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A. Sample of Laboratory Air Balance Schedule

1. GENERAL

A. Overview: This Laboratory Design Guide is to be used in conjunction with Michigan State University (MSU) Construction Standards Design Guidelines (http://ipf.msu.edu/resources/business-partners/standards-for-construction/index.html) and MSU Environmental Health and Safety (EHS) Programs and Guidelines (http://www.ehs.msu.edu/). Note that this guide is not all inclusive. It does not cover all regulatory issues nor does it cover all design conditions. It's important that MSU EHS be consulted on laboratory design at the planning stages of the project.

B. Applicable Regulations, Codes, Standards and Guidelines

- The design and safety guidelines include but are not limited to the following codes, standards and guidelines, latest issues available at the time the project proceeds with the schematic design unless noted otherwise:
  - ◊ Federal Code of Regulations (CFR), Title 29, Labor.
  - ◊ Michigan Occupational Safety and Health Administration (MiOSHA) General Industry Safety and Health Standards.
  - ◊ Centers for Disease Control and Prevention (CDC) Select Agents, Title 42, Chapter I, Part 72 – Interstate Shipment of Etiologic Agents.
  - ◊ Michigan Mechanical Code (MMC).
  - ◊ Michigan Plumbing Code (MPC).
  - ◊ American National Standard for Laboratory Ventilation (ANSI/AIHA Z9.5).
  - ◊ American National Standard for Emergency Eyewash and Shower Equipment (ANSI/ISEA Z358.1).
  - ◊ National Fire Protection Association (NFPA) 45 - Standard on Fire Protection for Laboratories Using Chemicals.
  - ◊ National Fire Protection Association (NFPA) 55 - Compressed Gases and Cryogenic Fluids Code.
  - ◊ American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - ◊ ASHRAE HVAC Applications Handbook 2015 Chapter 16 Laboratories.
  - ◊ National Institutes of Health - Design Requirements Manual. Confirm with MSU Design Representative if NIH Requirements are to be followed on a project by project basis.
  - ◊ CDC-National Institutes of Health (NIH) Biosafety In Microbiological and Biomedical Laboratories, 5th Edition.
  - ◊ Guidelines for Research Involving Synthetic Nucleic Acid Molecules (NIH Guidelines).
  - ◊ American Association for Accreditation of Laboratory Animal Care (AAALAC).
  - ◊ Institute of Laboratory Animal Resources (ILAR) Guide for the Care and Use of Laboratory Animals, 8th Edition.
  - ◊ ANSI/ASSE Z9.14 - Testing and Performance-Verification Methodologies for Ventilation Systems for Biosafety Level 3 (BSL-3) and Animal Biosafety Level 3 (ABSL-3) Facilities.

C. Health and Safety

- Hazard Assessment: Contact MSU EHS for a comprehensive hazard assessment.
- Dispersion Study
  - ◊ Exhaust dispersion studies, either scale model wind tunnel testing, computational fluid dynamics or numerical analysis method, are required to ensure proper, safe, dilution of exhaust emissions. Appropriate analysis method to be chosen by the qualified firm along with MSU IPF and MSU EHS. The chosen method shall be performed by qualified firms having at least 5 years of experience. All new lab buildings and exhaust renovations shall have dispersion study. Consider dispersion studies for all new constructions and major renovations.
- Computational Fluid Dynamics (CFD)
  - ◊ Refer to Architectural Fume Hood section and Mechanical Section for additional CFD requirements.

D. Energy Conservation

- Design shall include all measures to minimize total energy consumption, including electrical energy, steam/heating energy, cooling, and water, while not compromising the safety or the thermal requirements of the research environment. Include payback criteria in analysis.
- Energy Codes and Standards
  - ◊ ASHRAE 90.1.
  - ◊ Michigan Uniform Energy Code.
- Complete energy simulation modeling for new constructions or major renovations.

E. Commissioning

- Laboratory systems and components to be commissioned should include the following:
  - ◊ Fume hoods.
  - ◊ High-efficiency particulate air (HEPA) filtration systems.
  - ◊ HEPA decontamination systems.
  - ◊ Airtight isolation dampers.
  - ◊ Process water systems.
  - ◊ Liquid effluent treatment and neutralization systems.
  - ◊ Chemical decontaminant systems.
  - ◊ Laboratory gas systems.
  - ◊ Cascading pressure differential verification of laboratories and support areas.
  - ◊ Airlock door control interlocks.
  - ◊ Envelope pressurization and isolation functions.
  - ◊ Cryogenic liquid systems and alarms.
  - ◊ Water detection systems (e.g. in case of flooding inside containment zone).

- ◊ Functional testing will include all systems and no sampling is allowed.
- ◊ Biosafety cabinets.
- ◊ Hazardous gas detection and alarm systems.
- ◊ Eyewash and safety showers.
- ◊ Gas cabinets.
- ◊ Standby Power Systems (test generation and associated distribution equipment).
- ◊ Lighting Control Systems (Test adjustable timers and automatic lighting control systems and devices).

2. SITE AND UTILITY INFRASTRUCTURE

A. Site and Utility Infrastructure Design Considerations

- Review all planned connections to the utility systems with MSU Infrastructure Planning and Facilities (IPF).
- Emergency generators
  - ◊ Refer to Design Guidelines - Electrical unless noted otherwise and to MEP sections in Lab Guidelines and Design Guidelines.
  - ◊ If emergency generator is located outdoors, it shall be located in a sound-attenuated enclosure with adequate working space around the generator.
- Chemical/materials handling, deliveries and waste
  - ◊ Identify size of tanks, material of construction and chemical specific tanks
  - ◊ Access to tanks
    a. Identify frequency and manner in which tanks will be filled.
    b. Identify dimensions of vehicles that will make deliveries.
    c. Avoid blocking sidewalks with hoses/ trucks/ machinery.
  - ◊ Security of stored materials/tanks.
  - ◊ Environmental Protection Agency (EPA) and State hazardous waste shall not be stored.
  - ◊ Pathological waste storage and access for removal.
  - ◊ Consider secondary containment for all regulated waste in containers.

3. ARCHITECTURE

A. Architecture Design Considerations

- General Laboratories, i.e., organic chemistry, inorganic chemistry, and multidiscipline research.
  - ◊ Lead lined walls – discuss need and types with MSU EHS/Physicist.
  - ◊ Consider ventilated and alarmed centralized space to accommodate gas cylinder storage (in vicinity of loading dock) from which gases could be piped.
  - ◊ Chemicals shall not be stored within fume hoods. Where a storage space for chemicals is needed, a storage cabinet below fume hood may be provided. Do not duct flammable chemical cabinets into the fume hood bench top, but run separate

exhaust from cabinet to the exhaust duct or to a dedicated constant volume fume hood exhaust air valve or nearest constant volume fume hood exhaust air valve. Corrosive cabinets beneath hoods can be vented into the hood.

- ◊ Flooring shall be non-pervious, one piece with covings to the wall. Sealing of all room penetrations and joints shall be specified to maintain space pressurization.
- ◊ Provide separate ~~office~~ spaces with full walls and closable doors for laboratory employees to separate food and drink areas from laboratory work areas.
- ◊ Lab desks should be located near exit ways and in the path of fresh make up air.

- Biosafety Level 1 Laboratories
  - ◊ No additional requirements over a general laboratory.
- Biosafety Level 2 Laboratories
  - ◊ Contact EHS Biosafety Officer for cabinets used for applications with toxins or toxic chemicals. This type of cabinet will be vented out of the building.
  - ◊ Autoclaves are required for waste treatment prior to disposal. A minimum of 10 air changes per hour will reduce unpleasant heat and odors from lingering in the room. The autoclave need not be in the actual lab room, however should be available in close proximity.
  - ◊ Sink for hand washing and an eyewash facility must be readily available in the work area.
  - ◊ Chairs used in laboratory are must be covered with a non-porous material that can be easily cleaned with a suitable disinfectant.
- Biosafety Level 3 Laboratories
  - a. Designs are specialized and require EHS contact and support.
- Animal Research Facilities, i.e., Holding Rooms, Procedure Rooms and Surgery Suites
  - ◊ Facilities must meet the expectations and requirements of the ILAR Guide, 8th edition, to be fully accredited by AAALAC.
  - ◊ Campus Animal Resources (CAR) needs to be involved in all animal facility design at the planning stages of the project.
  - ◊ Do not install exterior windows in animal rooms; although doors may have viewing windows installed that should have the ability to be covered as needed for experimental uses.
  - ◊ Keep animal suites separate from offices and main pedestrian corridors to discourage unauthorized access as well as to mitigate odors and allergens.
  - ◊ Consider the transportation of animals, cages, feed, bedding, waste etc. in the layout and the vicinity to loading dock and elevators. Keep these routes separate from public access if possible.
  - ◊ Consider size of cage racks and other equipment when determining corridor size, a width of 6 to 8 feet can accommodate most facility needs.
  - ◊ Coordinate animal holding room layout with need for low sidewall exhaust grilles.
  - ◊ Doors need to permit movement of people and equipment and ideally should open into the animal housing room.

- ◊ Animal rooms (walls and floors) need to be washed down. Surfaces need to waterproof and sanitizable. Surface materials should be capable of withstanding cleaning with detergents and disinfectants and the impact of water under high pressure.
- ◊ Animal room/facility floors should be moisture resistant, nonabsorbent, impact resistant, and relatively smooth, although textured surfaces may be required depending on species and research needs. Floors should be capable of supporting racks, equipment and stored items without becoming gouged, cracked or pitted.
- ◊ Floor drains within animal rooms should be used with sloped floors and drain traps kept filled with liquid. To minimize prolonged increases in humidity, drainage should allow rapid removal of water and drying of surfaces Drainpipes should be at least 4 in. (10.2 cm) in diameter, although in some areas, such as dog kennels and agricultural animal facilities, larger drainpipes (>6 in.) are recommended.
- ◊ Animal areas need to be secured only to authorized personnel. Work with CAR staff to determine access control methods.
- ◊ Confirm with CAR if barrier type facility required and clean/dirty area.
- ◊ A laboratory bench and sink must be located within the facility (BMBL expectation).
- ◊ Location of necropsy room needs to be considered as well as carcass freezer.
- ◊ Clean cage storage areas.
- ◊ Ideally, animal housing rooms should contain 100% fresh air that is not recycled, space for changing station/biosafety cabinet, and storage for supplies; procedure rooms should also be available in the facility.
- ◊ Animal surgical areas have specialized requirements for animal preparation, surgeon preparation, surgical procedures (100% fresh air, non-recycled, positive room pressure), and post-procedural recovery (note: sinks are required near rooms if biocontainment level work (e.g., infectious disease) is being performed).
- ◊ Changing stations, biosafety cabinets, and surface work areas may need to be installed or added depending on needs of investigators.
- ◊ Coordinate barriers for light infiltration with requirements per animal type including openings around doors and any interior glass.
- ◊ Seal penetrations (conduit/piping/etc.) as needed to prevent pest infiltration as required.

B. Casework and Equipment

- Selection: Consult with Users and EHS.
- Fume Hoods
  - ◊ Performance: Low flow fume hoods may be used as long as they meet all the requirements of ASHRAE 110. The face velocity of low flow hoods should be not less than 80 fpm with sash full open. Conventional and variable air volume hoods shall have a face velocity of 100 fpm with sash full open..
  - ◊ Auxiliary air hoods and ductless fume hoods are not permitted unless approved by EHS.
  - ◊ Location: Follow the NIH general recommendations

a. Avoid locating fume hoods adjacent to doorways or in circulation pathways;
b. Perform Computational Fluid Dynamics (CFD) analysis when hood proximity or density may affect the operation of the hoods.

◊ Controls and Alarms: Make provisions to allow mounting of sash sensors, sash alarm and other devices provided by the laboratory control contractor.

◊ Fume hood monitors are required. Digital monitor displays are preferred.

◊ Clearly indicate on mechanical drawings and air balance schedule each fume hood type: Restricted Bypass CAV, Restricted Bypass VAV, Full Bypass VAV and CAV, Combination Sash, etc.

- Biosafety Cabinets (BSC)

◊ Biological safety cabinets must be National Science Foundation (NSF) listed, Underwriters Laboratories (UL) approved, and installed in accordance with the manufacturer's requirements. Cabinets, which when used and installed properly, will provide both product and personnel protection. However, if the cabinet is not installed properly (e.g., not ducting a Class II, B2 cabinet), then it will not be serviceable. Installation of a cabinet which deviates from the listed NSF requirements will void the NSF Standard 49 approved listing.
◊ Particulate filtration is required for Nano High Efficiency Particulate Air (HEPA) filters.
◊ Location: Cabinets must be located away from doors and other high traffic areas. All attempts should be made to neutralize any interference by air currents. Airflow is hindered by the operation of a biosafety cabinet located directly opposite of another cabinet or autoclave. Cabinets should not be installed directly under air supply inlets as external air currents degrade the effectiveness.
◊ Follow the NIH general recommendations for minimum clearance requirements.

- Autoclaves

◊ Autoclave space shall have adequate exhaust capacity to remove heat, steam, and odors generated by the use of the autoclave(s); and operate at negative pressure to the surrounding areas. Exhaust to outside.
◊ Canopy-type stainless steel hood shall be provided over autoclave.
◊ Floors shall be of liquid tight construction.

- Controlled Environment Rooms

◊ Cold rooms should be provided with remote water-cooled condensing units, which are not located directly above the room.
◊ Connect a high and low temperature monitoring and alarm system to IPF Central Control.

4. MECHANICAL

A. HVAC Design Considerations

- Refer to DESIGN GUIDELINES – MECHANICAL unless noted otherwise.

- Animal Research Facilities (Holding Rooms, Procedure Rooms and Surgery Suites)
    - ◊ HVAC systems for animal research facilities shall be independent from other building HVAC systems, and shall be provided with multiple AHUs and exhaust fans to provide redundancy and improve reliability.
    - ◊ Animal Holding Rooms and Procedure Rooms need to be capable of being maintained at any setpoint within the range of 65-80 dF (+/- 2dF) depending on species. Room humidity is to be maintained within the range of 30% min to 70% max year round.
    - ◊ All animal Holding Rooms will be designed to be capable of achieving 15 air changes per hour to provide flexibility in the use of static or ventilated racks. Coordinate with MSU Design Representative and MSU CAR as to the extent of provisions to be made for present and future ventilated rack exhaust connections. The indoor environmental monitoring system (Aircuity Optinet) will reduce the air change rate, on a room by room basis, to as low as 10 air changes per hour for the static cage rack holding rooms if measured contaminant level is acceptable. Provide visual pressurization indicator.
    - ◊ Animal Procedure rooms will be designed same air change rate as Animal Holding rooms to allow them to be used as such when desired. Provide visual pressurization indicators.
    - ◊ Sound and vibration attenuation is critical in research animal facilities, particularly breeding colonies. Follow NIH guidelines.
    - ◊ Air re-circulation within animal facilities is prohibited.
- Ventilation
    - ◊ Minimum outdoor air ventilation rate for laboratory spaces is 6 ACH. Ventilation rate can be reduced to 4 ACH occupied/4 ACH unoccupied with contaminant sensing using Aircuity Optinet System. Room ventilation system shall be designed for a turndown ratio of 16:2 ACH. Consult with EHS for required ACH.
    - ◊ Ventilation of environmental rooms which serve as occupied laboratory spaces shall be designed in accordance to the latest edition of ASHRAE 62.1. Environmental rooms used primarily for storage functions are not to be considered occupied spaces and do not require ducted ventilation air.
- Room Pressurization
    - ◊ Maintain at a negative pressure for laboratories that use hazardous chemicals and materials.
    - ◊ Maintain positive pressurization to prevent infiltration for laboratories such as clean rooms and sterile facilities.
    - ◊ Maintain positive pressurization for non-laboratory spaces such as offices adjacent to labs.
    - ◊ Potentially harmful aerosols can escape from the containment of the laboratory room unless the room air pressure is negative to adjacent non-laboratory areas. As a general rule, air should flow from low hazard to high hazard areas.
    - ◊ Clean rooms and surgical spaces should be maintained in rooms with a positive air pressure to adjacent areas.

- ◊ Air pressure in laboratories and typically animal care rooms should be negative in relation to the corridor or adjacent non-laboratory areas.
- ◊ Animal housing rooms housing immunocompromised animals should be at a positive pressure with respect to adjoining areas maintain pressure differentials at each barrier door.
- ◊ Review room differential pressure design with MSU EHS.
- ◊ Sealing of all room penetrations and joints shall be specified to maintain space pressurization.

- Diversities/Redundancy
  - ◊ Size supply and exhaust systems with additional capacity for future use.
  - ◊ Determine appropriate additional capacity with MSU Design Representative. Minimum additional capacity is 20%.
  - ◊ Diversity factor of 80% or higher can be applied to the main distribution ductwork and central AHUs and exhaust fans. Room zone distribution ductwork including terminal units shall be sized for 100% load.
  - ◊ Consider N+1 redundancy for any critical research. Discuss with Users.
  - ◊ Consider N+1 redundancy for animal research facilities per NIH guidelines.
- Noise and Vibration
  - ◊ Equipment that generates noise should be remotely or acoustically isolated wherever possible.
  - ◊ Isolate noise sensitive areas from noise sources wherever possible.

B. Air Handling Systems

- Supply Air Systems
  - ◊ Laboratory supply air shall be “once through” (100% outside air); and not be recirculated to other laboratory spaces or reused for other ventilation needs.
  - ◊ Provide multiple parallel AHUs to operate simultaneously to meet full load conditions.
  - ◊ Provide multiple supply fans in AHUs to achieve N+1 redundancy.
  - ◊ Vivarium requires dedicated, N+1 air handlers fed from the emergency power system.
  - ◊ Air valves serving animal holding rooms shall be selected such that air flow to these rooms can be increased an additional 10% minimum, future. Size the vivarium air handler with sufficient capacity to accommodate this additional air flow quantity.
  - ◊ Reheat coils serving animal rooms shall utilize normally closed (N.C.) control valves to prevent over-heating animals upon a valve failure.
- Exhaust Air Systems
  - ◊ Exhaust fans serving laboratory spaces shall be designed and approved for laboratory applications.

- ◊ Research areas shall be provided with dedicated and separated exhaust air systems from non-research functions areas. Laboratory supply and exhaust air systems shall be dedicated to lab areas within the building and shall not be part of HVAC systems serving other building areas (offices, vivarium, etc.)
- ◊ Offices contained within lab areas shall operate as positive with respect to the labs.
- ◊ Lab general and fume hood exhaust shall be manifolded whenever possible as permitted by code to reduce first cost and improve energy efficiency and maintainability.
- ◊ Exhaust air ductwork shall not be located in the same shaft with supply air ductwork and return air ductwork per NFPA 90A.
- ◊ Design to operate 24/7.
- ◊ Provide multiple manifolded exhaust fans to achieve N+1 redundancy.
- ◊ Connect at least one exhaust fan per system to the emergency electrical power system.
- ◊ Smoke dampers and/or fire dampers shall not be installed in laboratory exhaust ducts serving fume hoods, BSCs, or other containment type equipment. Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory hood exhaust fans.
- ◊ Provide drains in exhaust plenums located outside (drain valve/hose connection/cap) to remove routine condensation formation that occurs during the winter months. Drains should be routed to termination points inside the building and separately trapped. Portions of such drains exposed to outside must be heat traced.
- ◊ Locate lab exhaust fans on top floor roof with maintenance access. Do not locate positive pressurized ductwork segment in any occupied zones, including mechanical rooms.
- ◊ Fan stack shall be a minimum of 10’ above highest local roof with a minimum discharge exit velocity of 3000 fpm. Dispersion study is required to verify applicability of lower, safe stack height and velocities for energy savings.
- ◊ The exhaust location shall not be through a sidewall.
- ◊ Dedicated Exhaust Air Systems
    a. Radioisotope hood exhaust system should be independent of other building exhaust systems and shall be constant volume. Provision should be made for filters to be installed at hood outlet if required, and fan should be selected for recommended filter final resistance. Exceptions shall be made with approval of the Radiation Safety Officer.
    b. Perchloric acid exhaust systems are not allowed.
    c. Bio-safety cabinet exhaust system must be dedicated to each BSC unit and independent of other building exhaust system. Fans must be selected for recommended filter final resistance.
    d. Animal general research areas.
    e. Cage and rack washers – avoid horizontal runs, do not use laboratory terminal airflow units.
- ◊ Each animal room exhaust shall be equipped with a filter rack at wall typically in exhaust grille style filter frames. Discuss with MSU CAR.

- ◊ Wet exhaust ductwork serving sterilizers, autoclaves, and cage washers shall be constructed of stainless steel, and be pitched toward the source of moisture generation. Drainage shall be provided in these systems.

- Air Distribution Systems
  - ◊ Supply, exhaust and outside air shall be ducted for all spaces, i.e., not taken through ceiling plenums, shafts, mechanical rooms, or corridors.
  - ◊ Locate supply air diffusers away from the face of fume hoods or BSCs.
  - ◊ Consider perforated diffusers that supply air at high volumes and low velocity in areas close to fume hoods and bio-safety cabinets (to keep velocity less than ½ hood velocity.
  - ◊ Consider room airflow modeling for lab rooms and animal rooms. CFDs shall demonstrate hood capture effectiveness, optimize air change rates (ACH) and evaluate supply outlet and exhaust inlet locations.
  - ◊ Pressurization in and out of rooms shall be indicated on plans with directional arrows and airflow quantities as well as a LABORATORY AIR BALANCE SCHEDULE on drawings. See Appendix for sample.

- Thermostatic Zoning
  - ◊ Each laboratory shall be an independent thermostatic zone.
  - ◊ Each animal holding room shall be an independent thermostatic zone.
  - ◊ Each animal procedure room shall be an independent thermostatic zone.
  - ◊ Each corner room shall be an independent thermostatic zone.
  - ◊ Show laboratory terminal airflow unit service clearances on the plans.

C. Process Cooling Water

- Provide supplemental or dedicated water or air-cooled chillers for process chilled water for year round operation. Plant chilled water is not available year round.
- Central system should include 20% extra capacity for future expansion.

D. Energy Recovery

- Utilize energy recovery methods such as heat pipe, runaround loop, enthalpy wheel or plate and frame HX on general laboratory exhaust air as permitted by applicable codes and standards. Do not utilize enthalpy wheels on fume hood exhaust. Plate and frame HX has shown to be most energy efficient option with less maintenance when total airstream separation is required.
- Heating and cooling coils shall be designed to function at full load with and without the energy recovery system.

E. Controls

- Control System Architecture
  - ◊ If a critical systems emergency generator is available, at least one exhaust fan per system shall be on emergency power, along with associated controls.

- ◊ For Vivarium systems, the supply and exhaust systems as associated controls shall be on the emergency generator.
- ◊ Lab space supply and exhaust actuation shall be high speed electric actuation.
- ◊ Power DDC panels off emergency power w/ UPS' on each control panel.

- Building Level Monitoring
  - ◊ A Facility Monitoring system shall be considered for air change modification and integrated to the Building Automation System via BACnet along with a hardwired signal to the lab controls for ACH request.
  - ◊ Gas Detection Systems shall be alarmed through the Central Energy Management System and through the Access Control Security System per the Hazardous Material Gas Detection and Alarm Construction Standard.

- System Level Control
  - ◊ Upon complete failure of the exhaust system, the associated supply systems shall shut down to minimize positive pressurization. In Clean Room applications, upon complete failure of the supply system, the exhaust system shall be shut down.

- Zone Level Control
  - ◊ Room pressure shall be maintained by flow tracking. Supply flow shall track the exhaust flow. Door differential pressure measurement may be used for room pressure control in BSL-2 & BSL-3 facilities.
  - ◊ Lab Room Purge buttons shall be installed at each laboratory room exit and shall override the Facility Monitoring system to put the lab at a higher air flow as required. There shall be an alarm light on the outside of the lab to indicate a purge is in progress.

- Component Level Control
  - ◊ Fume Hood Controls
    a. Fume Hood exhaust actuation shall be high speed. Review with EHS on speed response time.
    b. Hood proximity/occupancy sensors shall be used to decrease face velocity.
    c. Each hood shall have a dedicated fume hood monitor with integral display and purge button.
    d. Consider light activated hood alarm.

5. PLUMBING

A. Plumbing Design Considerations

- Refer to DESIGN GUIDELINES – MECHANICAL unless noted otherwise.
- Isolation valves shall be provided to accommodate easy maintenance at each module or laboratory. Isolation valves shall be accessible and located on the floor being served.
- Animal Facilities

- ◊ The facility must have a hand wash sink and the housing rooms should be equipped with an animal watering system that could be automated watering system or provided by bottle filling (which necessitates a facility bottle filing station).

B. Plumbing Fixtures

- Emergency Showers and Eyewash:
  - ◊ Types and locations as preapproved by MSU EHS before construction.
  - ◊ In areas where whole body wetting is not required a hand operated hose spray may be used. This should have a quick opening squeeze lever valve with a flow of at least six gallons per minute in a spray pattern. This spray may be located near the laboratory sink.
  - ◊ Provide 60-95° F. water for the emergency showers and eyewashes unless directed otherwise by EHS. Refer to ANSI 358.1 for flow requirements. Combination drench hose/eyewashes can be cold water only without need for tempering.
  - ◊ Where feasible, floor drains should be installed near safety showers, with the floor sloped sufficiently down toward the floor drain.
- Each laboratory must contain a sink for handwashing.
- Laboratory faucets and cocks shall have vacuum breakers, as well as all devices to which hoses can be connected.

C. Pure Water Systems

- Indicate system type and performance criteria based on the most recent campus water analysis.
- Reverse Osmosis - central system preferred.
- Deionized Water Systems– department owned point of use polishers.
- 3-5 feet per second design velocity
- Do not oversize system. System needs to be designed to empty tank at least once a day. Dead legs are not allowed in system.
- Provide multiple storage tanks, redundant distribution pumps, and redundant final filters.

D. Drainage Systems

- Laboratory Waste: Chemical waste system must be installed and designed as an independent sanitary drainage system. MSU EHS must approve the design of chemical waste systems and obtain necessary permits prior to construction.

E. Natural Gas and Vacuum Systems

- Main lab shut off valve shall be located outside the lab and be easily accessible.
- Compressed Air: Provide a central system where possible.

6. FIRE PROTECTION

A. Fire Protection Design Considerations

- Refer to DESIGN GUIDELINES – MECHANICAL unless noted otherwise.

7. ELECTRICAL

A. Electrical Design Considerations

- Refer to DESIGN GUIDELINES ELECTRICAL unless noted otherwise.

B. Normal Power

- A separate receptacle panelboard shall be installed in each laboratory to serve outlets and equipment in the respective laboratory.
- Duplex receptacle outlets located in laboratory benches shall have a maximum spacing of 36 inches. Provide coverplates and GFCI outlets as required to meet cleaning requirements.

C. Emergency Power

- A separate User Generator shall be installed to serve designated laboratory functions that must remain operational in the event of a power interruption, such as fume hood exhaust, low temperature refrigeration, designated general use laboratory bench outlets, etc. The historic reliability of MSU self-generated electrical power should be considered when determining if a generator is required. Portable generator connection can be an viable option.
- Discuss generator fuel sources with PDC electrical design representative. MSU typically calls for natural gas. Fuel run time needs to be determined.
- Critical functions (HVAC, ventilated caging, and life support equipment), vivarium air handlers, animal room exhaust systems, terminal units and controls shall be fed from the emergency power system.
- Provide emergency power for laboratory systems where a power failure endangers life safety.
- Exhaust fans and corresponding supply fans shall automatically restart when power is restored after a power failure.

D. Lighting

- Lighting systems in animal rooms shall be designed to simulate an adjustable 24 hour daylight cycle using a timeclock.
- Lighting controls for animal rooms shall be located outside of the room adjacent to door to the room.
- Determine design light level intensities (foot candle levels) based on daylight requirements for animal type and caretaker/cleaning requirements for animal holding rooms. Provide separate controls for daylight and caretaker functions.
- Provide appropriate light source, intensity, and controls for entry into animal holding areas during nocturnal cycles. Provide control interlocks or procedures to prevent

daylight from being turned on or spilling into animal holding areas during nocturnal cycles.

8. TELECOMMUNICATIONS

A. Communication Design Considerations

- Refer to DESIGN GUIDELINES ELECTRICAL for telephone and Ethernet systems unless noted otherwise.
- Communication outlets located in laboratory benches shall have a maximum spacing of 36 inches. Provide covers as required for cleaning operations.
- Provide outlets and locations for AP devices.

9. ELECTRONIC SAFETY AND SECURITY

A. Building Access

◊ Refer to SAFETY: ACCESS CONTROL in Design Guidelines – General for scope of work.

B. Fire Alarm

- Refer to DESIGN GUIDELINES ELECTRICAL for general fire alarm scope of work.
- Laboratory spaces shall use a cross zoned smoke detection system. One smoke detector shall initiate a pre-alarm. A second smoke detector from an adjacent zone shall initiate general evacuation.
- Heat detectors shall be used in laboratories where products of combustion are produced as part of the laboratory process.
- Audible notification devices installed in animal rooms shall have “tones” that are inaudible to the animals.
- Low candela power visual notification devices shall be installed in animal rooms. These may be deleted with a variance from AHJ.

C. Refrigerant Detection and Alarm

- Refer to MSU Technical Construction Standard Section 283500.

D. Hazardous Material Gas Detection and Alarm

- Refer to MSU Technical Construction Standard Section 283600.

10. APPENDICES

A. Sample of Laboratory Air Balance Schedule – include air handling unit the room is served by if multiple systems present in building.

LABORATORY AIR BALANCE SCHEDULE

ROOM		PRESSURE RELATIONSHIP	ROOM AREA (SQ. FT.)	CEILING HEIGHT (FT)	ROOM VOLUME (CU. FT.)	REQUIRED AIRFLOW				DESIGN AIRFLOW										PRESS DIFF. CFM	REMARKS
NO	NAME					MINIMUM		PURGE		SUPPLY AIR		EQUIPMENT EXHAUST		GENERAL LAB EXHUAST		TRANSFER AIR		ACH			
						ACH	CFM	ACH	CFM	MIN	MAX	MIN	MAX	MIN	MAX	IN	OUT	MIN	MAX		
1100	WRITE UP	POSITIVE	-	-	-	-	-	-	-	200	200	-	-	-	-	-	-	-	-	200	
1200	LAB	NEGATIVE	2157	9.5	20492	4.0	1370	8.0	2735	1170	2535	-	-	350	1715	200	1020	4.0	8.0	820	NOTE 1
1523	FUME HOOD	NEGATIVE	103	9.0	927	4.0	65	8.0	125	90	1390	300	1600	-	-	210	-	19.4	103.6	-210	

NOTES:
1. LAB IS NEGATIVE IN RELATIONSHIP TO ADJACENT WRITE-UP SPACE. POSITIVE IN RELATIONSHIP TO CONNECTED TISSUE CULTURE, FUME HOOD AND LAB SUPPORT SPACES