LABORATORY HOODS, SAFETY CABINETS AND VENTILATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This standard includes:

1. Laboratory supply air.

2. Laboratory general exhaust, and Laboratory hood, cabinet, and snorkel exhaust.

3. Laboratory animal rooms design criteria.

1.02 CODES, STANDARDS and REFERENCES

A. CODES

1. Code of Federal Regulations (CFR)

2. National Electric Code (NEC)

3. Ohio Building Code (OBC)

4. Ohio Revised Code (ORC)

B. STANDARDS and REFERENCES

Use the most current Codes and Standards unless superseded by the Ohio Building Code or Ohio Law. A partial list of applicable standards and codes includes:

1. Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC).

2. American Conference of Governmental Industrial Hygienists (ACGIH), Industrial Ventilation - A Manual for Recommended Practices.

3. American National Standards Institute, American Industrial Hygiene Association, (ANSI/AIHA), National Standard for Laboratory Ventilation.

4. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Laboratory Design Guide.

5. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Heating, Ventilating, and Air Conditioning Applications.

6. ASHRAE 110 – Method of Testing Performance of Laboratory Fume Hoods

7. NFPA = NFiPA = National Fire Protection Association, Quincy, MA.

8. NFPA 45, Chapter 6 - Fire Protection for Laboratories Using Chemicals.

9. NFPA 70 - National Electrical Code.

10. NFPA 801, Chapter 5 - Recommended Fire Protection Practice for Facilities Handling Radioactive Materials.

11. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

12. NFPA 91 - Standard for the Installation of Blower and Exhaust Systems.

13. National Research Council (NRC), Guide for the Care and Use of Laboratory Animals, National Academy of Sciences, Washington, D.C.

14. NSF = The National Sanitation Foundation, Ann Arbor, MI.

15. National Sanitation Foundation (NSF) NSF 49 - Standard for Class II (Laminar Flow) Biohazard Cabinetry.

16. Scientific Equipment and Furniture Association (SEFA), Laboratory Fume Hoods Recommended Practices, SEFA 1.2.

17. The Ohio State University (OSU) Building Design Standards (BDS).

18. Institute for Laboratory Animal Research (ILAR)

1.03 VENTILATION SYSTEM DESIGN GUIDELINES

A. The purpose of Laboratory Ventilation Systems is to provide a safe environment to occupants, researchers, teachers, staff, students, visitors, and subjects, and to protect the laboratory and the business investment therein, by controlling and exhausting contaminants and providing acceptable ventilation, while simultaneously minimizing energy and maintenance costs.

1. The primary means of providing safety and controlling and exhausting contaminants shall be fume hoods (chemical hoods, radiological hoods, perchloric acid hoods, laminar flow hoods, biological safety cabinets (Class II, B2, or B3), glove box (Class III), snorkels, and Laboratory hood exhaust system. .

2. The secondary means of providing safety and controlling and exhausting contaminants shall be the Laboratory Ventilation Systems. In addition to safety, the Laboratory Ventilation Systems shall also provide comfort control within the room (temperature and, if applicable, humidity control). The Laboratory Ventilation Systems shall include Laboratory supply air, and Laboratory general exhaust.

1.04. HOOD PERFORMANCE and DESIGN GUIDELINES

A. Locate hoods away from air turbulence, egress traffic, operable windows, doors, air supply grilles and heavy traffic aisles.

B. Constant air volume “Bypass type” Fume Hoods shall not be permitted to be installed in new or renovated facilities unless authorized in writing (e.g. e-mail, etc.) by the University Engineer.

C. All Fume Hoods shall be variable air volume (VAV) type with vertical sash operation and position hardware. The fume hood shall be provided with a sash stop, set at 18-inches.

Commentary: *The intent of this requirement is to allow existing facilities undergoing a "partial" renovation to at least install fume hoods that can have volume control dampers and direct digital controls integrated in the future with the hood sash position hardware*.

1. New facilities or major renovations of laboratory facilities must have fully functional VAV fume hood systems (exhaust air/supply air/ fume hoods) and laboratory room pressure differential control systems or another type of control system that will maintain the proper pressure or supply/exhaust air volume relationship between the laboratory rooms and adjacent rooms.

Commentary: *The control methodology suggested above is intended to provide the proper pressure relationships, and thereby air flow direction, between rooms; it is NOT intended to restrict the acceptable manufacturers or vendors of controls or hardware systems that can accomplish this design intent*

a. All Fume Hoods for these applications shall be provided with automatic sash closure control system. The fume hood exhaust airflow control device must, upon opening the sash, respond to the change in sash position to maintain the proper face velocity within three seconds of the sash reaching its final position.

2. There may be special fume hood applications that require a different design configuration than indicated within this Appendix: these applications should be presented for review by OSU Environmental Health and Safety Department and accepted in writing (e.g. e-mail, etc.) by the University Engineer.

3. All fume hood conceptual designs and applications must be formally reviewed (e.g. e-mail) by OSU Environmental Health and Safety (EHS) Department and the University Engineer. The A/E shall provide documentation showing acceptance of the conceptual design to the OSU Project Manager. The OSU Project Manager shall maintain a record of this fume hood concept documentation.

4. All exhaust air control dampers shall be Normally Open.

Commentary: *The intent is to maintain a negative pressure within the lab room relative to adjacent rooms in order to reduce the potential for contamination of the adjacent rooms.*

D. All newly installed hoods must meet the testing requirements set forth in the National Institutes of Health (NIH) or ASHRAE Standard 110. On Site Testing for Constant Volume Fume Hoods or Variable Air Volume (VAV) Fume Hoods as necessary and in accordance with the latest published testing criteria.

E. For VAV hoods, tests shall be run at 60, 80 and 100 feet per minute (FPM).

1. The minimum acceptable lab hood face velocity, based on a standard 18-inch vertical opening, shall be 80 feet per minute.

F. Test results must be submitted to the A/E, OSU Project Manager and OSU Environmental and Occupational Health & Safety for review. Approved hoods will be

considered acceptable for use for the specific project application but not necessarily for ALL OSU buildings and laboratories.

G. Final as-installed field testing will be completed upon installation through a third party, certified to perform the following test(s). As-installed testing shall meet the NIH On Site Testing requirements listed in B of this section. Test results shall be submitted to the OSU Project Manager.

Commentary: *This field testing of hoods will normally be assigned to the Commissioning Agent that is contracted directly with the University.*

H. Chemical fume hoods, auxiliary hoods, canopy hoods, glove boxes, and horizontal flow (clean benches) are not to be permitted without careful review by OSU Environmental and Occupational Health and Safety and approval by the University Engineer.

Commentary: *Historical performance and maintenance problems associated with these hood designs plus the selection and proper application necessitates this review and approval process. The A/E has the fiduciary responsibility to provide the University with all the facts related to the selection of equipment chosen and recommended by the A/E*

In addition to the NIH test and ASHRAE 110 test requirements, a heat load must be placed on the hood during testing. Heat shall be applied to hood using hot plates and temperatures maintained at 90^{o} F (32.2^{o} C) measured 3 feet above working surface of the hood; and 1 foot from back of hood.

1.05 ENERGY COST CONSIDERATIONS

A. The Laboratory design, the equipment selections, and the equipment operation must incorporate all considerations to allow operation at the lowest energy costs.

1.06 MAINTENANCE COST CONSIDERATIONS

A. The Laboratory design, the equipment selections, and the equipment and accessory locations, must incorporate all considerations to facilitate maintenance, and allow maintenance at the lowest costs.

1.07 LAY-IN CEILINGS

A. Lay-in ceilings should be provided, if feasible for the particular application, in all Laboratory and Laboratory Support spaces which are required to have minimum air changes per hour (ACH's).

B. Ceiling heights (between finished floor and lay-in ceiling) within these spaces shall be designed and installed realistically as low as possible in order to minimize total ventilation volumes, while maintaining minimum ACH's, and thereby minimize total energy costs. Low ceiling heights may not be acceptable for ALL applications and should be properly addressed and documented by the A/E.

PART 2 PRODUCTS

2.01 LABORATORY VENTILATION SYSTEMS
A. LABORATORY SUPPLY AIR SYSTEMS

1. Laboratory supply air systems shall be capable of containing contaminants below accepted governmental and consensus industrial exposure standards, flammable limits, and noxious chemical odor thresholds.

2. An “Air Change” is defined as introduction of conditioned air to a space. Acceptable “conditioned air” shall be in compliance with ASHRAE Standard 62.1.

3. An “Air Change Rate” (e.g. air changes per hour; aka ACH) is defined as airflow in volume units per hour divided by the building space volume, between the floor and finished ceiling, in identical volume units.

4. The term “Occupied” refers to the presence of humans or animals within the room. The term “Unoccupied” refers to the absence of humans or animals within the room. The A/E must use judgment when applying these terms.

5. Minimum Laboratory Air Change Rates

    a. Minimum air change rates for laboratories shall be 6 air changes per hour when occupied except where noted below.

    b. Minimum air change rates for laboratories shall be 4 air changes per hour when unoccupied except where noted below.

    c. The above are OSU recommended minimum ACH's. The A/E remains responsible to consider and apply the heating and cooling ventilation requirements, the toxicity of the contaminants, hood manufacturer recommendations, all applicable codes, all applicable standards, and all recommended good practices for each application. The associate shall obtain approval from OSU before proceeding with the design.

    d. The Unoccupied ACH's are applicable only when the ventilation rates can be restored to the Occupied ACH's by the laboratory personnel when working during normally Unoccupied periods such as evenings, weekends, and holidays. The system must incorporate these Occupied and Unoccupied features and selections.

    e. A visual light indicating device may be located at the entry of each laboratory to show the Occupied/Unoccupied status of the room HVAC system.

        Commentary: *Other means of indicating the occupancy status of the room may be presented by the A/E; however, consensus must be obtained with the primary stakeholders and the University Engineer.*

6. Special ventilation areas (such as BSL 3 facilities, areas using known carcinogens, animal necropsy, autopsy, nanotechnology, etc) may require a different design configuration than indicated within this appendix: Conceptual designs for these applications should be submitted by the A/E for review by OSU Environmental Health and Safety and approved in writing by the University Engineer.

7. Animal facilities shall be designed in accordance with the latest requirements found at the Institute for Laboratory Animal Research.

8. Any facility requiring special accreditation shall conform to the latest requirements of the accrediting body.

9. Heating for 100% fresh air systems shall apply hot water preheat per Division 23. If the supply and/or exhaust fans are served by emergency power, then the main pump and the coil recirculation pump shall also be served by emergency power.

Commentary: *The intent of this paragraph is to emphasize that a reliable heating source is usually needed for critical lab applications (e.g. research labs). The A/E needs to be aware of this intent when balancing design concepts and costs and advise the University stakeholders of the benefits and/or consequences of the design concept.*

10. Pressure gradients between rooms and areas shall be obtained by designing and balancing total air volumes at any and all operating conditions:

A. Laboratory Rooms shall be maintained at negative pressures, in relation to Laboratory Support Rooms and non-laboratory areas, by total Laboratory exhaust volume being 5% greater than total supply air volume.

B. Laboratory Support Rooms shall be maintained at negative pressures, in relation to non-laboratory areas, but at a slightly less negative pressure than Laboratory rooms. The total exhaust volume being 5% greater than total supply air volume.

11. Laboratory room temperatures and humidity levels should be maintained during 'Occupied' and ‘Unoccupied’ periods in compliance with the OSU Building Design Standards unless the application requires more stringent requirements. The A/E shall obtain approval from the University Engineer for deviations from the Building Design Standards.

12. Laboratory noise levels should be maintained not to exceed Building Design Standard and ASHRAE Handbook HVAC Applications.

B. LABORATORY EXHAUST SYSTEMS

1. Laboratory exhaust fans shall be above the roof and readily accessible for maintenance.

2. For manifold exhaust air systems, provide at least N+1 or greater backup exhaust fan capacity, and isolate each exhaust fan, such that one exhaust fan may be stopped and serviced, while simultaneously retaining the full capacity and function of the total exhaust system.

Commentary: *“Manifold” refers to combining several points of exhaust needs (e.g. lab hoods) into a common duct or exhaust plenum. This “manifolded” exhaust must then be served by more than one exhaust fan in order to maintain proper exhaust air quantities to the individual hoods or exhaust devices in case one of the exhaust fans fails. The A/E must verify that “manifolding” exhaust ducts is acceptable for the particular application.*

3. All laboratory exhaust ducts shall be at negative pressure with respect the entire interior building envelope. It is prohibited to have any portion of any laboratory exhaust duct to be at any positive pressure with respect to any portion within the building envelope.

4. Laboratory exhaust shall be a vertical stack discharge at the roof of the building; the stack exit velocity shall be 3000 fpm minimum, or greater.

5. Exhaust stacks shall be sufficiently high such as to eject the exhausted contaminants away from the building, and away from all adjacent buildings. Exhausted contaminants shall be ejected in a manner such as to prevent re-entrainment of contaminants into fresh air intakes into the building, or into all adjacent buildings.

6. The exhaust stacks or ducts should be at least 8-feet higher than building elements within 33-feet, including any door, window, intake grille or occupied space.

7. Energy recovery systems should be provided for all laboratory exhausts to pretreat (heat or cool) the supply air for the laboratory. The A/E shall evaluate energy recovery system(s) and obtain approval for type of system(s) from the University Engineer prior to start of design.

Commentary: *Currently, air to air or heat wheels are not an acceptable heat recovery system for laboratory applications due to the potential for cross contamination. Coil run-around-loops are an acceptable heat recovery method.*

8. For Animal rooms, all exhaust air grilles shall include 35% pre-filters, nominal 2"-thick, to prevent animal hair and/or dander from accumulating in the exhaust ductwork, and from accumulating in the fan(s). The preferred design location for exhaust and return grilles is 18" above the floor.

9. For Animal rooms, where wash-down of the room is required, sensors for temperature control, humidity control, and lighting shall be located such as to never have water or water mist impacting on the sensor or transducer or transmitter.

10. Discuss, with the Project Manager, the need or desirability of exhaust systems being on standby or emergency power during the design process.

C. EXHAUST AIR DUCTWORK CONSTRUCTION

1. Materials for the Laboratory exhaust system shall be non-combustible. Suggested materials are:

   a. Radioisotope or bacteriological: stainless steel.

   b. General chemical exhaust: carbon steel sandblasted and coated with epoxy or coated with a phenolic.

   c. Perchloric acid: Type 316 stainless steel or rigid PVC, and inorganic ceramic coating.

Commentary: *PVC coated ductwork is not an acceptable composite. The choice of duct material for the particular application is the responsibility of the A/E and must be in compliance with NFPA 45.*

2. Fire dampers are prohibited in hood exhaust ducts, unless specified otherwise by local codes and approved by the University Engineer.

3. An interlocking arrangement to shut off laboratory exhaust fan, if laboratory supply fan fails, is prohibited.

4. Fire detectors and alarm devices shall not automatically shut off laboratory exhaust fans, except as required when actuating a fluorocarbon or carbon dioxide extinguishing system.

Commentary: *The maintenance of the exhaust pre-filter will normally be provided by the Using Department. The OSU Project Manager must communicate and document this requirement to the Using Department and OSU Operations.*

2.02. LABORATORY HOODS

A. CEMENTITIOUS-BOARD-LINED LABORATORY HOOD

1. The superstructure interior shall be fabricated of asbestos-free, acid-resistant, fiber-reinforced cement board at least 1/4-inch thick and manufactured for use in this application. Interior fasteners, brackets, and hinges shall be Type 304 stainless steel.

2. Interior access panels shall be flush mounted to minimize eddy currents.

3. Fluorescent light panel shall have a vapor-tight stainless steel frame.

4. Vertical sliding sash shall have 1/4-inch thick laminated safety glass. Sash frame shall be 18-gauge stainless steel rolled shape, mitered, welded and ground smooth. Sash will run in polished stainless steel guides with nylon bushings and shall employ vinyl-coated over nylon ball-bearing pulleys. Coated steel counterweights shall be concealed in the superstructure.

B. STAINLESS STEEL-LINED LABORATORY HOOD

1. Use 18-gauge Type 304 stainless steel for interior and baffles except worktop, which is to be 16-gauge. Provide No. 4 finish.

2. Exposed metal on the interior of the hood shall be stainless steel.

3. Vertical sliding sash shall have 1/4-inch thick laminated safety glass. Sash frame shall be 18-gauge stainless steel rolled shape, mitered, welded and ground smooth. Sash will run in polished stainless steel guides with nylon bushings and shall employ vinyl-coated over nylon ball-bearing pulleys. Coated steel counterweights shall be concealed in the superstructure.

C. RADIOACTIVE ISOTOPE OR CARCINOGEN LABORATORY HOOD

1. Use 18-gauge Type 316 seamless steel for interior and baffles except worktop, which is to be 16-gauge. Polish to No. 4 finish. Provide an integral trough in the worktop and cove corners which have 1/2-inch radius.

2. Exposed metal on the interior of the hood shall be stainless steel.

3. Equip each hood with an absolute filter housing to accommodate prefilter (15 percent ASHRAE) and high efficiency filter (HEPA 99.97 DOP). Provide a gauge to monitor pressure drop across filter.

4. Vertical sliding sash shall have 1/4-inch thick laminated safety glass. Sash frame shall be 18-gauge stainless steel rolled shape, mitered, welded and ground smooth. Sash will run in polished stainless steel guides with nylon bushings and shall employ vinyl-coated over nylon ball-bearing pulleys. Coated steel counterweights shall be concealed in the superstructure.

5. Comply with the Nuclear Regulatory Commission (NRC) standards (Codes 10CFR19 and 190CFR20); *and Ohio Administrative Code (OAC 3701**).***

D. PERCHLORIC ACID LABORATORY HOOD

Commentary: *Placement of this type of hood must be reviewed and accepted by OSU Environmental Health and Safety and the University Engineer during the Schematic Design Phase. This is the responsibility of the OSU Project Manager and the A/E.*

1. Use 18-gauge Type 316 seamless steel for interior and baffles except worktop, which is to be 16-gauge. Polish to No. 4 finish. Provide an integral trough in the worktop and cove corners which have 1/2-inch radius.

2. Exposed metal on the interior of the hood shall be stainless steel.

3. Vertical sliding sash shall have 1/4-inch thick laminated safety glass. Sash frame shall be 18-gauge stainless steel rolled shape, mitered, welded and ground smooth. Sash will run in polished stainless steel guides with nylon bushings and shall employ vinyl-coated over nylon ball-bearing pulleys. Coated steel counterweights shall be concealed in the superstructure.

4. Baffles are to be removable.

5. Provide spray-type wash-down system which will wash surfaces behind baffles. Exhaust ductwork and wash-down system for perchloric acid hoods must be in compliance with NFPA 45. The wash-down control and status indication shall be located at the hood. Arrange sash to prevent leakage of wash-down water from the hood.

6. Provide a blow-out panel with two (2) stainless steel arresting devices and stainless steel control cables.

7. Provide for easy visual inspection of hidden surfaces.

8. Use no organic coatings, lubricants or sealants.

9. Comply with latest edition of the American Conference of Governmental Industrial Hygienists (ACGIH) Industrial Ventilation Manual.

10. A/E shall review the placement of this type of hood with Environmental Health and Safety and the University Engineer during the Schematic Design Phase.

E. EXPLOSION-PROOF LABORATORY HOOD

1. Same construction as Perchloric hoods noted above except for the following:

2. Provide a blow-out panel in lieu of an automatic air bypass. Blow-out panel must have an arresting device.

3. Any device in the air stream shall be non-sparking and explosion-proof.

END OF APPENDIX W