

SECTION 15852

SPECIAL EXHAUST SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Laboratory Ventilation and Hazardous Exhaust Systems

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B. Related Sections:

1. Section 11610 – Laboratory Fume Hoods
2. Section 11611 – Laboratory Biological Safety Cabinets
- 3. Section 12345 – Metal Laboratory Casework**
4. Section 12346 – Wood Laboratory Casework
5. Section 15010 – Basic Mechanical Requirements
6. Section 15050 – Basic Mechanical Materials and Methods
7. Section 15240 – Mechanical Sound and Vibration Control
8. Section 15850 – Air Handling
9. Section 15880 – Air Cleaning
10. Section 15990 – Testing, Adjusting and Balancing

1.02 REFERENCES

- A. "Industrial Ventilation, a manual of Recommended Practice" published by American Conference of Governmental Industrial Hygienists (ACGIH)
- B. National Fire Protection Association (NFPA)
- C. American Society for Testing and Materials (ASTM)
- D. American National Standards Institute (ANSI)
- E. American Industrial Hygiene Association (AIHA)
- F. Center for Disease Control (CDC)
- G. The National Institute of Health (NIH)
- H. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- I. International Building Code (IBC)

1.03 SYSTEM DESCRIPTION:

A. Laboratory Ventilation and Hazardous Exhaust Systems

1. Pre-Design Considerations

- a. Laboratories shall be ventilated per ASHRAE Standard 62, NFPA 45, NFPA 91, ANSI/AIHA Z9.5, and UCB Sections 15850 and 15885.
- b. Early in the design process, the HVAC Design Engineer responsible for the fume hood exhaust system shall obtain a complete list of the chemicals and gases to be used and stored in the lab and submit to the University Environmental Health & Safety (EH&S) Environmental Compliance group through the University Project Manager. This list shall be used to analyze fume hood exhaust for flammability, toxicity, corrosiveness, and explosion hazards. In selecting and analyzing fume hazard control techniques, the HVAC Design Engineer shall work closely with University EH&S personnel.
- c. If perchloric acid must be used, a specialized, dedicated hood (stainless steel, porcelain coated, or non-plasticized PVC lined) labeled *for perchloric acid use only* must be installed. A regular chemical fume hood may not be used for perchloric acid. The perchloric hood must have its own non-reactive duct and exhaust fan, built-in water wash-down system, and other features as described in the ACGIH Industrial Ventilation Manual.
- d. Radioisotope hood installations and the use of radioactive materials on campus, require prior review, approval and licensing by EH&S Health Physics. Conventional chemical fume hoods are suitable for many low level radioisotope applications, however, the use of some materials such as radioactive iodine, requires a specialized radioisotope hood equipped with integral filter components. In these cases, service contracts must be set up for maintenance, calibration and filter replacement or disposal.
- e. Biosafety cabinet installations and proposals for biological or biomedical research must be reviewed and approved by EH&S and the UCB Institutional biosafety Committee (IBC) to evaluate conformance with requirements of the Center for Disease Control (CDC) and the National Institute of Health (NIH). Such requirements can be found in CDC/NIH publication: "Biosafety in Microbiological and Biomedical Laboratories." The CU-Boulder campus is not approved for biohazardous work above Biosafety Containment Level 2. Biosafety cabinet selection and room designs must comply with National Science Foundation Publication 49: "International Standard for Class II (Laminar Flow) Biohazard Cabinetry" in addition to CDC and NIH requirements. Biohazard cabinetry equipped with integral filter components will require a special service contract for maintenance, calibration and filter replacement or disposal.

- f. Other safety cabinets and enclosures for highly-reactive or toxic gases, and other specialized operations will have different and/or additional requirements than those listed above. EH&S must be consulted before planning such installations.

2.

- a. Laboratory modules in which hazardous chemicals are being used shall be maintained at an air pressure of at least 0.03" wg* that is negative to the corridors or adjacent non-laboratory areas. An exception to this requirement is where operations, such as those requiring clean rooms, preclude a negative pressure relative to surrounding areas; in this case, special precautions shall be taken (e.g., The HEPA units are laminar flow and will be located as far from the hood as possible in order to avoid air currents near the hood. In an emergency situation, a ventilation "off" switch will be located in the room near the door that will, when activated, shut off the air coming into the room (via a control damper) and shut off the air handler and fan. The main exhaust fan will continue to run, and the room will be negative.).

* Also meets **LEED EQc5: Indoor Chemical and Pollutant Source Control**.

- b. Air containing hazardous chemicals shall be discharged through hood/duct systems maintained at a negative pressure relative to the pressure of normally occupied areas of the building. Air exhausted from laboratory modules shall not pass unducted or be recirculated through other areas.
- c. If a hood is to be connected to an existing central or manifold exhaust system serving multiple fume hoods, then the air system will have to be evaluated to see if it has sufficient capacity for the addition of other exhausted equipment. Each individual exhaust drop on a central or manifold exhaust system shall be labeled for the specific room(s) it services.
- d. Hazardous exhaust systems are not typically equipped with filters to capture contaminants. In some cases, however, prefilters may be installed to protect heat exchange coils or other HVAC equipment from accumulating debris. Consult with EH&S regarding filters specifications for hazardous exhaust systems. Ductless (filtered) fume hoods may be used in place of ducted fume hoods only on a limited case by case basis and after review by EH&S and meets compliance with Building and Fire Codes.
- e. Fume hoods shall be located in close proximity to where chemicals are stored, and away from exits (minimum 10 feet) or where interfering air currents and cross drafts from doorways, windows, high traffic areas, HVAC systems, or other apparatus, could adversely affect the proper function of the hood enclosure.

General Design Criteria

- f. Make-up air shall be provided to compensate for the air being exhausted. The location and volume of make-up air is critical to assuring proper fume hood operation and worker protection. Air distribution around fume hoods shall be such that cross drafts, dead air pockets, and reverse air currents are to be avoided. Care shall be exercised in the selection and placement of air supply diffusion devices to avoid air currents that would adversely affect the performance of laboratory hoods, exhaust systems, and fire detection or extinguishing systems. Unless otherwise specified, supply air velocities shall be no more than 35 fpm at work stations and fume hoods.

3. Chemical Fume Hoods and Storage Cabinets

- a. Constant-volume chemical fume hoods must be capable of maintaining 100 fpm minimum face velocity through the sash opening with the sash at 13” measured from the top of the airfoil or 14” above work surface if airfoil is not present. Variable-Air-Volume fume hoods shall be capable of maintaining 100 fpm at all sash heights below 13”. (Provide sash with stops located 18” above working surface and with override release. Special local exhaust systems, such as fume extractor arm, drop canopy and slot exhaust, shall have sufficient capture velocities to entrain the hazardous chemicals being released per manufacturer specifications and/or ACGIH “*Industrial Ventilation, a manual of Recommended Practice*”.

NOTE: Some hoods require 120 fpm min. face velocity. HVAC Design Engineer shall consult EH&S for minimum face velocity.

- 1) Floor Mounted (Walk-In) Fume Hoods – HVAC Design Engineer shall consult EH&S for minimum face velocity at specified sash position(s).
 - 2) Combination Vertical and Horizontal Sash Fume Hoods - HVAC Design Engineer shall consult EH&S for minimum face velocity at specified sash position(s).
- b. Fume hoods must be equipped with audible and visual low air flow alarm which shall be field calibrated to alarm at 75 fpm face velocity. Provide one 2-gang duplex, 20A, 125V receptacle for electrical service to alarm. Receptacle shall be located on top panel of hood to accommodate alarm. A removable strap or cover shall be located over the power adapter plug to assure its fixed placement in the receptacle. Alarm shall be located on fume hood and installed per manufacturer specifications. Special equipment/systems such as Fume Extractor Arms, Drop Canopy and Slot exhausts, used for capturing hazardous vapors shall have an audible and visual low air flow or duct static pressure indicator.
 - c. Chemical fume ducts are generally not equipped with fire sprinklers or fire dampers, but whenever code requires, ducts shall be in fire-rated or fire-protected shafts. Where fume hood exhaust contains flammable vapor, UCB Standards compliance with the requirements of Building and Fire

Codes for automatic fire suppression systems protecting the fume hood and/or the exhaust duct. However, this requirement shall be carefully addressed on a case-by-case basis, since it may result in a variety of other potential hazards associated with fume hood operation.

- d. Class I – Division I interior lighting and other electrical utilities are required where internal utilities are desired.
- e. Sinks inside fume hoods must have a minimum 3/8” raised edge around cup sink cut out, i.e., provide a 3/8” lip above work surface. Do not install sinks inside hoods unless they are specifically requested and needed.
- f. Chemical fume hoods shall include base chemical storage cabinets which meet UCB Standard, Sections 12345 or 12356. Stand-alone chemical storage cabinets should be located in close proximity to where chemicals will be used, preferably adjacent to fume hoods. Chemical storage cabinets should be vented per UCB Standard, section 12345, 12346 or manufacturer’s instructions and provide a minimum of 10 air changes per hour.
- g. Flammable storage cabinets must be equipped with flame arrestors, and vented using metal or PVC duct. Materials used for venting must meet an NFPA Flame Spread Rating of 25 or less and be of rigid construction. Metal duct should be PVC coated or resistant to corrosive or reactive materials. PVC piping may be used to vent corrosive and other non-flammable storage cabinets. Chemical storage cabinets, whether they are stand-alone or built-in under a fume hood, must be UL listed for the materials they contain and must comply with the applicable requirements of NFPA 30, 45 and 99. Separate cabinets must be used to segregate, by hazard class, the following: acids, bases, oxidizers, flammables and organics. Cabinets must also be provided with spill-containment features or devices. Consult EH&S for additional requirements and restrictions in areas where flammable liquid dispensing occurs.
- h. Chemical fume hoods shall be equipped with an exterior mounted single point or remote adjustment baffle system.
- i. Exhaust fan, *ON/OFF* switches are not permitted on fume hoods or other special hazardous exhaust equipment/systems without expressed approval from CU EH&S. *ON/OFF* switches may be considered for special operations and situations, EH&S shall be consulted for review. Hazardous exhaust systems should be provided with emergency backup power and not shut down upon activation of any alarm, however, dedicated switches may be provided in the building fire alarm panel to allow capability for manual fan shut-down by the fire department.

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Ducts, Fans and Control Systems

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All chemical exhaust shall discharge through unobstructed, uncapped vertical stacks. The stacks shall terminate at least 10 feet above roof level, away from eddy currents, air intakes and openings. Discharge velocities shall not be less than 3,000 fpm. Fan selection, stack height and discharge velocity determinations shall give consideration to preventing the reentry of contaminants into buildings. A discharge-height exception might be made by the AHJ if it deems that adequate velocity and dilution will be achieved by the specified fan.

Controls and dampers, where required for balancing or control of the

exhaust system, shall be of a type that, in even the failure, will fail open to assure continuous outdoor air.

energy conservation devices are used, they shall not recirculate laboratory exhaust air or otherwise compromise the safety of the building occupants.

Methods of providing emergency ventilation shall be considered, such as variable-speed fan systems, stand-by local exhaust systems, etc., to protect occupants against major chemical spills or similar hazards.

Duct work shall be installed with a minimum of elbows, using round ducts and sweep ell's wherever possible. To further minimize friction loss and turbulence, the interior of ducts shall be smooth and free from obstructions, especially at joints. Rectangular elbows shall not be used unless there is no other choice. If used, turning vanes and inspection doors upstream of the vanes shall be required.

Ducts for ventilating chemical fume hoods and special exhaust equipment/systems for hazardous vapors must be stainless steel or PVC coated galvanized steel and of rigid construction.

Ducts for venting flammable storage cabinets must be metal or PVC duct. Materials used for venting must meet an NFPA Flame Spread Rating of 25 or less and be of rigid construction. Metal duct should be PVC coated or resistant to corrosive or reactive materials. PVC piping may be used to vent corrosive and other non-flammable storage cabinets.

Installation of ductwork must be in compliance with NFPA 91 and ANSI Z9.5, including provisions for properly sealing penetrations, grounding and sealing duct construction materials. Penetration of fire barriers should be avoided. Fume hoods and special exhaust equipment/systems shall be equipped with a balancing damper.

The fan housing and components shall be corrosion resistant and meet the AMCA standard for spark-resistant construction. The motor must be vapor tight (Class I, Division I) if it is located in the air stream. All fans, ducts, and power supplies shall be clearly labeled to indicate exactly which areas they serve.

- i. Ducts for ventilating flammable storage cabinets shall be tied into the hazardous exhaust as far down stream from the fume hood as practical to prevent fire-flashback.
 - j. Ducts for ventilating corrosive or reactive chemical storage cabinets shall be tied into the hazardous exhaust so as not to immediately mix with flammable storage cabinet exhaust.
 - k. Fans used for hazardous exhaust and are located in enclosed areas, such as attics, penthouses, and mechanical rooms, shall comply with ASHREA.
 - L. Internal fans or blowers are not permitted on or within fume hoods. Fans or blowers must not be located inside any duct that is used to vent hazardous exhaust.
5. Testing, Inspecting and Certification
- a. Testing, inspecting and certifying hazardous exhaust systems, fume hoods and chemical storage cabinets will be performed by Facilities Management Department and Environmental Health and Safety.
 - b. Testing procedures shall conform to UCB Section 15890 and sections 4.7, 4.8, 5 (excluding 5.5.4 and 5.5.5) and 6 of the ANSI/ASHRAE 110-1995 Standard: "Method of Testing Performance of Laboratory Fume Hoods". Calibrated air velocity measuring devices as specified in Chapter 9 of the ACGIH – "Industrial Ventilation, a Manual of Recommended Practice" shall be used in testing procedures. EH&S will use a calibrated, direct-reading air velocity measuring device for certification and inspection purposes. If a meter has not been calibrated at, or adjusted for 5,000 feet above sea level, a density-correction factor must be used when measuring air velocities. EH&S shall certify that the fume hood is in safe operating condition and meets applicable UCB Standards.

B. Dust Collectors

- 1. Provide the following information on the drawings
 - a) Manufacturer's name and model number
 - b) CFM at total pressure
 - c) Horsepower and TEFC motor: 3600 or 1725
 - d) Drive type: direct or belted
 - e) Maximum sq. ft. of ground slab that the unit can occupy

- f) Overall maximum height of unit including leg extensions and plenum silencer
- g) Capacity in cu. ft. of storage hopper
- h) Length of legs to provide clearance under hopper without violating overall maximum height restriction of building space.

C. Gas Cabinets

1. Continuously mechanically ventilated gas cabinets are required for the storage of cylinders of all gases that are greater than lecture bottle size and have an NFPA Health Hazard Rating of 3 or 4. Lecture bottles of these gases must be used and stored inside a chemical fume hood (NFPA 45 8.1.4.2 Special Ventilation Requirements of Gas Cylinders). (Examples of NFPA Health Hazard Rating 4: arsine, chlorine, hydrogen fluoride, phosgene; NFPA Health Hazard Rating 3: ammonia, carbon monoxide.)
2. Continuously mechanically ventilated, sprinklered gas cabinets are required for all cylinders larger than lecture bottle size that contain pyrophoric gases (NFPA 45 8.1.4.3 Special Ventilation Requirements of Gas Cylinders).
3. All gas cabinets must comply with 2000 Uniform Fire Code 8003.1.3.2
4. Duct for venting gas cabinet must be stainless steel or PVC coated galvanized steel and of rigid construction.
5. Compatibility of the gases and other chemicals being vented must be taken into account when determining the proper ventilation materials, mixing distance, etc.
6. The maximum allowable amount of flammable gases in any one area is determined by the square footage of the area, the types and concentrations of gas being used and stored, and whether or not the gases are stored in gas cabinets. Using NFPA 45 and 2000 UFC 8001.15A as guidelines, the maximum allowable amount of flammable gases stored outside of flammable gas cabinets is 0.012 cu ft (internal volume)/ ft² area. This equates to about four full size cylinders per 500-ft² area. The maximum allowable amount may be doubled if the gases are stored in ventilated flammable gas cabinets.
7. A gas detecting system is required when a cylinder larger than lecture bottle size containing a gas with a Health Hazard Rating of 4 is being used or stored in the laboratory (NFPA 55, Chapter 3 Toxic Gases).
8. A gas detecting system may also be required if a cylinder larger than lecture bottle size containing a gas with a Health Hazard Rating of 3 has been approved by EH&S to be stored outside of a gas cabinet.

9. EH&S will determine if a gas detecting system is required based on gas types, volumes, concentrations, toxicity, physiological warning properties and how the gases are to be used.

END OF SECTION