3.2.3 LABORATORY FACILITIES

3.2.3.1 General

Unless otherwise noted, the following guidelines apply to instructional science labs (including chemical, biology, animal, and special equipment laboratories), art studios, and scene shops.

3.2.3.2 Facility Planning and Design

The matrix below includes a suggested baseline for laboratory planning standards, and should be tested against actual equipment needs, workflow, and numbers of occupants on a project-by-project basis. The size requirements for laboratories can vary significantly. The matrix below represents guidelines for general classes in the noted areas. For advanced classes in these disciplines, the space requirement shall be developed for the specific used in coordination with Mason. Additional laboratory support and storage spaces may also be required. All spaces shall be in compliance with the CPSM. Where recommendations in the Design Manual differ from the CPSM, the greater space allocation shall apply. Suggested laboratory configurations and equipment lists can be found in Chapter 5, details 3.2-11 through 3.2-27.

	Space Type	SF/Seat
LABORATORY	Biology, General	52
	Chemistry, General	52
	Engineering, General	60
	Physics, General	41
	Geology, General	52
	Art and Architecture	60
	Research, Wet Lab	62
	Research, Dry Lab	40
LAB SUPPOR	Biology	13
	Chemistry	13

3.2.3.2.1 Lab Safety Requirements

3.2.3.2.1.1 All Laboratory Facilities

- All buildings that contain laboratories, art studios, or maintenance buildings where chemicals are used shall have an adequately sized and designed room for chemical storage and waste storage, as well as supplies. Refer to NFPA 30 – Flammable and Combustible Liquids Code.
- Refer to NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals.
- Design floors to support large pieces of laboratory equipment (i.e., mass spectrophotometers, freezers, etc.). In addition, vibration and stabilization may need to be considered for certain pieces of equipment (i.e., electron microscopes, etc.).

- All labs shall have hard floors, preferably chemical resistant (VCT and sheet vinyl are typically acceptable). For floors that are subject to extensive washing, refer to Animal Laboratories in Section 3.2.3.7 – Materials and Finishes.

- Decontamination stations such as sinks for hand washing and storage of clean clothes shall be designed into each laboratory, shop, studio or other such space. These facilities shall be located near exits leading to less hazardous areas.

- The most hazardous operations areas, such as chemical fume hoods, biological safety cabinets, and chemical storage areas must be located away from doors and exits in an area that is least susceptible to cross drafts, foot traffic, or sources of exhaust from other laboratory equipment. This is to improve safety and to minimize the chance that turbulence is created near the hood or cabinet.

- Sufficient areas convenient to all occupants must be provided to discourage eating and drinking in, and continuous occupancy of, potentially hazardous work areas.

- Typical labs are arranged to allow for a variety of student teams, from 2 to 8 people, depending on the course and discipline.

- For all instructional laboratories, provide sufficient space beneath the bench top to accommodate a person's legs and allow them to sit comfortably and erect while working at the bench top.

- Specific design requirements for microscope rooms depend on the type of microscope and the work to be performed. Vibration, ventilation, lighting, and utilities are important considerations.

- Fume Hoods

    - If fixed fume hoods, sinks, larger equipment and overhead storage can be located around the perimeter, a more flexible lab center will allow for a wider range of pedagogies and sub-disciplines over the life of the building. Coordinate with Mason to select the layout type appropriate for each laboratory.

    - Basic fume hoods for organic chemistry are typically 6'-0" wide; general chemical fume hoods for allow for two students to work in the hood .

    - Write up stations shall not be co-located with chemical storage areas.

3.2.3.2.1.2 Biology Laboratories

- All biological laboratories shall be provided access to a cold room within the same building as the laboratory.

3.2.3.2.1.3 Animal Laboratories

- If the College of Science will use the animal space, the space must be designed to meet AAALAC standards.

- Penetration in floors, walls, and ceilings should be sealed, to include openings around ducts, doors, and door frames, to facilitate pest control and proper cleaning.

3.2.3.3 Windows and Walls

3.2.3.3.1 All Laboratory Facilities

- Presentation areas with sliding marker boards, projector screens, and A/V equipment shall be located on an interior wall to allow for exterior glazing.
- Glass to the corridor is desired to allow for light to penetrate into the building and to allow for views into the dynamic teaching lab environment. Interior glazing also contributes to a safer lab environment.
- Seal all gaps between the room and adjacent construction.

3.2.3.3.2 Biology Laboratories

- Windows in biological laboratories shall be non-operational.

3.2.3.3.3 Animal Laboratories

- External windows are not recommended.

3.2.3.4 Doors

3.2.3.4.1 All Laboratory Facilities

- Hazardous waste storage rooms shall have hard key doors only.
- Doors shall be self-closing and self-locking.
- Doors shall be of sufficient dimensions to accommodate equipment and may not be less than 48 inches wide.
- Vision panels must be provided in the active leaf of all laboratory doors.

3.2.3.4.2 Animal Laboratories

- For laboratories containing research animals, doors shall open inward (doors to cubicles inside an animal room may open outward or slide).
- Vision panels on doors may be tinted to prevent disruption of the animals' light/dark cycle.

3.2.3.5 Accessibility

3.2.3.5.1 All Laboratory Facilities

- Aisles shall have a minimum dimension of 5'-0" based on American Disabilities Act (ADA). This represents good laboratory practice for safe circulation zones in the lab.
- Each lab shall be designed to have at least one position that is ADA compliant. This will affect the design of at least one fume hood (where applicable) and sink.

3.2.3.6 Furniture and Equipment

3.2.3.6.1 Autoclaves

3.2.3.6.1.1 All Laboratory Facilities

- Autoclaves are industrial appliances that require overhead exhaust and floor drains. The size and model of autoclave should be determined by the specific function for the area and the anticipated frequency of use.

- Install a water softener in locations that have hard water (e.g., Prince William) to prevent calcium buildup from disrupting the function of the autoclave.

- Provide all biological laboratories with access to an autoclave within the same building as the laboratory.

- Provide autoclave rooms with sufficient ventilation to accommodate a high heat load of the equipment in the room.

- Provide autoclaves with a drip pan capable of holding 30% of the autoclaves operating capacity.

- Autoclave effluent shall discharge directly to sanitary sewer, and shall not discharge to a neutralization tank.

3.2.3.6.2 Special Equipment

3.2.3.6.2.1 All Laboratory Facilities

- Locate any labs with vibration-sensitive equipment (that would equal or exceed the vibration resistance needs of a 400X microscope) on the lowest floor where there is a concrete slab on grade, or utilize a vibration table if placed on an upper level.

- Equipment containing high strength magnets has specific design requirements that must be followed to shield the magnetic field, limit radiofrequency disturbance, and provide adequate ventilation for cryogenic liquids used to cool the magnet. Coordinate design of laboratories containing this equipment with EHS, the end user, the vendor, and a project engineer with appropriate knowledge and experience.

- Laboratories containing radioactive materials shall be equipped with appropriate mechanisms to secure radioactive materials inventory (lockable freezer) and waste (lockable waste containers).

- All laboratories, art studios and scene shops using or storing gas cylinders shall have cylinder storage mounts, racks, or floor stands for each cylinder to be used or stored. Mounts shall be located at a height that allows for the cylinder restraint to be placed 3/4 of the way up the cylinder. The design of cylinders shall comply with 29 CFR 1910.101.

3.2.3.6.3 Casework, Benches, and Furniture

3.2.3.6.3.1 All Laboratory Facilities

- Organizing lab casework on a three foot module will allow for easy changes and can be well served by an interchangeable inventory of casework.

- Ideally, labs shall be organized on a two directional grid to add flexibility to casework layouts

- Select easily cleanable materials and finishes for laboratory casework that are compatible with substances used for cleaning and disinfection. All wet lab benches shall be made of epoxy resin.

- Construct all bench tops of materials that are impervious to the chemicals and materials used in the laboratory. Ideally, bench tops should incorporate a lip to prevent runoff onto the floor.
- Provide a biosafety cabinet in any room where infectious materials will be used in a manner than can generate an aerosol, splash or splatter. The type of biosafety cabinet will be determined by an EHS risk assessment.
- Cold and warm rooms shall have stainless steel counters, legs, and sink and wire shelves.
- All chairs shall be constructed of synthetic non-fabric, non-porous materials.

3.2.3.7 Materials and Finishes

3.2.3.7.1 All Laboratory Facilities

3.2.3.7.1.1 Wall Finishes

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3.2.3.7.1.2 Floor Finishes

- All laboratory floors must be made of wipeable materials (no carpeting or rugs). VCT or similar material is acceptable.
- Waste storage rooms shall have recessed floors and be sealed with concrete.

3.2.3.7.1.3 Ceiling Finishes

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3.2.3.7.2 Animal Laboratories

- Walls, floors, and ceilings should be water resistant and designed to facilitate cleaning and housekeeping.

3.2.3.8 Building Systems

3.2.3.8.1 General

- Arrange light fixtures, air ducts, and utility pipes to minimize horizontal surfaces for cleaning.

3.2.3.8.2 Plumbing

3.2.3.8.2.1 All Laboratory Facilities

- Refer to Section 3.3.3 – Plumbing Systems.
- For information regarding compressed air piping, vacuum piping, gas piping, chemical waste systems and processed water systems for laboratories refer to Chapter 4, Sections 22 61 13, 22 62 13, 22 63 13, 22 66 00 and 22 67 00.
- Design plumbing systems to accommodate easy service isolation and maintenance while minimizing disruption to laboratory functions. Adequate fluid temperature, pressure, and volume should be delivered to required laboratory functions. Consider future capacity allowances in building designs.

- Consider building services needed by researchers (centralized bottled gases, compressed air, etc.) in the design. All effluent plumbing from laboratories shall be made of chemical-resistant materials and drain into a neutralization tank before discharge to sanity sewer.
- Provide a sink with pressurized running water near the exit door in all laboratories.
- An ANSI-approved shower and eyewash must be located within a 10 second walk in all spaces where chemicals are used or stored. The pathway to the emergency shower and eyewash shall be unobstructed (i.e. no doors without panic bars, no doors that do not swing open in the direction of travel). The installation of both a shower and eyewash in a mutual location is preferred by Mason.
- An ANSI-approved eyewash must be available in all spaces where eyes may be exposed to small particulates.
- Emergency shower and eyewash locations should be determined by an EHS risk assessment.
- The floor beneath emergency showers and eyewashes must not be carpeted.
- Do not install drains under emergency showers unless sensitive or extensive equipment/electronics exist below that may be adversely affected by the use of the emergency shower.
- Floor drains shall not be located inside laboratories unless required for indirect discharge from equipment.

3.2.3.8.3 Heating, Ventilating and Air Conditioning

3.2.3.8.3.1 All Laboratory Facilities

- Refer to Section 3.3.1 – HVAC Systems.
- Refer to Chapter 4, Section 23 07 00 HVAC Insulation for information regarding duct lining for laboratories and animal use areas.
- Ventilation systems shall comply with NFPA 45, latest edition.
- Design all laboratories to provide the required air changes indicated in Mason's Laboratory Ventilation Management Plan, unless one of the following conditions applies:
    - Space internal loads dictate greater airflows for cooling.
    - The total fume hood and containment device exhaust air requirements exceed 12 air changes per hour.
- The minimum occupied and unoccupied air change rate will be determined by EHS via risk assessment and is dependent on the type of work being performed in the laboratory.
- The minimum occupied and unoccupied fume hood face velocity set-point will be determined by EHS. Maximum fume hood design air flow rates shall be based on sash height and face velocity criteria determined by EHS.
- Where internal loads dictate airflows greater than 12 air changes per hour; use of chilled beams shall be evaluated in collaboration with Mason/EHS.

- Where the total fume hood and containment device exhaust air flow dictate greater than 12 air changes per hour, low flow fume hoods shall be evaluated in collaboration with Mason/EHS.

- All laboratory exhaust, including general exhaust and local exhaust ventilation (e.g., chemical fume hoods, biosafety cabinets, and snorkels) shall be single pass and vented to the outside of the building.

- All laboratory exhaust, including general exhaust and local exhaust ventilation (e.g., chemical fume hoods, ducted biosafety cabinets, and snorkels) should be manifolded if the chemicals used in the laboratories are compatible.

- "Co-Mingling" or mixing of general laboratory exhaust and exhaust directly from fume hoods and other containment devices is allowable as long as it is accomplished in compliance with applicable building and life safety codes and the chemical used are compatible.

- "Co-mingled" or combined fume hood and general room exhaust systems must be considered and designed as "hazardous exhaust systems" in accordance with International Mechanical Code, and other applicable building and life safety codes.

- Where fume hoods and general room exhaust streams are combined, the ductwork shall be fully welded type 316 stainless steel. The stainless steel ductwork shall be run from the point of collection (hood connection or room exhaust grille/inlet) to the main riser for that portion of the building. The main duct riser and associated downstream ductwork shall be constructed of stainless steel or anti-corrosion coated galvanized steel or other suitable materials approved by the Mason and the AHJ.

- Where general exhaust and fume hood exhaust systems are NOT combined, the fume hood exhaust ductwork shall be fully welded type 316 stainless steel and shall be considered a hazardous exhaust system.

- No heat recovery wheels (or any other technology which does not completely separate the exhaust and intake airstreams) will be considered for energy recovery building exhaust which handles fume hood exhaust, whether combined or not.

- Variable air volume control dampers controlling the exhaust flow from fume hoods and general room exhaust shall fail OPEN upon loss of control power or control air.

- Where exhaust is required to be filtered with HEPA filters, bag-in/bag-out containment type filter housings shall be utilized and shall include bubble tight dampers the inlet and outlet of the filter housing. The dampers housing shall be fully welded to the filter containment housing. The housing and damper material shall be stainless steel and shall be fully welded construction.

- For fume hood duct design and construction, see Chapter 4, Section 11 53 00.

- Vacuum pump systems shall have water resistant HEPA filters on the suction side with the exhaust to the outside of the facility. Vent vacuum system exhaust to the outside of the building, not recirculated to the mechanical room. A sampling port may be needed to sample exhaust. Design filter housing for easy replacement of the filter, with maximum protection for maintenance personnel.

- Fume Hoods

- All chemical fume hoods shall meet all relevant design and testing protocols as required by ASHRAE 110. ASHRAE 110 testing shall be completed after the chemical fume hood is installed, and testing certificates/reports delivered to EHS. ASHREA 110 testing shall be specified as part of the building construction contract.
- Design all wet laboratories to accommodate at least one chemical fume hood to allow for flexibility and university expansion.
- All chemical fume hoods shall have the following features: lighting, movable sash, chemical and fire resistant work surface, a raised lip or recessed work area. Provide at least 2 linear feet of work space per user.
- All chemical fume hoods shall have a face velocity of 80-120 feet per minute when the sash is opened 18".
- All chemical fume hoods shall have a monitor with a digital display of the average face velocity. The monitor shall be equipped with an audible and visual alarm. The monitor shall have a digital display showing the average face velocity.
- If volatile radioactive materials are to be used, provide a chemical fume hood capable of trapping volatile radioisotopes to prevent their release into the environment.
- If perchloric acid is to be used, a chemical fume hood shall be manufactured to meet ANSI/AIHA Z9.5-2003 and NFPA 45.
- Locate chemical fume hoods and biological safety cabinets in an appropriate location within the laboratory that is least susceptible to cross drafts, foot traffic, or sources of exhaust from other laboratory equipment. They may not be placed near doors or emergency exits. Chemical fume hoods shall not be located close to biological safety cabinets.
- A 12-14 inch clearance above biosafety cabinets may be required to provide for accurate air velocity measurement across the exhaust filter surface.

- Biological safety cabinet operation, as specified by NSF/ANSI Standard 49-2007, Annex F plus Addendum #1 shall be verified at the time of installation and, as a minimum, annually thereafter. Operational tests include Down flow Velocity Profile Test, Inflow Velocity Test, Airflow Smoke Patterns Test, HEPA Filter Leak Test, Cabinet Integrity Test (A1 cabinets only), Electrical Leakage and Ground Circuit Resistance and Polarity Tests, Lighting Intensity Test, Vibration Test, Noise Level Test, UV Lamp Test (if present).
- Ventilation systems must be designed to handle anticipated heat loads generated by specific pieces of equipment. This is especially critical for biological laboratories as incubators, freezers, and other pieces of equipment generate significant heat loads.
- Ventilation ductwork must be compatible with chemicals exhausted from the space.
- Local exhaust ventilation must be designed to effectively capture anticipated airborne contaminants as close to the generation point as possible. Appropriate testing must be completed after the local exhaust is installed, and testing certificates and reports (when appropriate) must be delivered to EHS. Testing shall be specified as part of the building construction contract. Dust

collection systems are required for dust generating equipment, such as saws, to prevent a fire hazard.

- Prior approval by EHS is required for the use of canopy hoods.
- All exhaust in art studios and scene shops, including general exhaust and local exhaust ventilation (e.g., general ventilation, snorkels, and slot hoods) shall be single pass and vented to the outside of the building.
- All art studio and scene shop exhaust, including general exhaust and local exhaust ventilation, shall be manifolded if the chemicals used are compatible.
- For additional information regarding fume hood exhaust fans, refer to Section 3.3.1.4.20.5.

3.2.3.8.3.2 Animal Laboratories

- Provide ventilation in accordance with the Guide for Care and Use of Laboratory Animals. Heat and humidity shall be adjustable to accommodate a range of animal species.

3.2.3.8.3.3 Darkrooms

- Furnish darkrooms where chemicals are used with local exhaust ventilation to control airborne levels of photographic process chemicals. This shall be in the form of a flanged slotted plenum running the length of and behind the work area where chemicals are used. A capture velocity of 50 linear feet per minute (LFM) must be provided at the front edge of the work area. The required exhaust flow rate to produce this capture velocity shall be calculated by the following formula:
- $Q = 2.6 LVX$

  Where:

  Q = Volumetric flow rate in cubic feet per minute (CFM)

  L = Length of work area, in feet

  V = Desired capture velocity (in this case, 50 LFM)

  X = Distance from slot to front of work area, in feet
- Once the required flow rate is determined, the slot width shall be sized to provide a slot velocity of approximately 2000 feet per minute. The plenum shall be sized to provide a plenum velocity of approximately half the slot velocity. (Taken from the ACGIH Industrial Ventilation Manual, 22nd Edition.)

3.2.3.8.4 Electrical

3.2.3.8.4.1 All Laboratory Facilities

- Refer to Section 3.3.2 – Electrical Systems.
- Emergency generators shall be sized to provide adequate power for all exhaust fans serving combined fume hood and general room exhaust systems. Supply air handler outside air intake isolation damper actuators shall be served by the emergency power system and power OPEN to

prevent excessive negative building pressurization upon loss of primary power source. Supply air handlers do not have to be included in emergency generator capacity. Where fume hood exhaust is separate from general room exhaust, only the fume hood exhaust fans need to be included in calculating the emergency generator capacity.

- Laboratory research requires high-quality lighting for close work, in terms of both brightness and uniformity. Position fixtures to provide uniform, shadow-free, and glare-free illumination of the laboratory bench top. Lighting shall be at least 70 foot-candles and may be as great as 120 foot-candles depending on the application.

- Post emergency lighting, either electric or photoilluminescent, at each exit in a laboratory. This lighting must provide at least an average of 1 foot candle of light and 0.1 foot-candle at floor level.

- Art studios and scene shops require high-quality lighting for close work, in terms of both brightness and uniformity. Position fixtures to provide uniform, shadow-free, and glare-free illumination of the work bench. Lighting shall be at least 30 (according to OSHA) foot-candles and may be as great as 50 foot-candles depending on the application.

3.2.3.8.5 Communications (IT/AV)

3.2.3.8.5.1 All Laboratory Facilities

- All laboratories shall be equipped with a phone.

3.2.3.9 Acoustics

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3.2.3.10 Security

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