow for these circumstances, the sanitary system for new laboratory buildings shall be designed with sufficient hydraulic gradient that an equalization or neutralization tank can be installed at a later date without a redesign of the sewer system or the installation of a pump station.

Tanks used for equalization and neutralization of wastewaters can accumulate sludges and hazardous wastes, require maintenance, and cause odor problems. Therefore, equalization and neutralization tanks will not automatically be installed in new construction. The Designer shall investigate the potential use of the building and attempt to characterize the potential wastewater stream based upon this proposed use. Equalization and neutralization tanks shall be included in new construction if the anticipated characteristics of the wastewater stream indicate that these facilities are likely to be required.

Any facility being designed with darkrooms or photoprocessing facilities shall have a processing facility for recovering silver from the wastewater stream from the photoprocessing rooms.



D.13.7 Solid Waste

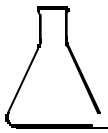
Waste Minimization: All laboratory facilities at the NIH shall adhere to the Environmental Protection Agency's solid waste management hierarchy, which encourages reduction of waste at the source. This hierarchy emphasizes waste minimization as the first step in sound solid waste management. The utilization of reusable products, which also has the effect of reducing the overall solid waste stream, is also encouraged. Waste products that cannot be reused shall be investigated to determine if they can be recycled. Only those products that can not be reused or recycled shall enter the waste stream for energy recovery or landfilling.

In general, solid waste management is an operational function. However, the requirements for environmentally friendly solid waste management must be included in the design of new construction in order for the solid waste management system to be efficient and convenient to use. Ease and convenience are keys to implementation of a successful solid waste management program. All facilities shall be designed with modern and sanitary waste compaction equipment. This equipment shall minimize attraction of pests and spillage of wastes and debris.

One design feature that can assist in waste minimization in laboratories is hazardous substance storage capacity. The Designer shall closely examine the anticipated use of the laboratory to determine a reasonable volume of hazardous substances that shall be stored in the laboratory to allow efficient laboratory operations. Excessive storage space in a laboratory can result in over-purchasing and hoarding of hazardous substances. This, in turn, can result in excessive hazardous waste generation as these substances are stored beyond their shelf lives.

Recycling: The NIH campus has an active solid waste recycling program. The program is administered by the Office of Research Services (ORS). This program establishes white office paper, baled corrugated cartons (OCC), aluminum cans, and polypropylene as primary recycling materials. Mixed paper, wood pallets, scrap metal, polystyrene, food and beverage containers, and yard waste are designated as secondary recyclable materials.

All new construction on the NIH campus shall be designed to be recycling friendly. This consists of placing recyclable collection

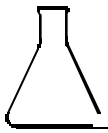


containers at convenient locations throughout the building to make it easy for NIH employees to accumulate recyclable materials. The selection of recyclables to be collected; the type, size, and number of collection containers; and the locations for the collection containers must be selected by the Designer based upon the planned use of the new facility. For example, more emphasis would be placed on collecting white office paper in an office building than an animal care facility. The Designer shall coordinate this selection with the ORS, Division of Safety, Environmental Protection Branch.

Support facilities for recycling must also be included in all new construction. These support facilities would include space in the loading dock for storage of recyclable materials. Paper products, particularly white paper and OCC, must be kept clean and dry to maintain market value. These require either a room for storage or an enclosed container. Sufficient container space will also be required for the other recyclable materials. Multicompartment recycling roll-off containers are commercially available and may be used for recyclable storage and transportation. The potential for attraction of pests, such as flies, wasps, or rodents, to these containers must be considered when designing a placement site. The placement of these containers shall not affect personnel using the loading dock.

The Designer may want to consider installation of a baler at facilities which are expected to generate sufficient amounts of OCC. A can flattener shall be considered for any facility expected to generate sufficient aluminum cans.

The selection of the recycling support facilities and equipment required for all new construction shall be made by the designer in coordination with the ORS, Division of Safety, Environmental Protection Branch. Potential options for the loading dock design have been developed by the ORS, Division of Safety, Environmental Protection Branch, and can be used as guidelines by the Designer.



Hazardous Waste: All hazardous waste generated on the NIH campus shall be handled in accordance with NIH's generator and TSD permits. Generally, this requires accumulation of the waste at the generation point, temporary (1 day or less) staging at the building loading dock, and transportation to Building 21 for processing. Any facility which cannot meet this format shall be considered a special exception to these guidelines. The Designer shall develop the solid and hazardous waste design for this building in consultation with the ORS, Division of Safety.

Demolition:

Site Assessments: Prior to the demolition of any facility on the campus, the designer shall have a site assessment performed by a qualified environmental engineer. The purpose of the site assessment will be to identify any environmental site hazards that could result in the release of hazardous substances during the demolition or new construction. Potential hazards that must be addressed include possible asbestos-containing building material (ACBM), lead paint, underground storage tanks, hazardous substance storage areas, and spills of hazardous substances.

This site assessment shall include a review of records regarding the design, construction, and use of the building to be demolished and the site; a review of records regarding responses to hazardous substances pill incidents or other emergencies; visual inspection of the building and site; and sampling and analysis of subject materials are areas to provide quantitative data to backup the qualitative assessment.

Recycling of Demolition Debris: Prior to mobilization on the site, the demolition contractor shall be required to submit to the ORS, the Division of Safety, a waste disposal and recycling plan for the demolition activity. This plan shall identify each type of waste material that will be generated by the demolition. The wastes shall be classified as hazardous waste, general waste, or recyclable waste. The alternatives for disposal or recycling of each type of waste material shall be discussed in the plan, with the objective of recycling as much of the demolition materials as possible. For any material that will not be recycled, the contractor shall be required to document in the plan, to the satisfaction of the ORS, Division of Safety, why recycling is not feasible. During the demolition activities the contractor shall be required, on a monthly basis, to report to the ORS, Division of Safety, on the status of the recycling activities. This will include weigh tickets or other forms of proof

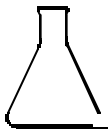
that the specified materials have been recycled. Payments to the contractor shall not be approved unless this documentation has been provided and the contractor is performing in accordance with the approved waste management and recycling plan.

The contractor shall also be responsible for completing and delivering to the Division of Safety, Environmental Protection Branch, of the following forms:

- Contract Recycled Material Notification Form
- Exempt Recyclable Material Manifest
- Nonhazardous Recyclable Material Manifest

Copies of these forms are attached.

Any wastes generated during the demolition that are designated as hazardous wastes or that require special waste-handling procedures (e.g., asbestos waste) shall be properly handled, transported, and disposed of by the demolition contractor. All manifests, certificates of disposal, and other documentation of proper handling and disposal shall be provided to the ORS, Division of Safety.

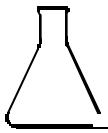


Contract Recycled Material Notification Form

Project Title	
Location of Project	
Contact Number	
NIH Project Officer (Name and Phone)	
NIH Contract Officer (Name and Phone)	
Name of Contractor (Company, Contact Person Name and Phone)	
Sub Contractor (Attach List If Necessary)	
Types of Materials Anticipated To Be Recycled: (Building materials includes items intended for reuse, provide description of other.)	___Ferrous Scrap Metal ___Nonferrous Scrap Metal ___Concrete/Asphalt ___Glass ___Insulation ___Plastics ___Building Materials ___Electrical Wire/Cables ___Wood ___Other

The above information should be forwarded to the NIH Division of Safety, Environmental Protection Branch (EPB), (Bldg. 13/Rm 2w64, NIH) if recycle able material will be removed under this contract. A recycle able material manifest, either nonhazardous or exempt shall be prepared for each shipment of recyclable materials. Any manifest for shipment of exempt hazardous materials (e.g. scrap metal with lead paint) should be forwarded to the EPB, 3 days prior to shipment for approval and will be signed by an EPB representative on the shipping day. The contractor shall forward to EPB, completed copies of all shipping documents together with weight tickets signed and dated by the contractor in verification of their accuracy within 30 days of the shipping date.

The exempt Recyclable Material Manifest will be used for scrap metal which contains hazardous waste, constitutes as an inherent component or external coating, but is still acceptable to a recycle outlet.



The Nonhazardous Recyclable Material Manifest will be used for any nonhazardous waste which is being recycled and is **not** scrap metal and is acceptable at a recycling facility must be shipped as hazardous waste using a hazardous waste manifest signed and approved by the EPB.

Name_____

Signature_____ Date _____

DES/NIH Project Officer

Name; _____

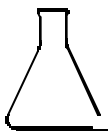
Signature: _____ Date _____

DES/Contractor Contact Person

Name: _____

Signature: _____ Date _____

Revised 10/26/95 Chief, Environmental Protection Branch Representative



Revised 10/26/95 Manifest No. _____

EXEMPT RECYCLABLE MATERIAL MANIFEST

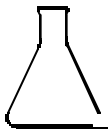
Generator Name_____
Address:_____
_____
Phone No._(_____)_____

Generating Location:_____
Address:_____
_____
Phone No._____

	Description of Waste	Net Weight	Units
Container Type	_____	_____	____
	_____	_____	____
	_____	_____	____
	_____	_____	____
Container Type	_____	_____	____
	_____	_____	____
	_____	_____	____
	_____	_____	____
Container Type	_____	_____	____
	_____	_____	____
	_____	_____	____
	_____	_____	____

It is certified that the scrap metal described above is a recycle able material as defined in Title 40 CFR 261.6 (a)(1) and COMAR 26.13.02.06. This shipment to a facility for reclamation does not require a Uniform Hazardous Waste Manifest, disposal at an EPA-or-State permitted facility, or compliance with other hazardous waste requirement for Title 40 CFR 262-266 or Parts 268-270 or 124 and Maryland State Regulation COMAR 26.13.03.07. This material has been properly described, classified and packaged and is in proper condition for transportation according to regulations.

_____ _____
Generator Name (NIH Representative) Signature Shipping Date



Truck/ Container No._____ Phone No. _____
Transport Co. _____

Driver Name:_____
Address: _____
_____
Vehicle Licence # _____
Vehicle Certification; _____

I hereby certify that the above named material was picked up at the generating site listed above.

I hereby certify that the named material was delivered without incident to the destination listed below.

_____ _____
Signature Ship Date Signature Delivery Date

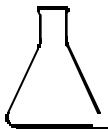
Site Name:_____
Phone No.: _____

EPA Generator ID No. (If waste is not inherently hazardous.)_____
Address: _____
_____
Comments: _____
_____
_____
_____

I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

_____ _____ _____
Recycling Facility Representative Signature Shipping Date

RECYCLING FACILITY: Please attach a copy of the weight ticket to a copy of this manifest and return to the Generator at the above address.



Revised 10/26/95
Manifest No._____

NONHAZARDOUS RECYCLABLE MATERIAL MAIFEST

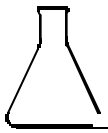
Generator Name_____
Address:_____
_____
Phone No._(_____)_____

Generating Location:_____
Address:_____
_____
Phone No._____

Description of Waste	Net weight	Units	Container Type
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

It is certified that the material described above does not contain free liquid as defined by 40 CFR Part 260.10 or any applicable State law and is not a hazardous waste as defined by 40 CFR Part 261 or any applicable State law. This material has been properly described, classified, and packaged and is proper condition for transportation according to applicable regulations.

_____ _____
Generator Name (NIH Representative) Signature Shipping Date



Truck/ Container No._____ Phone No. _____
Transport Co. _____

Driver Name:_____
Address: _____
_____
Vehicle Licence # _____
Vehicle Certification; _____

I hereby certify that the above named material was picked up at the generating site listed above.

I hereby certify that the named material was delivered without incident to the destination listed below.

Comments:_____

_____ _____
Signature Ship Date Signature Delivery Date

DESTINATION

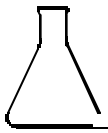
Site Name:_____
Phone No.: _____

Address: _____
_____
Comments: _____
_____
_____
_____

I hereby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

_____ _____ _____
Recycling Facility Representative Signature Shipping Date

RECYCLING FACILITY: Please attach a copy of the weight ticket to a copy of this manifest and return to the Generator at the above address.



D.14 Fire Safety/Fire Protection

This fire protection section includes specific requirements for laboratory facilities. The general fire protection requirements are found in Section H-Reference Materials.

All laboratory areas are considered Class B per NFPA 45 definitions.

Fire Resistant Materials and Construction: All laboratory corridor walls shall have a minimum 1 hour fire rating. One hour fire rated partitions shall have 45 minute opening protection. Each vision panel shall not exceed 0.84 square meters.

Fire Dampers: Fire dampers shall not be provided on any fume hood system.

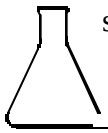
Automatic Sprinkler Systems: All sprinkler system designs shall meet, at a minimum, NFPA 13 Ordinary Hazard Group II spacing and hydraulic requirements.

Open storage (in the laboratories) shall not be permitted, on a horizontal plane, within 0.46 meters of the sprinkler deflectors (as measured vertically from the bottom of the sprinkler deflector to the horizontal plane). Enclosed perimeter storage (i.e. within cabinets), to the underside of the ceiling, shall be permitted.

Fire Protective Signaling Systems: All laboratory corridors shall be equipped with ionization type smoke detectors if the constructed width of the corridor is greater than 1.5 meters.

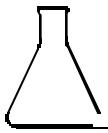
Duct Smoke Detection: Duct smoke detectors shall not be installed in air handling units of less than 425 m^3/min., in air handling units which serve only one fire area, or in fully sprinklers buildings. Where duct smoke detectors are installed they shall be of the photoelectric type, connected to the building fire alarm system and cause shutdown of the associated air handler upon alarm.

Fire Extinguishers: Laboratory fire extinguishers shall be located in the corridors. The maximum travel distance to an extinguisher, from any point, shall be 15 meters.



Means of Egress: A minimum 0.30 meter clear aisle space shall be maintained around laboratory benches and furniture.

Flammable Storage Cabinets: A flammable storage cabinet (FSC) shall be provided in each laboratory. Additional FSCs shall be provided per NFPA 45 requirements. All FSCs shall be constructed of metal. The exterior of all FSCs shall be appropriately signed. The FSC shall be located as remote as possible from the exit doors of the laboratory. FSCs shall not be installed beneath fume hoods. FSCs shall not be located in corridors. The integrity of the FSC shall not be compromised by its mounting method. The FSC shall not be vented.



D.15 Pest Management

Consideration of pest management shall be given to any function, finish, or detail contributing to pest infestation and harborage in or around the building. Design features shall promote cleaning, maintenance, and better storage while minimizing pest access. Floor penetrations and void areas shall be minimized and completely sealed. The Designer shall ensure that areas of pest ingress, such as doors, windows, loading docks, etc., are fitted with appropriate pest exclusion devices. Consideration shall be given to designs that minimize pest harborage and promote proper cleaning. Examples of harborages are inaccessible voids behind and under equipment and casework, unsealed cracks or joints between pieces of equipment or finish materials, or the use of unsealed foam or fiberglass insulation on pipes and equipment.

The NIH Division of Safety, Pest Management Unit shall be consulted to review and approve all plans for new construction or renovation of old space.