UNIVERSITY OF VICTORIA
Occupational Health, Safety and Environment

Chemical Safety – Special Hazards

Safe Work Procedure (SWP – 015)

Anesthetic Gas (Isoflurane)

Last revised: November 22, 2024

REVISION HISTORY

	Revision Date	*Author*	*Position*
1.	November 22, 2024	Paraskevi Lagaditis	OHSE consultant

DOCUMENT APPROVAL

Approved by: Laboratory Safety Committee

Chris Papadopoulos	November 22, 2024
Chair, Laboratory Safety Committee	*Date Approved*

**This revision replaces all previous versions of this document. If a copy is printed, it is the users' responsibility to verify the copy is the most current version of the document.*

University of Victoria

PURPOSE

To provide general guidance and instruction of the safe use in laboratories of anesthetic gas inhalants, in particular isoflurane. Each lab must develop a lab-specific work procedure unique to the experiments and activities being performed (See procedure #7). All written procedures must be reviewed and approved by the Animal Care Committee of the Office of Research Services.

SCOPE

The SWP is a document to provide guidance to limit worker exposure from handling anesthetic gas inhalants, in particular isoflurane, used in animal research laboratories and facilities.

TRAINING

The following training is required to be completed prior to being permitted to prepare and work with anesthetic gas:

- WHMIS
- Lab Safety for Lab Workers
- Gas Cylinders Safety Training Parts 1 & 2
- Biosafety for Lab Workers
- Animal care specific training and tutorials
- Lab SWP with documented signoff by the individual and their supervisor.

Refresher training in the General and Lab SWP must be provided when:

- there has been an extended timeframe of inactivity, or
- there has been an incident or injury, or
- 2 years has elapsed since the original training

REGULATION AND POLICY

The University of Victoria will follow WorkSafeBC Occupational Health and Safety Part 30 and the University of Victoria Occupational Health, Safety & Environment Department.

RESPONSIBILITY

It is the responsibility of personnel undertaking activities with special hazards to complete all required training and adhere to these safe work procedures, including any additional lab or job-specific procedures.

It is the PI's or supervisor's responsibility to ensure that individuals working with special hazards have been trained prior to commencing work and have demonstrated competency in safely performing all duties associated with isoflurane in accordance with these procedures.

DEFINITIONS & ABBREVIATIONS

SDS – safety data sheet

BSC – biosafety cabinet

PPE – personal protective equipment

WAGs – waste anesthetic gases

ACGIH – American Conference of Governmental of Industrial Hygienists

NIOSH – National Institute for Occupational Safety and Health

TWA – time weighted average

TLV – threshold limit value

LEV – local exhaust ventilation – in particular extraction arm or snorkel

HAZARD

General anesthesia is a practice to prevent human or animal patients from experiencing pain during medical procedures or surgeries. One method of applying anesthesia is through inhalation of a gas to induce sedative effects and/or unconsciousness. Inhaled anesthetic gases include nitrous oxide and volatile halogenated liquids such as halothane, isoflurane, sevoflurane, desflurane, enflurane and methoxyflurane. The most common halogenated anesthetic gas inhalant used in animal research at UVic is isoflurane. Isoflurane is a non-flammable colourless liquid that is highly volatile at room temperature and pressure.

All work with anesthetic gas inhalants must be performed with either a dedicated exhaust or a scavenging system to prevent exposure to researchers. Anesthetic gas that leaks into the room are called waste anesthetic gases (WAGs). The BC Occupational Health and Safety Regulations (OHSR) currently has not established an exposure limit for isoflurane. The ACGIH recommended 8h TLV-TWA exposure limit to a halogenated anesthetic gas is 50 - 75 ppm. Meanwhile the NIOSH maximum (ceiling) exposure limit over the course of 60 minutes cannot exceed 2 ppm. For other halogenated anesthetic agents such as halothane or methoxyflurane, the BC OHSR mandates exposure not to exceed an 8h TWA of 2 ppm. These low concentrations are below the human odour detection threshold. Acute exposure to high concentrations of anesthetic gas can cause adverse effects such as headaches, irritability, fatigue, nausea, drowsiness, and/or impaired judgement or coordination. Chronic exposure has been linked to hypotension, liver disease, kidney disease, tachycardia and respiratory depression.

It is strongly recommended to use fume hoods or hard-ducted BSCs. If using an LEV snorkel for administering anesthetic gas inhalant in any type of set of methods, a risk assessment needs to be completed to determine if the method is suitable. Exposure monitoring may be required to assess the potential of WAGs in the work area. LEV snorkels have limited capture zones and orientation of the LEV snorkel can unintentionally introduce anesthetic gas inhalant into the worker's breathing zone before being exhausted. Contact Occupational Health Safety and Environment at (250) 721-8971 or ohs@uvic.ca to request a risk assessment.

In some cases, such as when using specialized equipment or for vulnerable workers in particular pregnant workers, respirator protection may be necessary, Contact Occupational Health Safety and Environment to request a risk assessment and arrange a respiratory fit test.

MATERIALS

Note see Appendix 1 (page 8) for photos of equipment and materials described in this section

Vaporizers

Vaporizers are an anesthetic gas delivery system. They are designed to vaporize an anesthetic liquid agent and deliver a known concentration of vaporized anesthetic gas. Vaporizers have to be refilled and maintained as per manufacturers' directions. Oxygen gas cylinders tanks are also connected to vaporizers to ensure a breathable environment with the anesthetic gas. Vaporizers must be calibrated at least once every two years.

Anesthetization boxes

An anesthetization box is the least recommended option for anesthesia delivery because there is a higher risk of personal exposure to isoflurane. It is strongly recommended to only use an anesthetization box in a fume hood or hard-ducted biosafety cabinet and avoid an LEV snorkel. Anesthetization boxes are simply a box or container with a lid and are usually employed for specific types of anesthetic agents or procedures (for example the open drop method delivery of anesthesia). It is recommended to use a container in which it is possible to see and observe the contents when the lid is closed (e.g. a desiccator). If not using a lid, do not use an LEV snorkel for ventilation exhaust but only a fume hood or hard-duct biosafety cabinet. In addition, the volume of the anesthetization box must be known in order to calculate the amount of anesthetic inhalant to use to effectively anesthetize.

Induction Chambers

Induction chambers are specialized boxes with gasketed inlet and outlet port connections to deliver and release anesthetic gas. Vaporizers are connected to the inlet port of the induction chamber and the outlet port is routed directly to a ventilation system (e.g. fume hood). If using an LEV snorkel arm, it is recommended the snorkel be placed at the induction chamber lid opening and a charcoal canister is equipped on the outlet port. Induction chambers either have sliding top or hinged top openings; the sliding top openings are best for minimizing anesthetic gas release. Induction chambers are also used in scavenging systems.

Scavenging systems

Anesthetic scavenging systems are a specific type of local exhaust ventilation equipment for administering anesthetic gas in concordance with oxygen gas into an induction chamber. Scavenging systems collect WAGs that vent or leak close to the source of the anesthetic gas vaporizer during anesthetization and/or operation. Regular preventative maintenance is required to ensure proper function, in addition scavenging systems must be calibrated at least once every two years. There are two types of scavenging systems, active and passive.

- Active scavenging systems require its exhaust connected or routed within six inches to a fume hood, hard-ducted biosafety cabinet or LEV snorkel. The negative pressure created by the active ventilation connection ensures WAGs are effectively removed and is a preferred method over passive scavenging. Both nitrous oxide and halogenated anesthetic gases can be used with active scavenging systems.
- Passive scavenging systems do not have a negative ventilation connection but instead rely on the positive pressure from the vaporizer or exhalation of the animal to drive halogenated WAGs towards an absorption filter device. Flushing with oxygen before completing anesthesia delivery is an important step to minimize worker exposure to isoflurane. Filter devices are typically a charcoal canister that are connected to the system and must be monitored and replaced when over saturated. Nitrous oxide anesthetic gas cannot be used with passive systems. Passive scavenging systems are considered portable and are applicable for operating areas that do not have access to a fume hood, hard-ducted biosafety cabinet or LEV snorkel arm. They are not recommended for operations that are longer than 3 hours.

Charcoal canisters

Charcoal canisters are designed by manufacturers, such as F/AIR, to absorb halogenated WAGs. They are not effective for adsorbing nitrous oxide anesthetic gas. Charcoal canisters must be weighed before use to monitor saturation. An increase of a specified weight of the canister by the manufacturer (commonly 50 grams) indicates that the canister will no longer effectively adsorb WAGs. Some manufacturers may also indicate a time limit on the canister which in practice is not as reliable as weighing the canister after each

procedure. Once a charcoal canister is loaded onto the passive scavenging system, it is kept connected until the weight gain has been achieved (whether in one session or multiple sessions).

PROCEDURE

1. Handling

a. Review and familiarize the SDS of isoflurane prior to use

b. Ensure PPE is worn, including safety glasses, nitrile gloves and lab coat

c. Only open isoflurane bottles under active ventilation such as a fume hood, hard-ducted biosafety cabinet or LEV snorkel.

d. Use an anti-spill adapter on isoflurane bottles

e. Only handle isoflurane within either a fume hood or hard-ducted biosafety cabinet, this includes refilling vaporizers that do not have a key adapter

- If using an LEV snorkel, ensure to position as close as possible and volatiles are not exhausted up towards the worker's breathing zone; be aware that LEV snorkels have a limited capture zone
  If exhaust ventilation is not available, use a respirator when opening isoflurane bottles or filling a vaporizer

f. Follow basic methods for minimizing exposures when using isoflurane for anesthetic procedures and incorporate applicable steps into a research/lab specific SWP:

i. *Open Drop Method/Bell Jar with an Anesthetization Box*

- Set up area within fume hood or hard-ducted biosafety cabinet
  - If using an LEV snorkel arm, ensure working area is delineated (e.g. tape on the bench top) where volatile capture is confirmed and only handle isoflurane in that zone .
- Soak gauze or cotton ball with calculated of volume of isoflurane
- Ensure box is placed fully in a fume hood or hard-ducted biosafety cabinet
  - If using an LEV snorkel, ensure it is placed as close as possible to the lid opening and volatiles are exhausted away from the worker's breathing zone.
- Create a barrier in the box to physically separate the soaked gauze.
- Open lid, place soaked gauze or cotton ball within and close the lid
- Open lid and place animal within the box
- Wait until anesthetization is complete before opening again
- Remove soaked gauze or cotton ball to the designated container within the fume hood for isoflurane contaminated materials
  - If using an LEV snorkel, do not remove soaked gauze/cotton ball but rather leave box open overnight under ventilation
- Keep box open under active ventilation for a prolonged time to ensure volatiles have been exhausted (e.g. 1 hour or overnight)

ii. *Induction Chamber*

- Use the lowest concentration of anesthetic gases as possible
- Use a gasketed chamber with exhaust port to scavenge waste gas
- Use induction chambers with sliding top lids as opposed to hinged lids to minimize release of anesthetic gas

- Ensure ventilation is used by the following options:
  - If using a fume hood or hard-ducted biosafety cabinet, place induction chamber within and ensure outlet port faces the back of the fume hood or hard-ducted biosafety cabinet
  - If using an LEV, attach a charcoal canister to the exhaust port, position LEV as close as possible to the lid opening and ensure volatiles are exhausted away from the worker's breathing zone.
- Check vaporizer level before connecting to the inlet port of the induction chamber
  - If necessary, refill vaporizer as per manufacturer's directions
  - Use anti-spill adaptor that fits on an isoflurane bottle when refilling
  - If possible, fill vaporizer in a fume hood or hard ducted biosafety cabinet or in capture zone of LEV snorkel
- Turn on vaporizer after everything is loading into the induction chamber
- Avoid opening and closing the induction chamber while vaporizer is active
- Turn off vaporizer when anesthetization is complete
- Flush with oxygen to purge anesthetic gas
- Open induction chamber to unload
- Keep opened induction chamber under ventilation for prolonged time to evacuate anesthetic gas before disassembling (e.g. at least 1 hour or overnight)

iii. *Scavenging system*

- Ensure scavenging system, vaporizer and oxygen flow is calibrated and certified every two years.
- Ensure scavenging system is inspected before each use
  - Maintain a maintenance log and inspection checklist that can be reviewed prior to use
- Check vaporizer level
  - If necessary, refill vaporizer as per manufacturer's directions
  - Use anti-spill adaptor that fits on an isoflurane bottle when refilling
  - If possible, fill vaporizer in a fume hood or hard ducted biosafety cabinet or in capture zone of LEV snorkel.
- For active scavenging systems, ensure exhaust hose is routed to a fume hood, hard-ducted biosafety cabinet or LEV snorkel arm
- For passive scavenging system with charcoal canisters
  - Inspect charcoal canister before using
    - If canister is visually defective do not use and dispose via hazardous waste
  - Weigh and record baseline weight of new charcoal canisters in addition to before and after each subsequent use.
  - Keep charcoal canister connected to the passive scavenging system for multiple uses until specified weight gain has been reached.
  - Do not exceed maximum use hour outlined by manufacturer
  - Connect the charcoal canister to the exhaust hose of the scavenging system
  - Keep charcoal canister at level below the vaporizer

- If applicable, ensure holes on bottle or top of canister are not blocked
  - Follow manufacturer's recommendation if cannister is placed upright or on its side to ensure canister vents are not blocked

2. Storage

a. Store isoflurane or liquid anesthetic agents in one of the following possible options
   - In a laboratory fridge between 2-8 °C
   - In a vented chemical storage at room temperature
   - In a flammable cabinet, if there is no vented chemical storage or a laboratory fridge.

b. Minimize to only one bottle of isoflurane or liquid anesthetic agents on the bench top

c. Ensure isoflurane bottle outside of the storage area is secured or in a secondary container.

3. Spills

a. Follow OHSE's general spill response instructions

b. Do not attempt to clean up any spill if not trained. Seek assistance or call Campus Security (250-721-7599)

c. Small volumes of halogenated anesthetic gases evaporate readily at normal room temperatures and may dissipate before any attempts to clean up or collect the liquid

d. Specific steps for small spills (less than 100 mL) within a fume hood or hard-ducted biosafety cabinet
   i. Absorb any liquid with an absorbent spill pad
   ii. Place absorbent pad a in designated container for contaminated materials
   iii. Keep container as further back in the fume hood as possible
   iv. Close the fume hood and leave overnight
   v. Transfer absorbent pad into a secondary container (Ziploc bag) and dispose via hazardous waste via toxic solid waste pail

e. Specific steps for spills for large volumes outside of a fume hood, biosafety cabinet or capture zone of an LEV snorkel:
   i. Secure the area and warn others.
   ii. Immediately evacuate the area.
   iii. Post "do not enter" signs on the doors of the lab.
   iv. Contact Campus Security at 250-721-7599.

f. Complete a *Department Incident & Investigation Report* to document and review the spill incident.

4. Decontamination

a. Ensure disposable materials that have been exposed to isoflurane remain under exhaust in a fume hood or hard-ducted biosafety cabinet for at least one hour before disposing
    i. If possible, leave contaminated materials under exhaust overnight
    ii. If using an LEV snorkel, ensure volatile capture zone is delineated and materials are placed within that zone
b. After one hour or overnight, place contaminated material in a sealed bag and place in toxic solid pail for disposal via hazardous waste.

5. First Aid and Emergencies

a. Call 911 to summon an ambulance if there is a medical emergency.
b. Call Campus Security at 250-721-7599 for first aid.
c. If material has contacted the eyes, use emergency eyewash and flush for at least 15-20 minutes.
d. For skin contact, flush affected area with running water for at least 15-20 minutes.
e. For inhalation, move immediately to fresh air and seek medical attention immediately.
f. Report emergency to PI/supervisor and OHSE as soon as possible.

6. Waste Disposal

a. Do not stock pile or accumulate contaminated materials, empty or expired solutions. Dispose as soon as possible.
b. Ensure all materials in contact with isoflurane have been placed under ventilation such as fume hood or hard-ducted biosafety cabinet for at least one hour or overnight to exhaust volatiles.
    i. If using an LEV snorkel, ensure capture zone is delineated and materials are only kept in that zone
    ii. After volatiles have been exhausted, bag and seal all disposable into a secondary bag and place in a toxic solid pail
c. Dispose unused and/or expired solutions or empty bottles of isoflurane via hazardous waste (adhere a green hazardous waste pick up sticker)
d. Dispose used charcoal canisters via hazardous waste by double bagging (adhere a green hazardous waste pick up sticker)

7. Lab SWP

In additional to this general SWP and Office of Research Services specific SWPs, each lab that is using isoflurane or a liquid anesthetic agent requires a Lab specific SWP that includes specific procedures:

a. Type of anesthetic agent
b. Type of anesthetizing procedure
c. How to prepare and dismantle anesthetization set up
d. Decontamination
e. Waste disposal
f. Spill response

All Lab specific SWPs must be reviewed and approved by the Animal Care Committee of the Office of Research Services.

APPENDIX

Figure 1. A vaporizer commonly used for delivery of isoflurane anesthetic gas

Figure 2. Common anti-spill adapters for isoflurane bottles

Figure 3. Anesthetic gas chambers

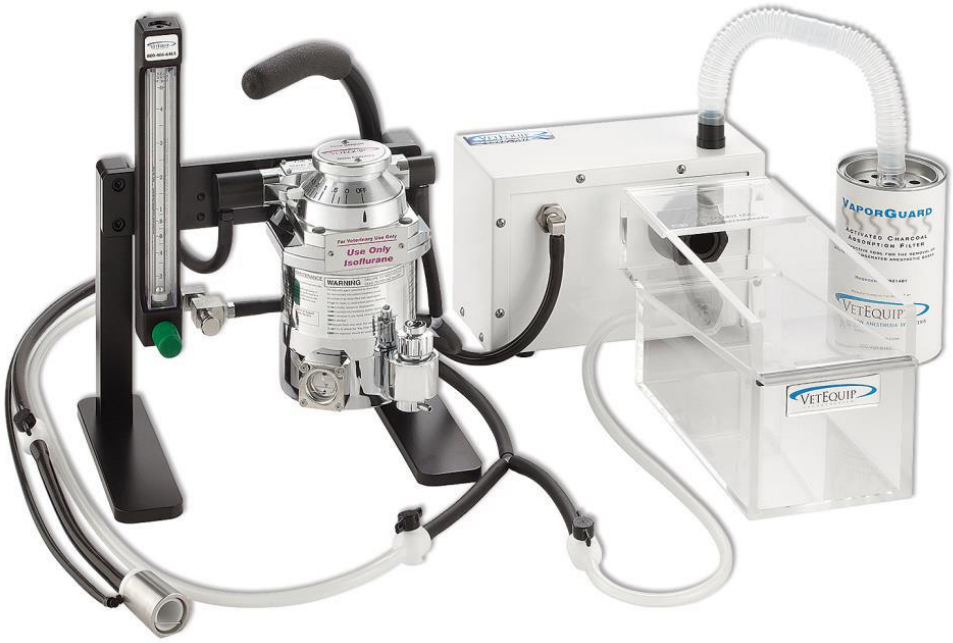

Figure 4. Passive waste anesthetic gas scavenging system

Figure 5. Commercially available charcoal canisters

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