Halogenated Anesthetic Gases

Isoflurane, halothane, enflurane, desflurane, and sevoflurane are common halogenated anesthetic gases. Halogenated anesthetics are typically clear, colorless, highly volatile liquids at ordinary temperature and pressure. Exposure to these substances occurs when vapors escape into the work environment during the anesthetic administration process. These gases possess very poor warning properties so odor is not an adequate indication of overexposure.

Nitrous oxide is not covered by this guideline because it is not typically used in animal research. During preapproval review of an IACUC application, DEHS staff will review safety measures for using nitrous oxide with the PI.

HEALTH HAZARDS

The Registry of Toxic Effects of Chemical Substances reports adverse health effects in addition to central nervous system effects. Halogenated anesthetics have been described as tumorigens, mutagens and human reproductive effectors. Health hazard information is available by subscription from the U of M domain at http://ccinfoweb.ccohs.ca/rtecs/search.html or from anywhere at http://toxnet.nlm.nih.gov/

EXPOSURE LIMITS

The National Institute for Occupational Safety and Health (NIOSH) has recommended that the average concentration of halogenated agents should not exceed 2 ppm (15 mg/m^3) during any 1 hour period. The Occupational Safety and Health Administration (OSHA) has not yet established a permissible exposure limit (PEL) for anesthetic gases.

WASTE ANESTHETIC GAS SCAVENGING IS REQUIRED

Provide local outside exhaust for locations where anesthetic gases are used. Anesthetic gas nose cones and knock-out chambers must be used with a waste anesthetic gas scavenging system. Knock-out boxes may require local exhaust ventilation or may be required to be used in a fume hood in order to achieve adequate control of waste anesthetic gas.

Upon request DEHS will evaluate scavenging systems used to control exposures to anesthetic gases and will evaluate personal exposure monitoring for laboratory workers. Contact DEHS staff at 612-626-6002 or dehs@umn.edu

CONTROL MEASURES

General Controls

- Train workers in proper anesthesia system setup, operation and maintenance and provide adequate supervision
- Use a keyed filling system whenever possible to fill vaporizers or fill vaporizers in a fume hood.

Engineering Controls

In order to reduce the risk of exposure to escaped vapors, one of the following control measures should be in place during the anesthetic application process:

- **First Choice:** Placement of entire gas mixing and delivery system inside a fume hood **or**
- Use of an anesthesia machine connected to a building exhaust system
- **Second Choice:** Installation of local exhaust over isoflurane delivery system to address a single source of anesthetic gas such as that shown in the photo to the right **or**
- Installation of a back draft or down draft exhaust table for procedures that involve multiple sources of anesthetic gas (e.g. knockout box and procedure table)
- **Third Choice:** Capture of waste gas using gas scavenging canisters. Because there are many problems with maintaining effective control with absorption systems, this method is only allowed as a control measure under the following circumstances:
  - There is no fume hood or other local, hazardous exhaust system available for use
  - Leak checks are performed routinely on equipment
  - Saturation levels of canisters are checked by weighing before and after each use
  - Researchers are well trained and supervised in proper use and maintenance of the anesthetic equipment.

Notes on use of absorption systems:

- Discard the canister when it reaches the manufacturer specified capacity.
- Use the lowest concentration of anesthetic necessary to maintain anesthesia.
- Decrease air/oxygen flow rates during anesthetic gas administration to reduce the concentration of waste gases forced into the work environment. For example, reducing the oxygen flow rate from 2 to 0.4 LPM for a single mouse on a nose cone will still effectively anesthetize the mouse but will reduce waste gas leakage.

- Absorption canisters with exhaust ports located on the top work better than those with the exhaust ports on the bottom. Both types of cylinders should be used in the upright position. The cylinder with exhaust ports on the bottom must be elevated to alleviate back pressure. The canister with exhaust ports on the top has been designed to minimize development of open channels through the charcoal which results in better capture.

f/air gas scavenging canister
with exhaust ports on the bottom

VaporGuard gas scavenging canister
with exhaust ports on the top

Filtering Fume Hoods which absorb contaminants on filters instead of exhausting to the outside are *not* allowed for use as a control measure in university facilities for the following reasons:

- Filter media will not trap all chemicals. It only traps chemicals with an affinity for the particular absorbent.
- The filters require a high degree of attention and maintenance.
- Users must be thoroughly trained and diligent about properly using and maintaining such as system If not properly maintained, hazardous chemicals exhaust back into the room.
- Gases (such as anesthetics) with poor warning properties will provide no indication (such as odor) if the filters become overloaded or otherwise leak.
- Long term, ducting to the outside tends to be less expensive and more effective than changing filters.

LABORATORY SPECIFIC SOP FOR ANESTHETIC GAS USE

Each laboratory where anesthetic gases are used must include safe operating procedures (SOP) for the use of anesthetic in their Laboratory Safety Plan. The SOP is the foundation for training laboratory workers about normal and emergency operations. The SOP must address the following issues.

Personal Protective Equipment

Gloves, lab coats and eye protection such as chemical goggles or a face shield must be worn when handing stock bottles of liquid anesthetic agents.

Work Practices

Anesthetic gases should be stored in a cool, well-ventilated location away from direct sunlight. A ventilated chemical storage cabinet is preferred.

Signs and symptoms of exposure

- **Acute Exposure:** nausea, vomiting, skin irritation, nose/throat/respiratory irritation, headache, dizziness, drowsiness and other specific effects from data
- **Chronic Exposure:** hypotension, tachycardia, respiratory depression, and elevated blood glucose levels and other specific effects from data

Emergency exposure procedures

- **Eye Care:** If anesthetic gases come in contact with eyes, immediately flush them with copious amounts of water for at least 15 minutes, preferably in an emergency eyewash
- **Skin Care:** In the event of skin exposure, remove contaminated clothing and immediately wash the affected area with soap and water
- **If Swallowed or Inhaled:** In the case of ingestion, obtain medical attention immediately. If anesthetic gases are inhaled, move the victim to a source of fresh air

Note: After any over exposure to anesthetic gases via skin, inhalation, ingestion, or eye contact the victim should immediately seek medical evaluation. In the Twin Cities Boynton Health Service or, if the exposure occurs after hours, University of Minnesota Medical Center, Fairview can provide the evaluation.

Emergency spill procedures

In the event of a spill, immediately evacuate the spill area and close all doors. From a safe place dial 9-1-1 to report the spill. On the UMTC campus you may call DEHS at 626-6002 during work hours. Secure the area and prevent people from entering until emergency response personnel arrive. Consult the University of Minnesota Hazardous Chemical Waste Management guidebook for further information.
http://www.dehs.umn.edu/hazwaste_chemwaste_umn_cwmgbk_sec3.htm

FOR FURTHER INFORMATION

Federal OSHA Fact Sheet Number 91-38 (Waste Anesthetic Gases)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FACT_SHEETS&p_id=128

OSHA Guidance Document – ANESTHETIC GASES: Guidelines for Workplace Exposures
http://www.osha.gov/dts/osta/anestheticgases/index.html

University of Minnesota Research Animal Resources
http://www.ahc.umn.edu/rar/anesthesia.html

Contact University of Minnesota DEHS at 612-626-6002 or dehs@umn.edu for an evaluation of your control system or to have personal exposure monitoring conducted in your work area.