PART 1: GENERAL

1.01 RELATED SECTIONS

A. Section 01004 – Energy Guidelines
B. Section 01008 – Energy Modeling Guidelines
C. Section 15955 – Building Automation and Control System Guidelines

1.02 RELATED STANDARD DETAILS

A. Detail 3.7.1, BACS Low Hood Density Tracking Lab Zone Control
B. Detail 3.7.2, BACS High Hood Density Tracking Lab Zone Control
C. Detail 3.7.3, BACS Low Hood Density Cooling Tracking Lab Zone Control
D. Detail 3.8.5, BACS Central Laboratory Exhaust System Control

1.03 REFERENCE CODES AND STANDARDS

A. 2010 Building, Mechanical, Plumbing, and Fire Codes of New York State
B. ANSI/AIHA Z9.5-2012, Laboratory Ventilation Standard
D. NFPA 45-2011, Standard on Fire Protection for Laboratories Using Chemicals
G. Cornell University Environmental Health and Safety Laboratory Ventilation Management Program  
   http://sp.ehs.cornell.edu/lab-research-safety/chemical-safety/lab-ventilation/Documents/Cornell_LVMP.pdf
H. OSHA Technical Manual, Ventilation Investigation, Section III, Chapter 3,  
I. NYSDEC DAR-1, Guidelines for the Control of Toxic Ambient Air Contaminants


K. NYSDEC 6NYCRR Chapter III, Part 201, Permits and Registrations

L. NYSDEC 6NYCRR Chapter III, Part 211, General Prohibitions

M. NYSDEC 6NYCRR Chapter III Part 212, General Process Emission Sources

N. NYSDEC 6NYCRR Chapter IV, Part 380, Prevention and Control of Environmental Pollution by Radioactive Materials

1.04 SCOPE

A. This Standard defines Cornell’s expectations for the design of laboratory spaces, including space layout and the design of ventilation systems. Such designs will strive to balance the sustainability goals of the University while maintaining the safety and health of laboratory occupants and the general public.

B. This Standard applies to construction of new facilities and renovations to existing facilities in which chemical work is to be done at laboratory-scale. Facilities in which chemical work is conducted beyond lab-scale, or for which other hazards, such as high chemical hazard, radiological or biological hazards are the design drivers, are regulated by state and federal standards that may require specific design permitting and certification. Designers shall consult with Facilities Engineering and Environmental Health and Safety (EH&S) before proceeding to determine a basis for design in order to address the special considerations for these types of spaces.

1.05 DEFINITIONS

A. For the purposes of this Standard, “Laboratory” refers to a space or facility where relatively small quantities of hazardous chemicals (i.e. amounts that can be safely handled by one person) are used on a non-production basis. Such workplaces will be provided with once-through ventilation; that is, there will be no recirculation of air from these workspaces to the building. In addition, it is expected that the laboratory suite shall be kept negatively pressurized relative to the corridor. However, it may be possible that ancillary areas within the suite be kept positively pressurized relative to the main laboratory space.

B. “General exhaust ventilation,” also called dilution ventilation, differs from local exhaust ventilation in that in lieu of capturing emissions at their source and removing them from the air, general exhaust ventilation allows the contaminant to be emitted into the workplace air where it is diluted at an acceptable level (e.g. to the Permissible Exposure Level or below). Dilution systems are often used to control evaporated liquids (OSHA Tech Manual).
C. “Local exhaust ventilation” systems are composed of five parts: fans, hoods, ducts, air cleaners, and stacks. Local exhaust ventilation is designed to capture an emitted contaminant at or near its source before the contaminant has a chance to disperse into the workplace air (OSHA Tech Manual).

D. “Computational Fluid Dynamics” is the use of numerical methods to calculate and visualize air flow patterns or particulate migration.

E. A “Vacant” laboratory is one that is unassigned to an occupant and therefore can have the general ventilation and fume hoods turned off or turned down to levels needed only for general temperature control.

F. “Occupied” mode is that which the building controls system sensors recognize that a person is physically within the room and the ventilation must increase to control the accumulation of contaminants.

G. “Unoccupied” mode is that which the building controls system sensors recognize that there is no one present in the room; the ventilation is allowed to decrease.

H. Fume hood “Hibernation” describes when the lab is assigned to an occupant, but the operation of the fume hood is not required, and the fume hood exhaust can be temporarily shut down. This allows the lowering of required ventilation to minimum levels mandated by applicable ventilation Codes. Chemical storage or use within the fume hood is not allowed.

1.06 SUMMARY COMMENTS

A. General room ventilation shall be provided to prevent the buildup of fugitive emissions in the laboratory. A general room ventilation system shall be designed to maximize the clearance of contaminants from the room while minimizing overall energy use. In laboratories where the heat load exceeds the required ventilation rate standalone cooling systems should be considered.

B. The Engineer shall provide a “basis of design” statement for all lab designs that clearly defines all system criteria and assumptions made during the project design process. Documentation shall include, but not be limited to, design and operational criteria such as, laboratory air change rates, anticipated chemical usage, description of the lab ventilation control system, equipment heat loading, anticipated occupancy, and diversities as well as references to codes and standards used.

C. CFD Modeling shall be used to verify ventilation effectiveness on all new buildings and major renovations that include laboratory facilities with a total project cost exceeding 5 million dollars. On projects with total project costs between 500K and 5M, contact Facilities Engineering to discuss if CFD modeling will be required.
D. The mechanical system selection, including heat recovery systems, shall be supported by a life cycle cost analysis of the options. The designer shall submit an economic analysis during schematic design.

E. Prior to the design of new laboratory facilities, a chemical usage questionnaire must be completed by the Consultant and reviewed with Environmental Health and Safety and Facilities Engineering.

1.07 LABORATORY EXHAUST SYSTEM ANALYSIS

A. All laboratory exhaust systems must comply with the NYS Building Codes, ANSI/AIHA Z9.5, and NYSDEC requirements including (but not limited to) 6NYCRR Parts 201, 211, 212, and 380.

1. Effluent discharge shall be a minimum of ten feet above the roof surface with a velocity of 3,000 feet per minute (fpm) velocity unless it can be demonstrated that a specific design meets the dilution criteria necessary to reduce the concentration of hazardous materials in the exhaust to safe levels at all potential receptors (ANSI/AIHA Z9.5).

2. Exhaust System Classification: The consultant shall be required to perform an analysis to classify the exhaust system when the use of flammable vapors, gases, fumes, mists or dusts, and volatile or airborne materials posing a health hazard, such as toxic or corrosive materials are expected. Classification shall be made in accordance with the New York State Mechanical Code Section 510 concerning Hazardous Exhaust Systems.

3. A dispersion analysis shall be performed on all new buildings and major renovations that include laboratory facilities with a total project cost exceeding 5 million dollars. On projects with total project costs between $500K and $5M, contact Facilities Engineering to discuss if modeling will be required.

4. Consultants shall also consider the requirements of NYSDEC Guidelines DAR-1 and DAR-10 when performing the exhaust analysis.

1.08 LABORATORY DESIGN CRITERIA

A. Ventilation Rates:

1. Ventilation Rates: Laboratories shall be designed to operate at the following default ventilation rates:

   a. Occupied Mode - 8 air changes per hour (ACH)
   
   b. Unoccupied Mode - 4 ACH
2. Higher ventilation rates may be required, and less may be acceptable, when the laboratory process is well defined. The designer must demonstrate that the proposed ventilation rate will control room air contaminant concentrations below the current threshold limit values (TLV-TWA) established by the American Conference of Governmental Industrial Hygienists (ACGIH).

3. The mechanical system shall be adjustable and capable of operating at lower flow rates; to be determined by an Environmental Health and Safety review of chemical operations in the laboratory as follows:
   a. Occupied Mode: 6 ACH
   b. Unoccupied Mode: 3 ACH
   c. Hibernation Mode: General ventilation as needed to maintain Code mandated occupied ventilation rates.
   d. Vacant Mode: 1 ACPH or higher depending on the controllability of the air devices at their lower ranges.

B. Casework and other furniture shall be located to allow for the sweeping of the general ventilation from supply diffusers to exhaust points without creating areas where there may be accumulation of chemical vapors or fumes.

C. Acoustics: The design shall carefully consider acoustics and result in a laboratory noise level of NC 50 or lower. Proper acoustic design should be accomplished by providing appropriate fan size and type. Sound attenuators are acceptable, though not preferred. When used, sound attenuators must be packless and constructed of 304 stainless steel.

D. Hood placement: The location of fume hoods, supply air terminals, laboratory furniture and pedestrian traffic should encourage horizontal, laminar flow of supply air into the hood, perpendicular to the hood opening.
   1. Hoods shall not be placed in the line-of-egress from the laboratory; locate at least 10 feet from any doors (except emergency doors)
   2. Hoods shall be separated from each other as far as practical.
   3. Corner locations shall be avoided, locate hood a minimum of 1 foot away from a perpendicular wall.
   4. Hoods shall be placed to avoid pedestrian traffic immediately in front of the hood.
   5. Large pieces of equipment shall not be positioned in front of a hood.
6. Hoods shall not be placed where they would face each other across a narrow aisle (6 ft. minimum spacing), as this will cause turbulence at the face of the hood.

E. Ventilation System Design Criteria:

1. No chemical fume hood installations are allowed in rooms with return air to other spaces. All chemical use rooms (wet labs) shall have once-through ventilation.

2. Hoods which are high hazard or unique use, such as perchloric or other acid digestive systems, as well as radio-iodination hoods shall not be installed in a manifolded type exhaust system and must be separately exhausted.

3. Provisions shall be made for local exhaust of instruments, gas cabinets, vented storage cabinets or special operations not requiring the use of a fume hood (local capture devices).

4. The occupied fume hood exhaust rate shall be designed to provide an average face velocity of 80-100 FPM at an 18 inch sash opening height. Minimum fume hood exhaust shall be determined based on the expected chemical use. Coordinate with Cornell EH&S and Facilities Engineering when establishing minimum fume hood airflow rates.

5. Supply air delivery must be designed to ensure hood performance and maintain pressurization requirements. Supply diffuser type and location within the room shall be such that the effectiveness of the ventilation to remove contaminants is enhanced; and that the exhaust systems, fire protection or extinguishing systems are not adversely affected.

6. Diffusers shall be located at least 4 feet from the face of a fume hood.

7. Perforated ceiling/plenum supply air or perforated duct diffusers may be used. Discharge velocities may not exceed 200 FPM at the diffuser outlets (or anywhere else within the lab).

8. Air velocity caused by supply outlets, window drafts, traffic, etc. shall not exceed 30-50 FPM at the hood face.

9. Supply diffusers shall provide throw patterns that sweep air across work surfaces and away from occupant breathing zones.

10. Exhaust ducts shall be sized for 1,400-2,000 FPM velocity at full flow.
11. Exhaust Fans shall be located as close to the discharge point as possible. If located in a mechanical penthouse, the penthouse shall be ventilated at a minimum rate of one air change per hour.

12. Duct chases shall be reasonably oversized for future additional ducts. Systems that require maintenance or inspection shall be accessible. Laboratories backed on utility corridors are encouraged.

13. Fume hood exhaust ducts shall not contain fire dampers.

14. Fans shall be as close to the discharge point as possible. If located in a mechanical penthouse, the penthouse shall be ventilated at a minimum rate of one air change per hour.

15. Duct chases should be reasonably oversized for future additional ducts. Systems that require maintenance or inspection shall be accessible. Laboratories backed on utility corridors are encouraged.

F. Control System Design Criteria:

1. VAV control systems are preferred. Two-position control systems shall be full analog with setpoints established via programming.

   EXCEPTION: Hoods used for volatile radioactive material discharge must maintain a relatively steady flow rate. The use of occupancy based variable volume air systems that change the hood flow rate are not allowed.

2. Pressurization shall be established by initial balance and maintained by supply tracking the exhaust. Through-the-wall pressurization controllers shall be avoided. Special care should be made during renovations to seal windows and corridor wall penetrations. Monitoring of exhaust shall be reported to the building dashboard.

3. The design professional shall specify the following parameters for each laboratory airflow control device (supply, exhaust, and general): flow at maximum cooling mode; flow at occupied sash open position; flow at occupied sash closed position; flow at unoccupied sash full position; flow at unoccupied sash open position; flow at unoccupied sash closed position; flow at occupied hibernation mode; flow at unoccupied hibernation mode; flow for vacant mode; and response time of controls. Please see Cornell Standard Details 3.7.1, 3.7.2, and 3.7.3 for a sample schedule specifying the level of detail required when establishing the airflows for each operational mode.

4. Single mode infrared sensors, with a minimum of two sensors per laboratory area, shall be used to establish occupancy/un occupancy intervals. Schemes that utilize Time-of-Day (TOD) light switches and/or manual switches to establish lab occupancy shall be avoided.
5. Please refer to Section 15955 – Building Automation and Control System Guidelines and Cornell Standard Details 3.7.1, 3.7.2, and 3.7.3 for additional information on laboratory controls.

PART 2: MATERIALS AND EQUIPMENT

2.01 EXHAUST DUCTS

A. Duct materials shall be compatible with vapors to be exhausted and in conformance with applicable Codes.

1. Horizontal branch ducts on most duct systems using solvents and potentially flammable vapors installed from a fume hood connection to the point where the duct connects to a main or riser shall be stainless steel (Type 316, minimum 26 gauge).

2. The use of galvanized duct is acceptable for laboratory general exhaust ducts and risers.

3. For systems using corrosive vapors and perchloric acid, FRP or plastic duct shall be specified.

B. All duct seams and joints shall be sealed. Stainless steel ductwork shall be welded. Solvent welding is acceptable for PVC and FRP ductwork.

2.02 EXHAUST FANS

A. All fans used for fume exhaust shall be AMCA Type B spark-resistant construction.

B. Fans shall be Class 1 belted utility sets with a steel scroll sized to operate below 2,000 RPM. All components exposed to the air stream shall be coated with primer, baked enamel and a baked phenolic coating. In-line centrifugal fans of the same material and coatings are acceptable where space precludes the use of a utility fan. Fans constructed of PVC or FRP shall be used where high concentrations of corrosives are anticipated.

2.03 FUME HOODS

A. It is preferred to use active face velocity controls and fume hoods suitable for VAV operation. Conventional (a.k.a. “standard”) hoods and other hood designs are allowed only under special situations and must be approved by both Facilities Engineering and Environmental Health and Safety.

B. Constant volume fume hoods shall have bypass grills of adequate size to maintain an acceptable face velocity over the entire range of sash movement.
C. Hoods with vertical sashes shall be installed unless required by the Americans with Disabilities Act. Obtain approval from Facilities Engineering for special circumstances that require the use of alternative hood sash designs.

D. Auxiliary air fume hoods shall not be used.

E. Fume hoods shall have stops installed at an 18-inch sash height.

F. Fume hoods shall be specified to meet “As Manufactured” ANSI/ASHRAE 110 defined performance tests conducted on a representative hood that demonstrates adequate hood containment.

2.04 CONTROLS AND ALARMS

A. All new fume hoods must be equipped with a device providing the following minimum control and alarm points:

1. Face velocity display.
2. Visible and audible alarms for high and low face velocity.
3. Local alarm reset.
4. Standby velocity setting (for unoccupied mode).
5. Sash position input.
6. Hood exhaust feedback.
7. Dry contact for alarming status to the BACS.

B. Please refer to Section 15955 – Building Automation and Control System Guidelines for additional material specifications for Laboratory Control Systems.

PART 3: EXECUTION

3.01 LABORATORY COMMISSIONING

A. All newly installed and renovated laboratory ventilation systems shall be properly commissioned. Total laboratory airflows shall be measured via a duct traverse in addition to hood face velocity measurements. If the hood is equipped with VAV or two position controls, the airflows shall be measured and documented in all modes of the intended operation. The project team should be made aware that a controls technician will be necessary to accomplish these commissioning efforts. Coordination between Cornell EH&S and the commissioning agent shall be made well in advance of the scheduling of final commissioning activities.
B. EH&S will perform a smoke or dry ice capture test to qualitatively determine the hoods ability to contain contaminants.

C. In order to pass the fume hood certification process, all center points of a uniform, sixteen point grid at the 18 inch sash height should have velocity readings within +/- 10 fpm of each other. Face velocity shall be initially measured at 100 fpm, with the ability for EH&S to reduce the face velocity to 80 fpm if the fume hood demonstrates sufficient containment.

D. Laboratory projects shall also be subject to a carbon dioxide test to determine the overall laboratory ventilation effectiveness. This test shall be performed by EH&S.

E. In addition, the design documents should include requirements to perform a tracer gas capture test on one hood of each type specified in the project. The Contractor shall procure qualified individuals to perform this test, which must be done in accordance with methods outlined in ANSI/ASHRAE Standard 110.

F. Signage will be placed on the fume hood upon final acceptance by EH&S.

G. Laboratory noise levels shall be measured and documented to ensure they meet the maximum design conditions of NC 50.