

Element D Services

Heating, Ventilating, and Air
Conditioning

D304202 HVAC Laboratory Exhaust and Ventilation

PART 1 - GENERAL

1.1 OVERVIEW

- A. This section supplements Design Guideline Element D3042 on exhaust and ventilation with additional criteria for projects involving design of laboratory exhaust and ventilation systems.
- B. Refer to Design Guideline Element D3042 for the following:
 - 1. General design criteria related to exhaust and ventilationsystems.
 - 2. Special Contract Document requirements and products applicable to the Project.

PART 2 - DESIGN CRITERIA

2.1 GENERAL

- A. In general, laboratory exhaust systems shall comply with procedure and support room ventilation air requirements of NFPA 45, 90A, NIH, CDC, OSHA Regulation 29 CFR, Part 1910, ACGIH a Manual for Recommended Practice for Design 27th Edition, and ANSI/AIHA Z9.5 latest edition.
- B. Special exhaust systems as noted below and where determined to be hazardous, shall not be housed in the same chase that contains environmental supply, return, and exhaust ducts. Special exhaust systems shall be labeled "hazardous" consistent with specification requirements.
 - 1. Laboratory hood exhaust systems.
 - 2. Biological laboratory exhaust.
 - 3. Radioactive hot lab exhaust.
 - 4. LN₂ freezer room exhaust system. Refer to Design Guideline Element Z4050.
- C. Where laboratory classification is BSL-1 or BSL-2 and laboratory protocol does not allow for hazardous exhaust as a portion of the laboratory exhaust system, combined environmental/laboratory exhaust systems may be used and may be located in the same chase as environmental supply and return ductwork. The combination environmental/laboratory exhaust ductwork should still be labeled "hazardous" to be consistent with specification requirements.
- D. All ductwork that carries environmental supply and/or return air may be installed in the same chase as this is non-hazardous exhaust. Hazardous lab exhaust shall be in its own dedicated shaft.
- E. Exhaust fans serving laboratory hoods shall be connected to an emergency power source. Refer also to Design Guideline Element D3000 for additional emergency power requirements.
- F. Evaluate recirculation of air in non-laboratory areas.

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- G. Evaluate sensible cooling in low hazard, high heat load areas. Supplemental cooling from fan coil units may be required.

2.2 LABORATORY HOOD EXHAUST FANS

- A. While the type of exhaust system depends on hood characteristics, incorporate the following features into the design to avoid excessive noise levels and ensure accurate air balancing.
1. Exhaust shall be continuously monitored and an alarm system (local audible and visible alarm and an alarm at MD Anderson Cancer Center's central monitoring services, shall be provided for each hood and biological safety cabinet).
 2. Select exhaust fans to operate at low tip speed (approximately at 50 percent of the maximum permissible tip speed) and maximum static efficiency. Refer to ASHRAE 90.1 for additional fan efficiency requirements, specifically FEG rating.
 3. Furnish to the Owner for review during the Design Phase, fan selection data on a performance curve and ensure that the fan discharge is directed vertically upward.
 4. Size ductwork to maintain velocity in the ductwork between 1200 and 2000 fpm to prevent condensed fumes or particulate from adhering to the walls of the ducts or settling out onto horizontal surfaces and to address acoustical issues.
 5. Assist the sound consultant in performing a sound analysis for each exhaust fan and provide sound attenuation, if required.
 6. To ensure that design airflow is achieved on manifolded and shared exhaust systems, specify pressure independent, factory-set, field-adjustable automatic airflow controls for each fume hood and ducted biological safety cabinet.
 7. An independent flow monitor shall be provided on each exhaust fan with provisions to alarm to the building automation system (BAS). Provisions must be incorporated in the design to allow access to the independent flow monitor.
- B. Each laboratory exhaust air system shall have a corresponding supply air system to comply with laboratory, hood exhaust air, and laboratory ventilation exhaust air changes per hour (ACH) requirements listed below:

Room Description	Occupied ³ ACH (minimum)	Unoccupied ACH (minimum)	Vacant ⁴ ACH (minimum)
Fume Hood Rooms	6	6	4
Radio Chemistry	8	6	4
Laboratories ⁴	6	4	4
Equipment Room ⁴	6	4	4
Tissue Culture Room ³	6	4	4
Dark Room	10	10	4
Storage Room	4	4	4
Glass Wash Room	8	6	4
Cold Room ⁵	15 CFM total	15 CFM	15 CFM total

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Notes:

1. Occupied defined as space with personnel present during specific time.
 2. Vacant defined as space that is not assigned to a lab user and that does not have equipment that generates chemicals.
 3. BSL3 are exempt from the occupied and unoccupied air change rate.
 4. Room shall have override capability for changing from unoccupied to occupied modes.
 5. Cold room manufacturers typically only require a small amount of ventilation air for clean rooms. Typically 15 CFM. Confirm with actual cold room requirements.
- C. Actual air change rates may exceed the above stated rates to maintain temperatures in the laboratory or prevent a hazardous environment. By definition, one ACH is the total of supply air and infiltration air from the surrounding spaces or the total of exhaust air and exfiltration air to surrounding spaces provided in one hour divided by the total room volume.
- D. Laboratory exhaust fans shall be an N+1 redundant system capable of maintaining constant volume with the capacity to exhaust listed rooms at the required minimum ventilation design air change rates. Laboratory exhaust fans shall only be allowed to reduce airflow when a wind tunnel study proves the airflow reduction will not cause unsafe discharge of exhaust fumes or entrainment into outdoor air intakes.
- E. Exhaust fans shall be direct drive. Where exhaust air filters require or merit such, exhaust fans shall be powered through the use of variable frequency drives that vary fan speeds to maintain exhaust air conditions during exhaust air filter loading. Fan speed is determined by maintaining an airflow measurement or static pressure setpoint (adjustable) from the BAS.
- F. The design exhaust rate through fume hoods will be determined based on maintaining full containment at maximum vertical sash height per the following criteria:

Hood Application	Airflow Configuration	Face Velocity in FPM (Operating [Sizing])			Exhaust CFM below min sash height
		@ Max vertical sash height	@ 18" vertical sash height	@ min vertical sash to 18"	
General Purpose	VV	60 [60]	60 [100]	60 [100]	150 AC/hr of hood interior volume
General Purpose	CV	60 [60]	>75 [100]	>75 [>100]	N/A
Radioisotope	CV	60 [60]	>75 [100]	>75 [>100]	N/A
High Chemistry	VV	60	100 [100]	100 [100]	25 CFM / sqft of work surface
Hydrogenation	VV	60	100 [100]	100 [100]	25 CFM / sqft of work surface
-Numbers without brackets are for specifying operating parameters.					
-Numbers in brackets [##] are for sizing ductwork and air terminal unit.					

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- G. Either variable or constant volume bypass type hoods will be utilized. For substantial organic chemistry areas, variable volume type hoods with restricted bypasses will be utilized for those spaces. In addition to fume hoods, the BSCs, flammable storage cabinets, and acid storage cabinets will be served as follows:
 - 1. Typical fume hoods and Class II Type B1 cabinets should be combined into a single laboratory exhaust system.
 - 2. Radioisotope hoods should have a dedicated exhaust system.
 - 3. Organic chemistry hoods may also require a dedicated exhaust air system.
 - 4. Acid storage cabinets will be ventilated utilizing a 2-inch galvanized pipe directly connected from the cabinet to the fume exhaust ductwork. An exhaust air valve will not be utilized for the cabinet.
 - 5. Some Class II Type B2 BSCs will utilize bag-in/bag-out 99.97 percent HEPA filters located on top of the BSC cabinet with supply air filters contained within the BSCs.
- H. The type of filtration components that will be placed in the laboratory exhaust shall be evaluated during Schematic Design based on the work being performed in each of the laboratories and exhaust hoods.
- I. Instruments that control air terminals shall be capable of changing the state of room pressurization, which will be dependent on current and future use of the laboratory.
- J. Storage rooms that contain laboratory specialty gases or liquid nitrogen stored in liquid cylinders shall be ventilated and shall have the appropriate gas detection monitoring and alarm systems per OSHA requirements to protect personnel from accidental asphyxiation.

2.3 LABORATORY EXHAUST DUCTWORK

- A. Equip BSC's with proper filtration components to capture potential contaminants.
- B. Route exhaust ductwork through the building roof and terminate at a distance no less than 25 feet and downwind from any outside air ventilation air intake. The final location and orientation of the laboratory exhaust or outside air intake will be determined from wind tunnel results.
- C. The allowable exhaust air stack height shall be minimum 12 feet above centerline height of air intake or roofline. The stack discharge air velocity shall be equal to or greater than 3000 fpm (3600 fpm for an NIH funded project).
- D. Locate exhaust discharge stacks where exhaust air cannot be easily reintroduced into building outside air intakes. Owner prefers to locate outside ventilation air intakes on the side of the building; not on the roof. Refer to Design Guideline Element D3041 for additional criteria on outside air intakes.

2.4 AIR DEVICES

- A. Refer to Sound Criteria in Design Guideline Element D3002.

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- B. Specify exhaust diffusers to be square perforated face diffusers with round necks in open laboratory areas. Increase neck sizes for the diffuser since they are being used for exhaust air purposes.
- C. Air terminals shall be used to control the exhaust airflow rates from rooms, hoods, and BSCs via feedback signals from standalone controllers and setpoints (adjustable) from the BAS.

PART 3 - SPECIAL CONTRACT DOCUMENT REQUIREMENTS

3.1 GENERAL

- A. Include a single line riser drawing of the general exhaust ventilation exhaust systems in the Contract Documents. This shall be initially provided in the Schematic Design Submittal.
- B. When high plume exhaust fans are being considered in the design of a laboratory exhaust system, note plume heights, design airflow rates, static pressure requirement, and maximum brake horsepower requirements on the equipment schedule on the Drawings.
 - 1. A/E shall consider wind velocities as listed in the Appendix of the "Climatic Design Information" chapter of ASHRAE Handbook of Fundamentals or airport weather data.

PART 4 - PRODUCTS

4.1 GENERAL

- A. Refer to Owner's Master Construction Specifications.
- B. Evaluate energy recovery units as appropriate to the application in accordance with the latest state adopted edition of ANSI/ASHRAE/IESNA 90.1. Refer to Design Guideline Element D3041 for energy recovery requirements.
- C. Specify high efficiency / low exhaust volume design for constant volume fume hoods installed in rooms smaller than 1500 square feet of floor space per hood (typical for radioisotope fume hood installations) or variable volume rooms where fume hood density dictates minimum airflow rates.
- D. Specify high plume, dilution mixed flow fans with direct drives for laboratory exhaust where feasible.
- E. Evaluate and provide test data for manufacturers of HVAC airflow tracking equipment proposed on the Project that are not currently specified in Owner's Master Construction Specifications, Proposed products should operate with BACnet open protocol and should also be compatible with the building automation system.
- F. Evaluate an exhaust ductwork material that is capable of withstanding the corrosion products from a synthesis laboratory.

PART 5 - DOCUMENT REVISION HISTORY

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Issue	Date	Revision Description	Reviser
	20190301	Original Issuance	

Issue	Date	Revision Description	Reviser
Rev. 1	20210412	2.2.B.F revisions by Ken Schroeder	Ken Schroeder

**END OF ELEMENT
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