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# Clemson University Chemical Hood Program

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## Introduction

Chemical hoods are critical to the safety of laboratory personnel and the advancement of research throughout Clemson University. They are the most important component used to protect laboratory workers from exposure to hazardous chemicals and other agents used in the laboratory. When properly installed, maintained, and used, they can provide protection from these hazards. When this does not occur, the health and safety of laboratory occupants and maintenance personnel can be severely compromised, and research efforts can be hindered. A chemical hood system is designed to protect the operator from being exposed to undesirable substances, so its most important function is containment. The type of hood selected; installation of the hood and exhaust ductwork; balance of supply and exhaust air; type of fan chosen; maintenance of the system; and operator use of the hood all affect the performance of the hood.

This document has been developed to establish policy and provide guidelines to ensure that hoods and other ventilation devices are properly selected, installed, maintained, and used in order to prevent the compromise of the health and safety of Clemson University personnel and to limit possible hindrance to research efforts as a direct result of chemical hood performance deficiencies.

## Approval for Purchase/Installation of Hoods/Ventilation Devices

**The purchase, relocation, installation, or modification of any laboratory hood or other laboratory exhaust device (canopy, snorkel, glove box, ventilated storage cabinets, etc.) requires prior approval by the Office of Environmental Health and Safety (EHS).** EHS must be notified of any changes to be made in hazard control ventilation systems including chemical hoods. EHS shall review all hazard control ventilation system plans/blueprints/change orders to ensure the safety of these systems. EHS must approve the selection of chemical hoods before they are purchased in order to ensure that the proper hood has been selected to protect laboratory occupants from the hazards that they are working with.

## Procedure for Unplanned Hood Shut-Down (System Malfunction)

**In the event that an airflow indicator should signal low or no airflow; or if personnel recognize that such a condition exists otherwise, the person first recognizing this problem should follow the procedure outlined below:**

1. If the hood has no airflow, airflow is reduced, hood flow alarm activates when sash is positioned at working height, etc:
    - **a.** Immediately stop all work in the hood.
    - **b.** If safe, do the following: 1) Stabilize reactions and turn off equipment (i.e., hot plates) or other electric devices 2) Close any open containers of chemicals, radioactive materials, etc. 3) Close the hood sash.
    - **c.** Report the problem immediately to University Facilities **(656-2186)** and the Lab Director and/or Building Manager.
    - **d.** Notify others in the area and on additional shifts that the hood(s) is/are not operating and cannot be used.
    - **e.** If it can be accomplished safely, the hood(s) should be posted with a sign that boldly states that the hood(s) is/are not functioning and may **NOT** be used until repairs/corrections have been made and sign is removed. If it is determined not be safe to take the time to post the hood, it should then be decided whether or not it is safe to post the lab door after exiting the lab. If it is safe to do so at that time, the door should be prominently posted "**HOOD FAILURE—DO NOT USE CHEMICAL HOOD(S)".**
    - **f.** If more than one hood or lab is affected, and if it is determined that it is safe to enter, other affected labs must be checked by lab personnel to ensure that all processes are shut down, etc. Lab doors and/or hoods must be posted. UF will then be notified by the department when the hood(s) and/or building is safe for repairs.
    - **g.** If processes/reactions that could create a hazard to lab/building occupants cannot be stopped/contained, the lab(s) and/or possibly the building should be evacuated until the hazard is eliminated. Activate fire alarms; **call 656-2222** and give details to the dispatcher. Evacuate accordingly. When EHS/emergency/fire personnel arrive, follow their instructions and do not re-enter the building until permission is given by the Hazmat commander or EHS personnel.
    - **h. Do not use** the hood(s) until repairs have been made and UF provides information that the hood(s) is ready for use and removes posting. If changes/repairs are made that could potentially affect the performance of the hood, UF will contact EHS. EHS will test/certify that the hood(s). After testing, EHS will remove **"DO NOT USE**" sign(s) if hoods meet performance standards. If not EHS will contact UF to request further repair.

## Scheduled Hood Repair/Maintenance Shut-Down

1. UF informs department chairs or designated departmental contact when work will begin and an estimated time to completion. When possible, UF will work with department to schedule shut-downs at times most convenient to the department work schedule

2. UF assigns the work order to proper maintenance personnel
3. UF employee will place a warning label on laboratory doors where affected hoods are located. They will also knock on the door and inform lab personnel (if the lab is occupied) of the shut down. UF employees will enter the lab only if it is necessary to perform the repair/maintenance. Departmental contact/building managers or other assigned departmental personnel will be responsible for notifying all affected hood users by email or other written notification. The department must ensure that all employees are informed and understand how the information for hood shut downs will be disseminated. If email messages (from departmental contact) and Facilities postings on lab doors do not seem to be sufficient; the department should assign someone to post individual hoods within the labs.
4. UF will notify the departmental contact before beginning work to confirm that it is safe to shut down the hood ventilation system and begin work.
5. After work is completed, UF employee fills out work order work order should include nature of deficiency; corrective action taken; any additional deficiencies not included in the work request and whether or not action was taken to correct these other deficiencies
6. If changes are made that could affect the performance of the hoods, UF contacts Environmental Health and Safety Office to initiate hood air flow/containment testing. If not, UF will remove the postings and inform lab personnel and/or the department contact that the hoods may be used again.

**Regardless how University Facilities receives notification of deficient hoods, they must treat this as high priority.** In the event that University Facilities is notified of a deficient hood they must notify the department contact which hood will be affected by shut down and post accordingly. They must ensure (ask user) that all hazardous operations, materials, etc. have been stopped/contained. If there are a large number of hoods involved or perhaps an entire building, UF should contact their departmental contact to make sure that all labs have been checked and appropriate action to contain hazards has been taken. Facilities personnel will not enter any area until they have been given information by lab personnel or department chair or designated contact that it is safe to begin repairs. If the Fire Department has been called to control a hazard, UF personnel will wait for permission from the Incident Commander or EHS personnel before entering the area or initiating repair work.

## Responsibilities:

### Primary Investigators (PI's)

- Ensure that lab personnel have been trained on how to use chemical hoods safely.
- Provide lab personnel with this document (this document can also be found on the EHS website (http://ehs.clemson.edu). Ensure that they review and understand the policies/procedures. It is a good idea to post a copy of pg. 3 of this document "**Procedure for unplanned shutdown**" on or near hoods.
- Ensure that hoods have been cleaned out and/or decontaminated prior to removing a hood from service for repairs, modifications, or removal/relocation. All chemicals and other hazardous materials must be removed from the hood. If the hood is used for work with radioactive materials, the proper survey/decontamination procedures must be conducted before any work on the hood is allowed.
- If a laboratory hood or exhaust system has been used for perchloric acid and is not a designated/posted perchloric acid hood, you must inform EHS and UF of this use. This information must be made known to maintenance personnel before any inspection, maintenance, cleaning, or any other work is done on any part of the exhaust system or hood interior. **The hood and all parts of the exhaust system must be posted.** (**see p. 16 for more info on Perchloric acid**)
- Contact the EHS Radiation Safety Officer (656-7165) to initiate a hazard survey of any hoods used for work with radioactive materials that are going to be taken out of service or prior to any repairs/maintenance scheduled for the hood(s),
- Submit all requests for purchase or installation of any chemical hood/exhaust device to EHS and University Facilities for approval **before ordering/obtaining or installing** any such equipment.
- Do not alter/modify any laboratory hood/exhaust device without prior approval of EHS and University Facilities.
- Report all Chemical hood deficiencies to University Facilities at **656-2186**, immediately upon their identification. Information provided to dispatcher should include: description of work, location of hood(s), lab contact information, etc. Deficiencies that should be reported include: No air flow or apparent reduction in air flow; sash that does not operate smoothly; broken/cracked glass in sash; malfunctioning air monitor alarm; etc. Post hood(s) **(appendix A)** discontinue use until hood is repaired if deficiency is related to airflow, capture/containment or if it is thought to be unsafe for any other reason (i.e., malfunction of mechanism that allows the sash to open/close--can result in sudden failure (drop).
- Ensure that the hood is safe for maintenance personnel to begin work before facilities personnel arrive.
- If it is determined/suspected that a hood is not functioning properly, the hood must be posted and the hood **must not** be used until it is determined by Facilities and/or EHS to be functioning properly; at which time the posting will be removed. Ensure that all employees/students working with chemical hoods understand and follow this rule.

- Check lab door and hood for posting (Appendix A or B) before using hood. If hood has been posted with one of these notices, **DO NOT** use the hood until the notice has been removed by Facilities, EHS, or departmental contact.
- Utilize proper and safe work practices as related to Chemical hoods in this program. **(also, see section IV "Ventilation" of the 2000 Chemical Hygiene Plan)**

**Laboratory Personnel Reponsibilities**

- Report all Chemical hood deficiencies to supervisor and to University Facilities at **656-2186**, immediately upon their identification. Information provided to dispatcher should include: description of work, location of hood(s), lab contact information, etc. Deficiencies that should be reported include: No air flow or apparent reduction in air flow; sash that does not operate smoothly; broken/cracked glass in sash; malfunctioning air monitor alarm; etc. Post hood(s) **(appendix A)** discontinue use until hood is repaired if deficiency is related to airflow, capture/containment or if it is thought to be unsafe for any other reason (i.e., malfunction of mechanism that allows the sash to open/close can result in sudden failure (drop).
- Check lab door and hood for posting (Appendix A or B) before using hood. If hood has been posted with one of these notices, **DO NOT** use the hood until the notice has been removed by Facilities, EHS, or departmental contact.
- Utilize proper and safe work practices as related to Chemical hoods in this program. **(also, see section IV "Ventilation" of the 2000 Chemical Hygiene Plan)**
- Contact EHS (656-7557) to perform testing/inspection of hood(s) if the inspection sticker indicates that the last inspection was conducted more than one year from the "date of last inspection" marked on the sticker.
- Ensure that all chemicals or other hazardous materials have been removed from the hood. Also confirm that the hood interior has been decontaminated (if UF employees will come in contact with the hood interior) before UF personnel are scheduled to begin work on the hood(s). If the hood is used for work with radioactive materials, the hood must be surveyed/decontaminated before scheduled hood work begins.

**Department Chair (or Designated Contact) Responsibilties**

- Provide information to all laboratory personnel explaining the methods that Facilities will use to notify users of hood shut downs (posting of individual labs) as well as methods to be used by the department (email or other written notification, etc.)
- Communicate/distribute information pertaining to scheduled hood shut downs as well as how users should respond to hood system failures. At a minimum, this message should be distributed by email and/or other written notice to all users. If the message is sent by email, a request for notification of receipt should be used. Information must also be provided to all users explaining how lab personnel will be notified by the department in the event of a scheduled or an unplanned outage. If sending email or other written message to lab personnel, as well as instructing lab personnel to check hoods and lab doors for postings before using hoods proves not to be effective, the department should implement other safeguards; such as, having the departmental contact or other designated personnel post individual hoods.
- In the event of a scheduled or unscheduled hood shut down, Facilities must be informed that all affected hoods have been checked and that it is safe for them to begin repair work.
- Call in repair order to Facilities dispatch **(656-2186**) if lab personnel or EHS personnel report to you that there is a hood malfunction or deficiency.

**University Facilities Responsibilities**

- Communicate pertinent information related to compromised airflow to, or work on chemical hoods/hood exhaust system to departmental contact and UF employees who will be performing the hood or roof work.
- Provide advanced notice (as much as possible) to the residents of buildings housing chemical hoods of regularly scheduled maintenance that will impact hood performance.
- Perform routine work that will compromise airflow to chemical hoods in a manner which is least disruptive to building occupants.
- Maintenance personnel must be provided with, trained in the use of, and **required to use** the appropriate personal protective equipment (PPE) when they are performing work involving potentially hazardous exposure. PPE for this type of work would normally include goggles, gloves, and protective clothing, but may also include a respirator. Anyone using a respirator for protection from a respiratory hazard must be part of the University Respiratory Protection Program (**656-7557 or 656-2583**). The PPE should be determined based on hazard assessment.
- Before beginning work on a call for hood failure, check with departmental contact to ensure that it is safe to begin work on hood/exhaust system.
- Verify that all chemicals or other hazardous materials have been removed from the involved hood(s). Also confirm that the hood interior has been decontaminated (if UF employees will come in contact with the hood interior). If this has not been done, contact the lab personnel or department contact to ensure removal of chemicals and other hazardous materials and decontamination of the hood surfaces before beginning work.
- UF employee(s) will place a warning label on laboratory doors where affected hoods are located **(Appendix C)**. They will also knock on the door and inform lab personnel of the shut down if the lab is occupied. UF employees will enter the lab only if it is necessary to accomplish/ facilitate the necessary repair/maintenance
- UF employee(s) will complete the required work as directed on the work order. If problems/deficiencies other than those listed on the work permit are discovered, make repairs/corrections required to correct the deficiency.
- UF employee(s) will fill out work order and note any repairs/adjustments, etc. made that were not included on the original work description.
- Where changes in airflow/hood performance might occur as a result of maintenance activity, EHS must be notified once work has been completed. If no such changes are made, UF will remove postings and inform department contact that hoods may be used again.
- Perform routine maintenance on all chemical hoods/exhaust devices semiannually. (Maintenance schedule attached)
- Maintain maintenance and repair records for each hood. Records should include date of work; type of maintenance/repair; name(s) of maintenance personnel. Routine maintenance categories should be listed and criteria given for corrective action for deficiencies.
- Complete and permanent records shall be maintained for each laboratory ventilation system. Records should include: As-built drawings; commissioning report; testing and balance reports; inspection reports; maintenance logs; reported problems

- Hoods in all labs should be numbered. All exhaust stacks and fans should be numbered with room number(s) and coordinating hood numbers.

**Environmental Health and Safety**

- All chemical hoods, snorkels, canopy hoods, and glove boxes will be tested/inspected by EHS on an annual basis to ensure that adequate airflow and proper containment is being provided. Hood inspections will include measurement of the hood face velocity as well as airflow visualization tests (smoke challenge). Chemical hood face velocities should measure 100 linear feet per minute (lfm) at an 18" sash height. The face velocity must be a minimum of 60 lfm with the sash fully open. Hood velocities for volatile radioactive materials (unbound Iodine or unbound tritium) should be 120-125lfm. Face velocities approaching or exceeding 150lfm should generally not be used, because they may cause turbulence around the periphery of the sash opening and can reduce the capture efficiency of the hood.
- The hood must also meet a smoke challenge test at both sash heights. Smoke challenge must be met by: 1) Using a smoke tube, 6 inches within the face of the hood around the outside edge of the opening. 2) Igniting a smoke candle in the hood and visually observe if there is leakage of smoke from the hood or ductwork or is smoke is being drawn back into the building or surrounding buildings.
- Upon completion of the inspection, a sticker will be placed on the left side of the hood at the sash. This sticker will inform the user of: the date that the hood was tested; the average airflow (lfm) at the face of the hood; the sash height at which the hood should be operated (maximum opening); what types of materials are allowed to be used in the hood; and the date by which the next inspection/text should be conducted. Where it is recognized that hoods are deficient in a manner that could compromise the safety of the occupants of the lab, EHS shall post the hood (**Appendix B**—ATTENTION—This hood has failed…), then notify the department contact. Where deficiencies are recognized but do not compromise the immediate health/safety of the lab occupants (cracked sash glass, sash not operating properly, etc), EHS will contact the PI, lab manager, or department contact and provide information about the deficiency.
- Ensure that each hood is marked appropriately with sash height requirements; check airflow alarms/monitors to ensure that they are functioning properly. Sashes will also be inspected to ensure that they are functioning properly and safely, glass is not cracked or broken, etc.
- Report all chemical hood deficiencies to lab personnel or department contacts in a timely manner
- Monitor the chemical hood program to ensure compliance with policy.
- Review and revise this policy when necessary.
- Perform a radiation survey on hoods used for work with radioactive materials prior to removal when they are being decommissioned and before maintenance or repairs are performed, etc.
- Maintain a hood database (database should include: identification/location of hood, performance of hood at last testing, date of testing/inspection, whether or not hood has properly operating alarm/air flow monitor, exhaust information (does hood exhaust meet current regulations), any deficiencies found during testing/inspection
- Review all plans/blueprints/change orders for hazard control ventilation systems including hoods prior to the initiation of such work.

- Review all requests for purchase and/or installation of any chemical hood/exhaust device prior to purchase/installation of those devices.
- Conduct airflow/containment testing after any hood repairs that could affect hood performance as well as renovations/new installations, etc. and post accordingly. If hood(s) is functioning properly, EHS will remove any EHS or UF postings and place appropriate sticker on hood(s).

**Design and Construction**

- All hazard control ventilation system plans/blueprints/change orders must be reviewed by EHS to ensure the safety of these systems.
- Chemical hood face velocities should measure 100 linear feet per minute (lfm) at an 18" sash height. Face velocity should measure a minimum 60lfm with the sash fully open.
- All new hoods should be purchased with sash stops. These should be set at 18" when the hood is installed.
- Sinks that are incorporated into the hood surface should have a retaining edge surrounding them in order to prevent potential spills of hazardous materials from being inadvertently released to the sewer system, etc.
- Electrical outlets must be outside the hood.
- Sashes must be made of safety glass.
- Where hydrofluoric acid is used, sashes will be made of plastic or Lexan with a flammability rating of 25 or less when tested in accordance with ASTM E162-76.
- Windows in labs containing chemical hoods must be fixed closed. Breezes coming in through open windows can adversely affect the proper function of the hood.
- Hoods should be located so that persons exiting the lab do no have to pass in front of the hood.
- New hoods will not have on/off controls accessible to laboratory personnel. These controls should be disconnected from existing hoods whenever possible.
- To ensure that Kimwipes, paper towels, and other materials are not sucked up into the ductwork/fan, screen suitable for stopping unwanted materials, but large enough so as not to restrict air flow should be installed.
- Laboratory exhaust system ductwork shall comply with the appropriate sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards.
- Stainless steel used for hood ducting must be a minimum of 18 gauge and seams must be welded (i.e. no slip fits). Materials selected for hood ductwork must be resistant to corrosion by the agents used.
- Chemical hoods must have dedicated ductwork, which is not integrated with other ventilation ducts.
- The positioning of hoods with respect to doorways and ventilation registers must always be considered in order to prevent disturbance from air currents. (ANSI Z9.5) Materials for ductwork use for exhaust of chemical hoods must be selected based on the materials that will be used in the hood.
- Exhaust system materials must be noncombustible.
- All chemical exhaust devices must be properly exhausted to the exterior of the building, with proper stack height/exhaust exit velocity (a minimum of 10ft. above adjacent roof lines or structures on the roof, or high velocity that will achieve an effective stack height of 10ft or more). Exhaust stack must be in a vertical up direction, as well as a minimum of 10ft.

(physically or effective exhaust height) above any air intake that is within 50ft. of the stack. A minimum discharge velocity of 3000fpm should be maintained to ensure that no re-entrainment into the building or any surrounding building occurs. (ANSI Z9.5) Aesthetic conditions concerning external appearance shall not supersede the requirements for effective stack discharge. Architectural structures to mask the unwanted appearance of the stack, as long as the stack extends vertically one stack diameter or more above the masking structure and otherwise meets the requirements are allowable. An evaluation of the masking structure is required to assure that it is not counterproductive to avoiding discharge re-entrainment. (ANSI Z9.5)

- Duct velocities should be maintained between 1600-2000 fpm to minimize noise, static pressure loss, and blower power consumption within a duct system.
- If condensation within the duct is likely, all horizontal duct runs shall be sloped downward at least 1 inch per 10ft. in the direction of the airflow to a suitable drain or sump. In addition, appropriate cleanout ports shall also be provided. Exhaust duct sizes should be selected to ensure sufficiently high airflow velocity to retard condensation of liquids or the adherence of solids within the exhaust system.
- Rain caps or elbows may **not** be used on hood exhaust systems.
- Exhaust fans must be adequately sized to provide the necessary amount of exhaust airflow in conjunction with the size, amount, and configuration of the connecting ductwork. Each fan's rotational speed and motor horsepower shall be sufficient to maintain both the required exhaust airflow and stack exit velocity. Where exhaust fans are applied to centralized or manifolded laboratory exhaust systems, all fans and motors shall be adequately sized and the overall system controlled to provide the necessary amount of exhaust airflow, stack exit velocity, and the necessary negative static pressure in all parts of the exhaust system. Manifolded systems shall operate continuously to provide adequate ventilation for any hood at any time it is in use and to prevent backflow of air into the laboratory or other parts of the building. Hoods should be on at all times. Fan redundancy must be included where hoods are manifolded.
- Fans must be located physically outside the building, preferably on the highest level roof of the building served; or in a roof penthouse or roof mechanical room that is always maintained at a negative pressure with respect to the rest of the facility, and provides direct fan discharge into the exhaust stack(s).
- There should be no flexible connections on the discharge side of the fan and all ductwork on the discharge side of the fan must be welded and/or flanged and gasketed construction.
- Branch ducts shall enter a main duct so the branch duct centerline is on a plane that includes the centerline of the main duct. For Horizontal main ducts, branch ducts shall not enter a main duct on a plane below the horizontal traverse centerline of the main duct.
- Horizontal runs of branch ducts shall be kept at a minimum.
- Traverse joints shall be welded or flanged with welded or Van Stone flanges. When nonmetallic materials are used, joints shall be cemented in accordance with the manufacturer's procedures. If the duct is coated with a corrosion-resistant material, the coating shall extend from the inside of the duct to cover the entire face of the flange. Flange faces shall be gasketed or beaded with material suitable for the service.

- Fire dampers shall not be used in hood exhaust systems
- Fire sprinklers shall not be installed in chemical hood exhaust manifolds
- Interior exhaust ductwork in unconditioned spaces shall be sloped toward the fan and insulated to reduce interior condensation and provide for its removal.
- All laboratory exhaust fans shall include provisions to allow periodic shutdown of inspection and maintenance without worker exposure to the exhaust airflow. Such provisions include: 1) ready access to all fans, motors, belts, drives, isolation dampers, associated control equipment and the connecting ductwork 2) Sufficient space to allow removal and replacement of a fan, its motor and all other associated exhaust system components and equipment without affecting other mechanical equipment of the need to alter the building structure.
- The hood static pressure shall be measured above the outlet collar of the hood at the flows required to achieve the design average face velocity.
- OSHA requires that a system be in place to allow users of a hood to determine whether or not the hood has airflow appropriate for the work being performed. To that end Chemical hoods should be equipped with airflow indicator (audible/visible) gauges. These devices are to be calibrated on an annual basis. Airflow monitors are required for all new hood installations and for hoods in buildings where renovation projects on the HVAC system involve the hoods. It will be the responsibility of University Facilities to calibrate these devices per manufacturer's specifications. A sticker, indicating the calibration date will be placed on each device upon calibration. EHS will catalog these devices into the Chemical hood database, and will check calibration stickers when performing chemical hood evaluations. All new hoods will be equipped with airflow monitors/alarms. All renovation projects involving hoods will include provisions for installing airflow monitors/alarms on new or existing hoods. Other existing hoods will be equipped with monitors/alarms as soon as possible. Purchase and installation for monitors for existing hoods shall be approved by EHS.
- All new hood installations as well as hood relocations should be evaluated by the ASHRAE 110 method prior to being placed into/back into service. EHS will determine when and which hoods must be tested by the ASHRAE 110 method.
- A general ventilation system that gives 6 to 12 room air changes per hour is normally adequate. More airflow may be required to cool laboratories with high internal heat loads or to service laboratories with large specific exhaust system requirements. All air from chemical laboratories must be exhausted outdoors and not re-circulated. Thus, the air pressure in chemical laboratories should be negative with respect to the rest of the building unless the laboratory is also a clean room.
- Sufficient make-up air must be available within the laboratory to permit hoods to operate at their specified velocities. Supply air distribution shall be provided to create air jet velocities less than half, preferably less than one-third of the capture of the face velocity of the laboratory exhaust hoods.
- As a general rule, airflow shall be from areas of low hazard, unless the laboratory is used as a Clean Room (Class 10,000 or better). When flow from one area to another is critical to exposure control, airflow monitoring devices shall be installed to signal or alarm a malfunction.

- All hoods should have an airfoil. Airfoils serve to minimize the turbulence as air enters the hood. Airfoils should not be removed from any hood and should be installed on those that do not currently have them.
- Radioisotope hoods shall not be manifolded with non-radioisotope.
- Perchloric acid hoods shall not be manifolded with any other hood.
- Hood ventilation systems shall be designed to include a minimum 25% excess capacity.

- **Written Commissioning Plan** A written commissioning plan should accompany design documents. The commissioning plan shall include written procedures to verify or validate proper operation of all system components and include:

  1) Laboratory chemical hood specification and performance tests
  2) Pre-occupancy hood and ventilation system commissioning tests
  3) Pre-occupancy laboratory commissioning tests
  4) Laboratory and System Drawings for Final System Design

  A laboratory chemical hood system includes all associated subsystems such a hoods, ducts, dampers, automated controls, filtration, fans, motors, and exhaust stacks. In laboratories, the air supply system is considered part of the hood system when operation can affect hood performance.

  **Preliminary and final commissioning documents shall be issued to EHS**. The documents shall include:

  1) Design Flow Specifications
  2) A Copy of Test and Balance Report
  3) Commissioning Test Data
  4) List of all ventilation system deficiencies uncovered and the details of how (and if) they were satisfactorily resolved.

  The commissioning plan shall address operation of the entire ventilation system where the hoods, laboratories, and associated exhaust and air supply ventilation systems are considered subsystems.

  All test instrumentation utilized for the commissioning process shall be in good working order and shall have been factory calibrated within 1 year of the date of use.

## GUIDELINES FOR MAXIMIZING HOOD SAFETY AND EFFICIENCY

- Chemical hoods shall be used in a safe manner, in accordance with standard safe work practices and manufacturers recommendations. Safe work practices include, but are not limited to the following:
- Keep sash height at or below the 18” level at which airflow was determined to be adequate, as indicated by a certification sticker. The sash offers protection from accidents so, when possible, keep the sash between your face and the process/reaction in the hood. However, the sash is not designed to protect against explosions. When an explosion hazard is present, rounded safety shields should be used. Full face protection (faceshield) should also be used in such circumstances.
- Sash stops installed on hoods shall not be removed unless necessary to place or remove equipment; decontaminate the hood, etc. Otherwise, they shall remain in position at the 18” installed position.
- Do not use hoods for storage. Only that equipment which is necessary for current processes should be in the hood; chemicals, waste containers, etc. should be in the hood only when in immediate use; otherwise, they must be properly stored in appropriate storage cabinets.
- Flammable liquids shall not be stored permanently in the cabinet under the hood unless that cabinet meets the requirements of NFPA 30 and NFPA 45 for flammable liquid storage.
- Keep all items in hood at least 6 inches from the front of hood. This greatly improves capture rate for volatile chemicals. Paint a line or place a strip of tape 6” inside the hood as a helpful reminder.
- Ideally, each chemical hood shall have a continuous monitoring device to allow convenient confirmation of adequate hood performance. If a hood does not have a properly operating alarm installed, attach a piece of tissue (Kim-wipe) to the corner of the hood. This will give, at least, an indication whether the hood is working or not until a proper monitor can be installed.
- Check the airflow alarm/monitor before each use of the hood.
- Motor-driven electrical equipment used in a chemical hood where volatile flammable chemical vapors may be present must be equipped with a non-sparking induction motor.
- Sinks incorporated into the hood surface should have a retaining edge surrounding them to prevent spills/leaks inside the hood from being released to the sewer system. For existing hoods with sinks without a retaining lip, a drain plug or spill control pads, pillows, etc. should be used to prevent accidental releases to the sewer system.
- Hoods should remain “on” at all times unless approval to turn them off has been granted by EHS. Hoods shall be “on”: whenever chemicals are being used in the hood (if chemicals are in the hood—they are considered as being used—chemicals should not be stored in hoods); whenever chemicals are being dispensed in the hood (into secondary, waste containers, etc.)—dispensing of chemicals should always be performed in a hood; whenever chemical cabinets under the hood are ventilated into the hood and contain highly toxic chemicals or volatile chemicals. Do not place large pieces of equipment in hood unless necessary.
- Keep hoods clean and organized and clean up any chemical spill immediately.
- Do not use the hood for any materials/chemicals that are not approved for use in that hood.

- Do not use hoods for chemical waste evaporation.
- Do not lean into the hood so that your head is inside the plane of the hood, as defined by the sash, without respiratory and other necessary personal protection whenever any process is in progress or chemicals are otherwise present in the hood creating the potential for release of vapors.
- Avoid opening and closing the hood sash rapidly, and avoid swift arm and body movements in front or inside the hood. These actions may increase turbulence and reduce the effectiveness of hood containment.
- Place equipment as far to the back of the hood as practical without blocking the bottom baffle.
- If equipment is to be placed in hood, place it on a stand that allows air to flow under the equipment.
- Do not operate the hood if the back baffles are not in place.
- **Always** make sure that hood is functioning prior to using it. If alarm/monitor indicates that the hood is not functioning properly, or if the hood is posted “ATTENTION: Failed inspection…DO NOT USE, etc., the hood **shall not be used** until the proper repairs/corrections are made.
- Do not disconnect or otherwise disrupt the function of hood alarms.
- Do not remove airfoil or baffles.

## Gloveboxes

- Gloveboxes shall not be used for manipulation of hazardous materials with the face or other panels open or removed.
- Gloveboxes shall be used when the properties of the hazardous materials, the planned manipulations, or a credible accident would generate hazardous personal exposures if the work were done in an ordinary laboratory hood.
- The design of the glovebox shall provide for retaining spilled liquids so the maximum volume of liquid permitted in the glovebox will be retained.
- Containment gloveboxes shall be provided with exhaust ventilation to result in a negative pressure inside the box that is capable of containing the hazard at acceptable levels.
- Exhaust piping shall be in accordance with the principles described in the ACGIH Industrial Ventilation Manual, ANSI Z9.5, and the ASHRAE 2001 Handbook
- Materials shall be resistant to corrosion by the agents to be used.
- A pressure monitoring device with a means to locally indicate adequate pressure relationships to the user shall be provided on all gloveboxes.
- If audible alarms are not provided, documented training for users in determining safe pressure differentials shall be required.
- Pressure monitoring devices shall be adjustable and subject to periodic calibration.
- Before access panels of the glovebox are opened or removed, the interior contamination shall have been reduced to a safe level.
- If the contaminant is gaseous, the atmosphere in the box shall be adequately exchanged to remove the potentially hazardous gas. This can be affected by exhausting the box through its ventilation system.
- If the contaminant is liquid, any liquid on surfaces shall be wiped with suitable absorbent material or sponges until visibly clean and dry. Used wipes shall be placed in a suitable container before being removed from the glovebox.
- If the contaminant is a powder or dust, all internal surfaces shall be cleaned and wiped until visibly clean. The exterior surfaces of the gloves also shall be wiped clean.
- Precautions to prevent hazards to personnel and contamination of the premises shall be made if the ducting is to be opened or dismantled.
- If there is any uncertainty about the effectiveness of contamination reduction procedures, personnel involved in opening the panels of the glovebox shall be provided with appropriate PPE.
- Design and construction, and materials shall conform to the requirements necessary for the type of work being conducted.

## Ductless hoods

Ductless hoods are designed to remove hazardous vapor from the work area as the exhausted air passes through an absorbent, such as activated charcoal. These hoods require constant attention and often do not provide adequate face velocity. The filters are designed for specific chemicals and will not protect against the variety of chemicals used in a typical university laboratory. Ductless hoods are plagued with the problems associated with “breakthrough” and with desorption of vapors form the absorbent. The user is also faced with expenses to replace filters and dispose of the expended filters. Routine monitoring is also required to ensure that “breakthrough” is not occurring and users are not being overexposed to harmful chemicals. We **do not** recommend the use of ductless hoods and the use of these hoods would be approved by EHS only in rare circumstances.

## Gas Cabinets

Toxic and flammable gases such as arsine, phosphine, silane, hydrogen chloride, ammonia, hydrogen, phosgene, selenide and nickel carbonyl (these are examples—not all inclusive) should be used in an approved gas storage cabinet.

## Chemical storage Cabinets

Storage cabinets used for the storage of highly toxic, mutagenic, teratogenic and carcinogenic chemicals must be vented. There may also be a need to vent cabinets where highly odiferous chemicals are stored. Cabinets for storage of flammables should not be vented unless some of the chemicals stored in them are also highly toxic or carcinogenic. If cabinets are not vented, the bungs on both sides of the cabinet must be kept securely in place. Venting of storage cabinets must be approved by EHS. Materials used for venting must meet regulatory requirements. Venting of chemical cabinets does not replace the need to properly store chemicals. Chemicals must be properly contained and sealed/capped. The types of chemicals listed above should be stored in secondary containers and caps should be taped with parafilm or preferably electrical tape.

## Vacuum Systems

Hazardous materials may be contained with a vaccum system. Because vacuum pump exhaust may contain hazardous materials it must be properly vented so that air in the laboratory air is not contaminated. Pumps and pump oils may also become contaminated with hazardous materials, so personal protective equipment must be worn when repairing pumps or changing pump oil.

## Snorkels

Hood Exhaust duct connections, commonly called snorkels, elephant trunks, or flex ducts are designed to be somewhat mobile. For optimal efficiency, these connections must be placed within three inches of equipment/experiment/process.

## Canopy Hoods

Canopy hoods are horizontal enclosures having an open central duct suspended above a work bench or other area. Canopy hoods are most often used to exhaust areas that are too large to be enclosed in a chemical hood. Application for these devices is limited.

*** Installation of all of the above listed ventilation systems must be approved by EHS.**

## Perchloric Acid Hoods

The use of perchloric acid requires the use a specially designed hood. The hood must be prominently labeled with a prominent sign stipulating that the hood is to be used for **"perchloric acid work only**". Perchloric acid shall not be used in any other type of hood without the permission of EHS. If you are aware of any hood not designed for perchloric acid use that has been used for perchloric, this should be brought to the attention of EHS and UF.

Perchloric hoods shall be constructed with an integral liner of a single piece of 316 stainless with welded seams (and as few seams as possible) or ceramic coated material. They shall have integral bottoms, and covered interiors to facilitate decontamination. The liner shall have coved corners. Ductwork shall also be stainless steel or PVC (must be properly fire-rated).

At a minimum, the blades and any other portion of the exhaust fan coming into contact with the perchloric fumes should be coated with PVC, Teflon, or another approved material that will resist the effects of the perchloric acid.

In order to avoid buildup of perchloric precipitates in the hood and the duct system, the hood must be equipped with a washdown system that will rinse the system thoroughly at the end of each work session involving the use of perchloric acid. The washdown mechanism shall be capable of cleaning the entire duct from the point of exhaust all the way back to the hood.

Ductwork for perchloric hoods should be taken to the roof in the shortest, most direct vertical path. Horizontal runs should not be used and even slopes of less than 70-80% should be avoided.

Exhaust systems serving perchloric hoods **shall not** be manifolded into a common exhaust plenum.

Perchloric hood fans/ductwork must be posted **"Perchloric Hood Fan/ductwork—Authorized personnel only".**

Perchloric acid is a colorless, odorless, fuming liquid that is miscible with water and extremely corrosive. Perchloric acid is noncombustible, however the anhydrous acid and certain perchlorate salts of organic, organometallic, and inorganic cations present a serious explosion hazard and have been set off by either heat or shock. Because of perchloric acid's extremely corrosive physical properties and it tendency to react violently with many oxidizible substances, it is among the most hazardous substances found in the laboratory and should be used and stored with extreme care.

Perchloric acid is very corrosive to all living tissue. It can cause severe burns on contact with eyes, skin, and mucous membranes and is a severe irritant. Its acute toxicity is moderate.

Although perchloric acid is not combustible, the anhydrous form is a serious explosion hazard due to its unstable nature and ability to react violently with many organic materials (e.g. wood, paper, cotton, etc.). Perchloric acid can cause violent explosions if it is misused, or if it is in concentrations greater than normal commercial grade strength (72%). At concentrations less than 72%, aqueous perchloric acid will not decompose spontaneously nor explode on standing. Mixtures of perchlorates with many oxidizable are explosive. When used cold, 70% perchloric acid acts as a strong acid, but is not considered to be a strong oxidizing agent; however, when heated it acts as a strong oxidizing agent. More concentrated solutions are strong oxidizers and increases in temperature increase the oxidizing power of perchloric acid. Hot concentrated solutions are very, very dangerous and should not be taken lightly. . Perchloric acid presents an additional hazard in that perchloric acid mist and fumes can condense in ventilation systems to form metallic perchlorates which can be explosive.

All perchlorates are potentially hazardous when in contact with reducing agents. Oxidizable organic compounds including alcohols, ketones, aldehydes, ethers, and dialkyl sulfoxides can react violently with concentrated perchloric acid.

**Personal Protective Equipment**: The following PPE shall be worn when handling perchloric acid.

**Lab personnel:**

Splash/Impact Goggles

Faceshield

Nitrile, PVC, or neoprene gloves

Lab coat

Chemically-resistant apron

***This acid should always be handled in a hood.**

**Perchloric hood/fan maintenance**

Access to the fan and stack shall be posted and restricted (roped or fenced).

Maintenance of perchloric hood systems shall be performed by authorized personnel only. **All** parts of the hood/exhaust system should be posted **("Perchloric Acid System—Authorized personnel Only"**) to ensure that uncontrolled maintenance does not occur.

Prior to any maintenance, complete washdown of hood system must be ensured.

Only non-sparking tools shall be used.

Use only fluorocarbon grease for lubrication of fan

All parts of system must be handled carefully (potential explosion from shock or friction from tools)

Maintenance/decon/dismantling of perchloric hoods should be done when building is unoccupied.

If used for perchloric acid heated above ambient temperature, tests should be conducted for explosive perchlorates before any maintenance or cleaning is done on any part of the exhaust system within the airstream or hood interior.

All maintenance personnel working on perchloric hood must be trained in the hazards of perchloric acid.

**Personal Protective equipment for maintenance personnel should include:** Splash/Impact goggles, faceshield, gloves (nitrile, neoprene, or PVC), chemically-resistant coveralls

**Biological Safety Cabinets**

This policy is written for chemical ventilation devices, so only the following information will be given for BSCs. Biological safety cabinets should not be used for work with lab chemicals unless they are designed and properly installed for such use. If you have a BSC in your lab and are using it to work with infectious agents, you must have the cabinet certified annually. Currently, Environmental Safety

Professionals of Knightdale, NC (919-217-2650 or 800-688-7167) provide this service for all BSCs. Costs for certification and necessary replacement of HEPA filters are billed back to individual departments. Cabinets that have not been inspected annually because they are not in use or are being used only for innocuous materials must be posted “NO INFECTIOUS MATERIALS….

Contact Robin Newberry, the University Biological Safety Officer, at 656-1806 for additional information.

## Laminar Flow Hoods

Horizontal laminar flow hoods “clean benches” are present in a number of laboratory facilities. These hoods provide a clean environment, but must be used only for the manipulation of non-hazardous materials. They offer product protection, not user protection. Since the operator sits in the downstream exhaust form the clean bench, this equipment must never be used for the handling of toxic, infectious, or sensitizing materials.

## Removing Hoods From Service

When a chemical hood is going to be taken out of service, the P.I. must first ensure that all hazardous agents have been removed and that it has been properly cleaned and disinfected. If radioactive materials have been utilized in the hood, the Chemical hood must be surveyed for radioactive material by the PI and by EHS. Once this has occurred the hood can be removed for relocation, surplus, etc.

## General Roof Work

In the event that UF employees need to conduct work activities on the roof of any building containing hood exhaust(s), the department(s) having responsibility for the hoods must provide UF with all pertinent information as related to hood activities. Certain activities related to the use of hoods may need to be stopped until the work in complete. University Facilities will subsequently notify all department chairs and building safety contacts for affected areas to inform them of the time frame of the work to be conducted. If the roof work involves airstreams of any part of the hood system, the department chairs and safety contacts will be notified and the UF will then post all hoods exhausting airstreams through which they may pass while completing the work. The sign to be utilized can be found in **Appendix A**:

Where hazardous exhaust is present, roof access UF will post a warning sign.

## Contractors Working with Chemical Hoods/Fans/Ductwork/Other Exhaust Devices

Before beginning work, all contactors and subcontractors involved with a renovation project involving chemical hoods or other ventilation devices for hazardous materials must consult with EHS.

Appendix A

# Danger!

**Do not use this Chemical Hood/Exhaust Device!**

**One of the following conditions currently exists:**

- **Workers on roof and in hood air stream.**
- **Hood repairs are currently being conducted which will compromise airflow to this hood.**

Repairs began on Date:_____
Time:_____

Repairs will be completed by Date:_____
Time:_____

**If you have questions, please call University Facilities at 656-2186 or your departmental contact.**

**Appendix B**

# ATTENTION!

**THIS HOOD HAS FAILED INSPECTION/TESTING.**

**THIS HOOD DOES NOT PROVIDE ADEQUATE PROTECTION.**

**THIS HOOD MUST BE REPAIRED BEFORE BEING UTILIZED.**

**ONCE THIS HOOD HAS BEEN REPAIRED, CONTACT ENVIRONMENTAL HEALTH AND SAFETY TO INSPECT AND CERTIFY THE HOOD.**

**IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT ENVIRONMENTAL HEALTH AND SAFETY @ 656-2583**

**INSPECTOR:_____ PHONE:_____**

**DATE:_____ ROOM:_____**

**HOOD IDENTIFICATION NUMBER:_____**

**Appendix C**

# ATTENTION!

## Do Not Use Chemical Hoods! Do Not Use Other Exhaust Devices (snorkels, canopy hoods, etc.) if hazardous materials are used in equipment being exhausted!

**One of the following conditions currently exists:**

- **Hood/Exhaust Failure**
- **Workers on roof and in hood air stream.**
- **Hood repairs are currently being conducted which will compromise airflow to this hood.**

**If you have questions, please call University Facilities at 656-2186 or your departmental contact.**

**FMH002 SEMIANNUAL FUME HOOD INSPECTION LUBRICATION**

TOOLS: ANEMOMETER, BELT TENSION TOOL, AND STRAIT EDGE.

PRELIMINARY:

1. NOTIFY OPERATIONS CONTROL OF EQUIPMENT PM TASKS, EQUIPMENT SHUTDOWN. LOCKOUT/TAGOUT EQUIPMENT IN ACCORDANCE WITH SOP AND TEST LOCKOUT/TAGOUT. LOCKOUTS CAN BE REMOVED FOR TESTING.

2 ADHERE TO ALL APPLICABLE SAFETY PRECAUTIONS, POLICIES, AND PROCEDURES INCLUDING PERSONAL PROTECTIVE EQUIPMENT.

CAUTION: VERIFY THAT THE UNIT IS NOT BIOLOGICAL OR RADIOACTIVE. CONTACT DON WORTHY OR EHS IF IT IS EITHER. DO NOT WORK ON THE UNIT UNLESS THE TASK HAS BEEN APPROVED BY THE ENVIRONMENTAL GROUP. IF IT IS A CHEMICAL FUME HOOD UNIT, CONTACT THE DEPARTMENT OPERATOR TO SEE IF THE UNIT CAN BE SHUT DOWN AT THIS TIME.

PROCEDURE:

3. OBSERVE UNIT WHILE OPERATING AND CHECK FOR EXCESSIVE VIBRATION.

4. CHECK FOR ANY SIGNS OF LEAKS FROM THE EXHAUST PIPING FROM THE FUME HOODS. PAY CLOSE ATTENTION TO THE PIPING CONNECTORS. ALSO CLOSELY INSPECT THE PIPING CONNECTIONS WHEN IT PENETRATES A WALL, CEILING, OR A ROOF. CHECK THE ROOF FLANGE FOR CRACKS OR LEAKS.

5. DE-ENERGIZE UNIT. CHECK BELT (S) FOR FRAYING AND CRACKING (IF APPLICABLE).

6. CHECK BELT (S) FOR DISCOLORATION CAUSED BY HEAT FROM CHAFING/RUBBING.

7. CHECK PULLEYS FOR TIGHTNESS, WEAR AND PROPER ALIGNMENT.

8. REPLACE BELT (S) AS REQUIRED.

9. CHECK BELT ALIGNMENT AND TENSION. ADJUST IF NECESSARY.

NOTE: COMPLETE THIS PART OF THE P.M. ONLY IF THERE ARE NO CHEMICALS IN THE FUME HOOD OR IF THE FUME HOOD HAS BEEN DECLARED "CLEAN" BY THE CONTROLLING GROUP OR EHS.

10. RESTART UNIT. CHECK THE AIRFLOW WITH AN ANEMOMETER TO VERIFY THE RECORDED FACE VELOCITY (TAG ON THE UNIT). READ AIR FLOW IN VARIOUS LOCATIONS INSIDE THE HOOD WITH THE HOOD **18 INCHES OPEN**. READ AT LEAST 6 AREAS, 3 IN THE BACK AND 3 IN THE FRONT.

11. MAKE SURE THAT THERE IS A TAG ON THE UNIT THAT TELLS WHAT THE VELOCITY OF AIR FLOW SHOULD BE (NORMAL MINIMAL IS 100 LINEAR FEET PER MINUTE, A MINIMAL 60 FEET PER MINUTE IF THE SASH IF FULLY OPEN, 125 FEET PER MINUTE IF THE UNIT IS RADIOACTIVE).

12. IF THE UNIT IS EQUIPPED WITH A FLOW ALARM, OPEN THE SASH ALL THE WAY (MORE THAN 18 INCHES) TO SEE IF THE UNIT WILL GO INTO ALARM. IF THE UNIT DOES NOT GO INTO ALARM, THEN REPORT IT. IF IT DOES ALARM, THEN CLOSE THE SASH TO THE PREVIOUSLY SET HEIGHT AND RESET THE ALARM.

13. ENSURE THE UNIT HAS A PERFORMANCE STICKER (NORMALLY LOCATED ON THE LEFT SIDE OF THE HOOD AT THE SASH). IF THE STICKER IS NOT THERE CONTACT DON WORTHY OR IF HE IS NOT AVAILABLE, CALL THE EHS DEPARTMENT AND LET THEM KNOW

14. VERIFY ALIGNMENT OF THE MOTOR AND SHAFT (IF APPLICABLE).

15. INSPECT FAN AND MOTOR HOUSING FOR RUST AND DETERIORATION.

16. CLEAN MOTOR GREASE FITTINGS AND REMOVE GREASE DRAIN PLUGS, IF INSTALLED.

17. LUBRICATE MOTOR WITH APPROVED GREASE. (GROUP ONE)

18. ALLOW EXCESS GREASE TO DRAIN AND REINSTALL GREASE PLUGS.

19. CLEAN AREA AROUND FAN SHAFT GREASE FITTINGS, BEARING HOUSING AND FAN SHAFT.

20. LUBRICATE BEARINGS WITH APPROVED GREASED (GROUP ONE).

21. CLEAN EXCESS GREASE FROM FITTINGS, BEARING HOUSING AND FAN SHAFT.

22. IF FAN HAS OILED BEARINGS LUBRICATE BEARINGS WITH APPROVED OIL (20 WEIGHT)

23. INSPECT MOTOR EXTERIOR FOR MISSING PAINT, CORROSION, EXCESS GREASE, EXCESS OIL.

24. AN MOTOR CASING, FAN/BLOWER GRID AND INSPECT IMPELLER BLADES IF APPLICABLE.

25. LUBRICATE THE AIR VOLUME CONTROLLING ACTUATOR. (USE SILICON SPRAY)

26. INSPECT NUTS, BOLTS, and WASHERS FOR TIGHTNESS/DETERIORATION.

27. ENSURE EQUIPMENT ALIGNMENT HAS NOT BEEN DISTURBED DURING REPAIRS OR REPLACEMENT OF FASTENERS.

28. REPLACE MISSING, WORN OR DETERIORATED FASTENERS
REPLACE BROKEN COLLAPSED OR CORRODED SHOCK MOUNTS AS NECESSARY.

29. REMOVE LOCKOUT/TAGOUT DEVICES AND RETURN EQUIPMENT TO NORMAL OPERATION.

30. NOTIFY OPERATIONS CONTROL THAT PM TASKS ARE COMPLETE.

31. REPORT ALL DISCREPANCIES TO THE PROPER PERSONNEL. SUPERVISION OR FACILITIES FOR A WORK ORDER.

## Sources:

**ANSI Z9.5 2003**

**ACGIH: Industrial Ventilation: A Manual of Recommended Practice 24rd edition**

**NFPA 45**