13 00 10 LABORATORIES

1. Intent: Provide laboratory facilities that meet basic legal and industry safety standards, that provide a safe environment for laboratory personnel to conduct their work, and that assure general design uniformity among University of Minnesota Laboratory facilities. Any proposed variation requires written approval from the Department of Environmental Health & Safety (DEHS).

2. References and Governing Regulations

"American National Standard for Emergency Eyewash and Shower Equipment," ANSI Z358.1
"Laboratory Ventilation," ANSI/AIHA Standard Z9.5
American National Standards Institute (ANSI)

"Biosafety in Microbiological and Biomedical Laboratories", Centers for Disease Control and Prevention and National Institutes of Health, US Government Printing Office

"Guide for the Care and Use of Laboratory Animals" and "Occupational health and Safety in the Care and Use of Research Animals," National Research Council, National Academy press, Washington, D.C.

"Guidelines for Construction and Equipment of Hospital and Medical Facilities,"
The American Institute of Architects Committee on Architecture for Health with assistance from the U.S. Department of Health and Human Services
American Institutes of Architects Press

"Industrial Ventilation: A Manual of Recommended Practice"
American Conference of Governmental Industrial Hygienists

National Fire Codes
Especially standards 45, 99, 101
National Fire Protection Association (NFPA)

"Design Requirements Manual"
NIH Office of Research Facilities, Development and Operations

OSHA 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories"
OSHA 29 CFR 1910.151(c) "Medical and First Aid"

3. Design Review Process
3.1. The contract documents shall contain an equipment and furnishings schedule that includes necessary product identification, function descriptions, handling, mechanical and electrical equipment/accessories, hardware indications, installation accessories and finishes.

3.2. File a Hazardous Materials Inventory Statement (HMIS) and a description of laboratory activities with the Department of Environmental Health and Safety (DEHS) and the Building Code Division when a construction project is proposed. This information is required for each control area. The HMIS is used to determine the hazard classification of a laboratory and fire separation areas within the building. If it is not feasible to prepare this information, or if it is not filed, the occupancy shall be classified as hazardous under the International Building Code. DEHS may assist the A/E with the collection and evaluation of the hazard information.

3.3. Laboratories Occupancy classifications should comply with National Fire Protection Association (NFPA) 101, "Life Safety Code."
Laboratories should also be designed with reference to one of the following occupancy classifications:
A. Business
B. Healthcare
C. Industrial

3.4. The A/E or Project Manager shall meet with the user to determine preliminary program requirements. The user shall provide a hazardous materials inventory statement (HMIS) and description of laboratory activities.

3.5. The A/E or Project Manager shall review the preliminary program requirements with DEHS, the Building Code Division and Disability Services. The HMIS form shall be filed with DEHS.

3.6. The A/E shall complete the programming design phase.

3.7. The users, DEHS, building code officials and the Project Manager shall review and approve the program design.

3.8. The A/E shall contact and work directly with DEHS to determine and arrange for the implementation of all design, construction, commissioning and documentation requirements associated with Biosafety Level 3 facilities.

3.9. The A/E shall review laboratory ventilation systems with the Department of Environmental Health and Safety (DEHS), Facilities Management and the code officials during the program phase of the design process.

3.10. A floor plan showing control areas, H occupancies, BSL3 facilities and laboratory compartments must be placed near the fire department entrance to a building.

4. General Design
4.1. Laboratories must be built as compartments to improve occupant safety and minimize disruptions to business activities and property loss that may be caused by a fire or chemical releases. This compartmentation is in addition to control area separations required by the International Building Code. Separate adjacent laboratories or other occupancy use areas by construction of smoke partitions.

4.2. Aisles serving a single work area must be a minimum of 36 inches wide. Double aisles must be a minimum of 60 inches wide. Avoid aisles longer than 20 feet. Arrange furniture for easy access to an exit from any point in the laboratory.

4.3. Provide adequate storage volume for research chemicals and waste. Chemical resistant storage trays shall be furnished to contain a spill of free liquid in the storage unit. Storage cabinets should have integral welded shelf hangers that interlock with shelf; shelf support clips should be avoided.in the storage unit. Refer to Division 12, Section 123553 - Laboratory Casework.

4.4. Provide sufficient storage space to protect new and waste chemicals. Without adequate storage space, containers of waste chemicals are often boxed and stacked on the floor where they might be broken and cause injury.

5. Electrical

5.1. Provide ground fault circuit interrupters (GFIs) on electrical outlets within 6 feet of all sinks and in locations where surfaces may be cleaned with sprayed water.
Identify emergency power outlets in accordance with Division 26, Section 262726- Wiring Devices.

5.2. Provide an outlet for every 3 feet of bench top.

6. Plumbing

6.1. Faucets, to which a hose or similar device may be attached, shall be provided with an approved vacuum breaker. Alternately, a special laboratory water supply equipped with an RPZ back flow device to separate it from the potable water may be provided. If a laboratory water system is provided, all connected outlets shall be labeled “Not Potable.”

6.2. A safety shower and eyewash shall be provided in each lab area equipped with a fume hood. An eyewash shall be provided in other laboratories using hazardous chemical or radiological materials. An eyewash shall be provided in a readily accessible location where BSL2 or BSL3 biological agents are stored and used. Minimize the number of tempering valves by creating laboratory emergency fixture loops. Refer to 13 00 12 - Emergency Eyewash and Safety Shower Installation.

6.3. Reagent grade 3 water is feasible to maintain and is usually adequate for central building distribution. Reagent grade 3 water, as specified by the College of American Pathologists or the National Committee for Clinical Laboratory Standards, is resistive at 25 degrees C of 0.1 megohms/centimeter and a pH between 5 and 8. If needed, higher-grade water can be generated at the point of use. Refer to Division 15, Section 15400 -Plumbing, item 3. High Purity Water Systems for more information.

7. Gases

7.1. Provide a single shut-off valve for each laboratory in accessible locations for central supply of flammable, combustible or oxidizing gases. Valves shall be outside of the areas in which the gases are used. These shut-off valves are in addition to those at the points of supply and use. They may be located adjacent to the corridor exit from the lab or, if security is not a problem, in the corridor.

7.2. Storage and supply systems for compressed and liquefied gases shall comply with requirements of NFPA and ANSI. Consult the following standards:
A. NFPA 50, Standard for Bulk Oxygen Systems at Consumer Sites
B. NFPA 50A, Standard for Gaseous Hydrogen Systems at Consumer Sites
C. NFPA 50B, Liquefied Hydrogen Systems at Consumer Sites
D. NFPA 51, Design and Installation of Oxygen-Fuel Gas Systems for Cutting and Welding
E. NFPA 54, National Fuel Gas Code
F. NFPA 55, Compressed and Liquefied Gases in Portable Cylinders
G. NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases
H. NFPA 99, Standard for Health Care Facilities
Chapter 3 - Use of Inhalation Anesthetics (flammable and non-flammable)
Chapter 4 - Use of Inhalation Anesthetics in Ambulatory Care Facilities
Chapter 5 - Respiratory Therapy

7.3. Systems for other gases shall comply with the manufacturer's recommendations. "The Handbook of Compressed Gases" by the Compressed Gas Association and the "Matheson Gas Data Book" by Matheson Gas Products may be consulted as a reference standard.

8. Utility Control Labeling

8.1. Controls for air, gas and other utilities shall be color-coded and labeled in accordance with the Scientific Equipment and Furniture Association (SEFA) 7 as follows:
Number Service Color Code Color of Letter
1 Cold Water Dark Green CW
2 Chilled Water Brown CH
3 Hot Water Red HW
4 Steam Black STM
5 Air Orange AIR
6 Gas Dark Blue GAS or NAT GAS
7 Vacuum Yellow VAC
8 Distilled Water White DW
9. Deioniozed Water White DI
10. Reverse osmosis Water White RO
11. Oxygen Light Green OXY or O2
12 Hydrogen Pink H or H2
13 Nitrogen Gray or Brown N or N2 or NIT
14 All Other Rare Gases Light Blue Chemical Symbol

9. Fire Extinguishers

9.1. Provide fire extinguishers based on the basis of the area protected and hazard class. Refer to NFPA 10. Provide an UL-listed, 5 pound multipurpose dry chemical fire extinguisher with at least a 1A20BC rating mounted near an exit for each laboratory.

10. Room Ventilation

10.1. **PROHIBITED:** Recirculation of exhaust air from laboratories, except in a clean room with an air lock.

10.2. **PROHIBITED:** Returned air from corridors in laboratory areas. Supply air to the corridor only.

10.3. Laboratories using hazardous chemicals shall be under at least.01 inches WG (2 Pa.) negative pressure with respect to adjacent areas. However, negative pressure must not exceed .05 inches WG (10 Pa.) to avoid outside air infiltration.

10.4. Provide at least 30 percent pre-filter and an 80 percent filters meeting ANSI/ASHRAE 52.1dust spot efficiency filters in the air supply. This corresponds to MERV 7 and 13 under ANSI /ASHRAE 52.2. Locate air filters down stream of the fan.

10.5. Humidifiers shall be located downstream of fans and filters. Indirect clean steam humidifying is required.

10.6. Laboratories shall be under negative pressure and have at least six air changes per hour while occupied. Labs where hazardous chemicals are used in closed systems or in a fume hood shall have between six and 12 air changes per hour while occupied. Where open use of hazardous chemicals is planned, 10 or more air changes per hour shall be supplied. General ventilation is not recommended to control exposures (Local exhaust ventilation is a much more effective and energy efficient method of controlling exposure.

10.7. Local exhaust ventilation devices shall be designed with reference to the latest edition of "Industrial Ventilation: A Manual of Recommended Practice by the American Conference of Government Industrial Hygienists."

10.8. Noise from the laboratory ventilation systems shall not exceed NC 45 throughout the laboratory.

11. Finishes (Fixtures, Floors, Casework)

11.1. To facilitate long-term maintenance and reuse of casework, metal casework shall be provided. In areas performing biological research casework is frequently washed with bleach solution. The following items are preferred in laboratories and may be required when appropriate:

A. Metal laboratory furniture with stainless or 1-inch epoxy resin bench top
B. Wall cabinets with a continuous enclosed front plane to the ceiling
C. Bleach solution-resistant waste lines
D. A glassware cleaning sink at least 12 inches deep. It is desirable to not install a lower shelf in sink cabinets because they are often damaged by water.

11.2. Laboratory floors, walls and doors require the following:
A. Floor finishes must be NFPA class I rated to minimize flame spread.
B. Floors shall be covered with a smooth, non-porous material that is resistant to a wide range of chemicals. Floors shall be sealed watertight.
C. Walls and doors shall be constructed or painted with a smooth, non-absorbent, washable material.
D. Interior finishes must be NFPA class A to minimize combustible load.
E. Doors shall be self-closing and lockable.
F. Lighting fixtures shall be flush-mounted with the ceiling and have removable, easily cleaned diffusers.

11.9. When infectious agents, human body fluids and general microbiology products are generated, an autoclave shall be designated to handle decontamination. It shall be provided with a dedicated exhaust to control odors. The exhaust system shall include a canopy over the door to the autoclave.

13 00 11 FUME HOODS/BIOLOGICAL SAFETY CABINETS

1. Intent: Provide fume hoods that safely capture hazardous, flammable, corrosive or toxic chemicals and that allow for changes in laboratory function and fume hood use.

2. Governing Regulations

2.1. See item #2 in section 13 00 10.

2.2. University of Minnesota Standards and Procedures for Design must be reviewed for specifications on material and equipment. These are general standards for typical research uses. In special circumstances, different standards may apply

3. General Features

3.1. **PROHIBITED:** Installing heated drying cabinets under fume hoods.

3.2 **PROHIBITED:** Installing filtering (recirculating) fume hoods.

3.3. Fume hoods in research laboratories must comply with ANSI/AIHA Z9.5 Class A performance standards. Capture efficiency as installed and used must be at least 4 AU O.1.

Supply air turbulence is a most significant factor effecting capture efficiency so supply air and location of hoods in a room must be carefully considered.

3.4. Locate hoods and BSCs in distal corners of a laboratory and away from high traffic areas to avoid high turbulence from people walking past the hood and to prevent blocking an exit if there is a chemical spill or fire near the hood.

3.5. As a general rule, provide 2 lineal feet of chemical storage space for each lineal foot of fume hood width. Refer to Division 12, Section 123553 - Laboratory Casework.

3.6. The average fume hood face velocity shall be 100 +/- 10 fpm with the vertical-sliding sash at 18 inches above the work surface. Also, on hoods wider than 4 feet, the safety shield must be in place. Readings shall be measured in the center of several square grids measured in the plane of the face opening. In addition, individual face velocities shall not exceed 20 percent of the open-face velocity average.

3.7. Fume hoods shall run continuously to minimize potential hazards when the fume hoods are off. Only the maintenance staff shall control the on/off switches.

4. Supply Air

4.1. **PROHIBITED:** Auxiliary air supply hoods.

4.2. **PROHIBITED:** Designs that may cause cross drafts and turbulent air in rooms.

4.3. To ventilate efficiently and minimize turbulence, diffuse supply air from behind the operator. Consider technology that diffuses air in a radial manner with high volume and low velocity, or other pattern-control technology.

5. Exhaust System

5.1. **PROHIBITED:** Modulating or controlling fume hood exhaust volumes to balance air requirements for air conditioning or heating.

5.2. **PROHIBITED:** Fire or smoke dampers in any chemical fume exhaust duct.

5.3. **PROHIBITED:** filters in any chemical fume hood exhaust duct.

5.4. High duct velocity results in high noise levels, excessive leakage and high power consumption. Therefore, air velocity on the suction of the fan shall be a minimum of 1,000 feet per minute (fpm) and shall not exceed 2,000 fpm under any circumstances. A velocity of 1,200 fpm is recommended.

5.5. General-purpose fume hood ductwork shall be 304 stainless steel. The fan and housing shall be corrosion resistant. Special purpose hoods may be constructed of other materials only after thorough review with DEHS and the user.

5.6. Ductwork shall be oval or round to ensure uniform airflow.

5.7. In constant volume exhaust systems, up to four hoods in the same room may be connected to a common exhaust duct leading from that room to an exhaust fan. If more than one hood is connected to an exhaust duct, a balanced, drop without a damper must be engineered or blast gate dampers must be provided.

5.8. Submit VAV and manifolded exhaust system proposals for review by DEHS and FM Energy Management staff. Include a design intent document with the proposal.

5.9. Provide an exhaust system for laboratory equipment such as flammable liquid storage cabinets, biological safety cabinets, gas cabinets, HPLC and analytic equipment.

6. Fans and Discharge

6.1. **PROHIBITED:** Square to round fabric connectors.

6.2. **PROHIBITED:** Radial-blade, paddle-wheel type centrifugal fans.

6.3. Use forward or backward curved industrial duty fans for fume hood systems. Select fans that have a chemical resistant coating and meet selected noise criteria.

6.4. Discharge ducts and fan housing shall be airtight when fans are installed in an equipment room. Fan shafts shall be sealed with a stuffing box shaft seal or equivalent device. Alternatively, install a fan with wheel back plate fins that pull air into the fan from the shaft opening. Seamless welded ductwork shall be installed on the discharge side of the fan. Transition fittings between the fan housing and discharge ductwork shall be factory fabricated with round connections. Flexible connectors shall have flanged ends and shall be factory fabricated.

6.5. Provide rain protection that does not direct or deflect air downward.

6.6. Stack-design and discharge velocity shall distribute contaminants outside the eddy current envelope of the building. On structures with roof areas at more than one level, discharge ducts within 30 feet of a higher level shall terminate at a point at least 10 feet above the elevation of the higher level. A wind study may be used to refine placement of exhaust stacks.

6.7. Consider clustering discharge ductwork or inducing outside air to help dilute discharge and increase the mass of the air column. Doing so raises the height of the column stack.

6.8. Maintain the maximum distance from fresh air intakes on the building and on adjacent buildings. Maintain at least 100 feet between fume hood exhausts and fresh air intakes.

6.9. Ventilate the equipment room where fume hood exhaust fans are located.

7. Fume Hood Construction

7.1. Non-combustible, corrosion-resistant construction is required.

7.2. Use an airfoil design to minimize air turbulence entering the hood.

7.3. Provide a vertical sliding safety glass sash that is balanced and counterweighted so it can be raised or lowered with one hand from any point along the bottom.

7.4. The vertical sliding safety glass sash shall have a positive steel mechanical latch 18 inches above the work surface. The latch prevents the operator from opening the sash above 18 inches without intervention. The operator shall be able to handle the latch with one hand and close it from any position.

7.5. Provide an 11-inch wide to 12-inch wide horizontal sliding safety-glass shield on hoods that are 4 feet and longer. The shield shall be suspended on bearings or slide in an easily cleaned channel. It must be supported so pressure is not displaced and the user cannot remove it.

7.6. A removable safety shield is permitted on hoods that are 4 feet or shorter. When a removable shield is provided, do not consider the area of the shield when calculating the exhaust volume of the fume hood.

7.7. Control the face velocity of the hood so that it does not exceed 200 fpm as the sash is lowered.

7.8. Locate electrical outlets on the exterior of the fume hood.

7.9. Locate utility controls for gas, water and vacuum on the exterior of the hood with utility outlets mounted on the interior sidewall. Label and color-code controls.

7.10. Provide a liquid-tight work surface built to contain at least 3/8-inches of liquid.

7.11. Mount cup sinks on a raised lip to partly contain a spill before the liquid flows into the sink. The cup sinks shall be 1/16 of an inch lower than the surrounding raised margins of the work surface.

7.12. Provide an electronic airflow indicator with an audible alarm in a conspicuous location so that the user can see the status of the airflow. Set the low airflow alarm at 80 fpm.

7.13. Interior lighting shall be vapor-sealed and covered with a safety glass lens. Bulbs shall be changeable from the exterior of the hood. Illumination levels at the working surface shall be at least 80 foot-candles.

8. Radioisotope Fume Hoods - Additional Requirements:

8.1. Contact DEHS for construction requirements pertinent to the user's license.

8.2. The interior lining and baffles of the fume hood shall be smooth, polished, type 304 stainless steel. The need for seamless welded construction depends upon NRC license requirements. Usually, seamless welded construction is not required.

8.3. The work surface shall be capable of supporting up to 200 pounds per square foot of shielding material.

8.4. Work surface corners shall be smooth, seamless stainless steel with 1/2-inch radius.

8.5. An exhaust filter enclosure with a pre-filter and a HEPA and/or charcoal filter usually is not required for radioisotope hoods. If required, however, the enclosure must meet the following specifications:

8.5.1. **PROHIBITED:** Proprietary or custom-sized filters and pre-filters.

8.5.2. The filter enclosure must be airtight and constructed of stainless steel.

8.5.3. The filter enclosure shall be easily accessible from the outside of the hood. The filter enclosure shall provide bag-in/bag-out of filters, so the maintenance staff is not exposed to collected material.

8.5.4. Provide an indicator on hoods with a filter enclosure that is clearly visible and indicates when the pressure drops across the filter.

8.5.5. Use a standard-size pre-filter and charcoal and/or HEPA filter on the filter enclosure.

8.5.6. To allow for filter loading, the initial, average face velocity of the fume hood shall be 120 fpm with the sash at 18 inches and a clean filter.

8.5.7 Fume hoods provided with filter enclosures always shall be individually ducted.

9. Biological Safety Cabinets

9.1. **Only Class II Type B2 cabinets** (sometimes referred to as total exhaust) can be used for work with small amounts of volatile toxic chemicals and radionuclides.

9.2. **Class II Type B1 or A2 cabinets** can be used for work with minute quantities of volatile toxic chemicals and tracer amounts of radionuclides if approved by DEHS.

9.3. Minimal use of alcohol and other cleaning chemicals is permissible in all types of biological safety cabinets.

9.4. Biohazard cabinets shall comply with NSF/ANSI Standard 49 for Class II Biohazard Cabinetry.

9.5. Laminar flow clean air devices such as clean benches shall comply with Institute of Environmental Sciences (IES) Standard IES-RP-CC002.

13 00 12 - EMERGENCY EYEWASH AND SAFETY SHOWER INSTALLATION

1. Intent: Provide an effective method for flushing harmful (toxic or corrosive) chemical or biological agents, or other foreign materials out of the eyes or off the body.

2. Governing Regulations: See item #1 in section 13 00 10 for governing regulation publications.

3. General Requirements

3.0 When possible supply sink mounted eyewashes, as this will facilitate flushing and maintenance. Wall panel eyewashes and eyewash models not attached to drains should be avoided.

3.1. Locate eyewashes and safety showers in areas where the eyes or body may be exposed to harmful chemicals or contamination with infectious agents. Refer to applicable material safety data sheets to determine whether materials are harmful. Laboratories, battery operations and cage washing areas are examples of areas where harmful chemicals may be used.

3.2. In laboratories where a fume hood is installed, provide an eyewash and safety shower. In BSL2 laboratories, an eyewash station must be readily available.

3.3. When necessary to protect against a harmful chemicals, locate eyewashes and safety showers so that the maximum distance from the hazard does not exceed 50 feet and so that they can be reached within 10 seconds. Occupants must not pass through a doorway or weave through equipment to reach the eyewash and safety shower.

3.4. When provided to protect against an exposure to a biological agent, locate the eyewash in a readily accessible location within 10 seconds of the work area. Be sure that the eyewash is located in an area under control of workers so that a door in the path of access cannot be blocked.

3.5. Locate eyewashes and safety showers in the normal path of egress. For example, in a laboratory, the eyewash and safety shower should be near a corridor door.

3.6. Tempered water shall be supplied to eyewashes and safety showers to between 60 degrees F and 95 degrees F. To minimize ongoing maintenance cost, consider designing tempered water systems on a loop that maximizes the number of fixtures served by a single tempering valve.

3.7. Use potable water to supply eyewashes and safety showers.

3.8. One handed operation of the eyewash is required. The valve shall remain activated until intentionally shut off. To provide consistency to building occupants, the activation device for the eyewash and safety shower must be uniform throughout the building.

4. Eyewash Performance

4.1. Eyewashes shall provide streams of water simultaneously released from two sides to clean foreign particles or liquids from both the eyes. The discharge pressure of the steam must be less than 25 psi. over the entire facial area.

4.2. Eyewashes shall have a flow rate of at least 0.4 gallons per minute.

4.3. The preferred activation method of the eyewash is a paddle with dimensions approximately 4 inches by 4 inches. The control shall require no more than 10 ounces of force for activation. The valve shall remain activated until intentionally shut off.

4.4. The maximum distance from the floor to the eyewash jets shall be 36 inches.

4.5. To facilitate weekly flow testing, drain eyewash fixtures directly into the sanitary sewer in accordance with the Minnesota Plumbing Code.

4.6. When eyewashes on flexible hoses are provided, a vacuum breaker is required to protect potable water.

5. Safety Shower Performance

5.1. Safety showers shall be deluge types with a continuous flow valve. The valve shall remain activated until intentionally shut off.

5.2. Safety showers may be installed in combination with an eyewash fixture. The supply lines and connections of combination units shall not create obstructions for persons using the laboratory.

5.3. Provide a head discharge of at least 20 gallons per minute for safety showers.

5.4. The distance from the floor to the shower shall be 82 inches to 96 inches.

5.5. Wall cord, ring and chain, or pull bar, located no higher than 48 inches from the floor may activate the shower. To prevent accidental discharge, locate the activating device so that it is not in the way of normal occupant activity.

5.6. Floor drains are not required under emergency showers.

End of Division 13 00 10 - Laboratories