Environmental Health & Safety

Anesthetic Gas Use Program

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Anesthetic Gas Use Program

Purpose
The Arizona State University (ASU) Environmental Health & Safety (EH&S) Department has developed this program to protect employees at ASU who have the potential for an occupational exposure to anesthetic gases. Inhaled anesthetics include two classes of chemicals: nitrous oxide and halogenated agents. Halogenated anesthetic gases include: halothane, isoflurane, sevoflurane, desflurane, enfurane, and methoxyflurane (used infrequently).

This guidance document is intended to ensure compliance with federal, state, and local requirements. Presently, the Occupational Safety and Health Administration (OSHA) has not adapted a regulation regarding waste anesthetic gases (WAG’s). OSHA requires employers to follow their “General Duty Clause” and has published a technical guideline, Anesthetic Gases: Guidelines for Workplace Exposures. The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) both recommend exposure limits for WAGs.

Scope
This program applies to all ASU employees who work with or supervise work involving anesthetic gases at ASU locations. Anesthetic gases are typically used in laboratories throughout ASU during animal surgical procedures.

Responsibilities
EHS is responsible for:
1. Development, implementation, and oversight of isoflurane use
2. Area and personal air monitoring to determine employee exposure
3. Reporting results of all exposure monitoring to employees and management
4. Ensuring compliance with all federal, state, and local regulations
5. Making technical guidance and training available to employees

Deans, Directors, and Chairs are responsible for:
1. Ensuring all personnel have been trained prior to anesthetic gas use
2. Following all safety guidelines for anesthetic gas use
3. Anesthetic gas equipment maintenance
4. Reporting any chemical spills, releases, or emergency response through the ASU Emergency Response Guide process
5. Compliance with the ASU Chemical Hygiene Plan and Hazard Communication Program
6. Ensuring reporting results of all exposure monitoring to employees
7. Ensuring completion of the incident reporting process for any health or safety related incidents
Employees are responsible for:
1. Completing the anesthetic gas safety training course
2. Following all safety policies, guidelines, and department Standard Operating Procedure (SOPs) for anesthetic gas use
3. Conducting leak checks on anesthetic machines before use
4. Inspecting all equipment prior to and after each use
5. Ensuring the WAG scavenging system is used with all anesthetic gas machines
6. Ensuring a WAG scavenge system (such as a chemical fume hood, a vacuum line out of the building, a down draft table, or an exhaust ducted biosafety cabinet) is used when using a bell jar or any other anesthesia induction method that releases anesthetic gases into the procedure area
7. Reporting any problems with equipment to your management
8. Reporting any chemical spills or releases to EH&S through the ASU Emergency Response Guide spill response process and to your management
9. Following the ASU Chemical Hygiene Plan and Hazard Communication Program
10. Ensure reporting of any health or safety concerns to your management

Capital Program Management Group (CPMG) Architecture, Planning & Construction is responsible for:
1. Evaluating engineering / design intent meets current code, client’s needs and best practices including but, not limited to:
   a. Energy conservation methods
   b. Capture velocity requirements
   c. Supply and exhaust air distribution / design layout requirements
   d. System integration with existing building automation controls if applicable
   e. Air changes requirements are evaluated in design for the lab space
   f. Proper exhaust discharge location
   g. Local alarm and visual indication requirements for lab spaces being negative relative to adjacent spaces
   h. Secure environment proposed for using isoflurane (example: lab doors with proper locks, isoflurane bottle storage, etc…)

**Regulatory Limits**
Presently, OSHA has not created or adapted a regulation regarding WAGs. NIOSH and ACGIH both recommend exposure limits for WAGs. The following table summarizes the recommended exposure limits.
<table>
<thead>
<tr>
<th>Anesthetic Gas</th>
<th>OSHA PEL(^1) (ppm)</th>
<th>NIOSH REL(^2) (ppm)</th>
<th>ACGIH TLV-TWA(^3) (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrous Oxide (N20)</td>
<td>None</td>
<td>25(^4)</td>
<td>50</td>
</tr>
<tr>
<td>Isoflurane</td>
<td>None</td>
<td>2(^5)</td>
<td>75(^6)</td>
</tr>
<tr>
<td>Halothane</td>
<td>None</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Desflurane</td>
<td>None</td>
<td>2</td>
<td>None</td>
</tr>
<tr>
<td>Sevoflurane</td>
<td>None</td>
<td>2</td>
<td>None</td>
</tr>
<tr>
<td>Enflurane</td>
<td>None</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>Methoxyflurane</td>
<td>None</td>
<td>2</td>
<td>None</td>
</tr>
</tbody>
</table>

Footnotes
1 – PEL: permissible exposure limit, ppm: parts per million
2 – REL: recommended exposure limit measured as a time weighted average (TWA) during the period of anesthetic gas administration, not to exceed one hour
3 – TLV – TWA: threshold limit value – time weighted average. This value refers to an 8-hour workday and a 40-hour work week
4 – Measured as a TWA over the period of anesthetic gas administration
5 – Ceiling limit concentration of no greater than 2 ppm over a period not to exceed one hour
6 – ACGIH has recommended a TLV-TWA of 75 ppm for enflurane. A higher target concentration of 75 ppm was set for isoflurane because it is a geometric isomer of enflurane

**Ventilation and Engineering Controls**

An effective room HVAC system when used in combination with an anesthetic gas scavenging system should reduce, although not entirely eliminate, the contaminating anesthetic gases. If excessive concentrations of anesthetic gases are present, then airflow should be increased in the room to allow for more air mixing and further dilution of the anesthetic gases. Supply register louvers located in the ceiling should be designed to direct the fresh air toward the floor and toward the workers to provide dilution, and removal of the contaminated air from the operatory. Exhaust register louvers should be properly located (usually low on the wall near the floor level) in the room to provide adequate air distribution. They should not be located near the supply air vents because this will short-circuit the airflow and prevent proper air mixing and flushing of the contaminants from the room.

ASU CPMG is responsible for evaluating capture velocity requirements, verifying supply and exhaust air distribution and design layout requirements, verifying if an exhaust and scavenging system should be integrated with the existing building automation controls, verifying that air changes requirements are evaluated in design for lab space, and verifying proper exhaust discharge location.

Please refer to the OSHA “Anesthetic Gases: Guidelines for Workplace Exposures” documents for further guidelines on ventilation controls and how to reduce workplace exposures to WAGs.

**Training**

All employees working with or supervising work with anesthetic gases shall complete online safety training via EH&S website entitled Anesthetic Gas Safety Training prior to
using any anesthetic gas. For information on how to enroll in the training please see https://cfo.asu.edu/ehs-training.

All employees working with or supervising work with anesthetic gases shall complete online safety training via ASU Blackboard Suite entitled Anesthetic Gas Safety Training prior to using any anesthetic gas. For information on how to enroll in the training please see https://cfo.asu.edu/ehs-training. The training shall consist of the following: regulatory limits, health effects of nitrous oxide and halogenated agents, sources of exposure, WAG scavenge systems, anesthetic gas equipment inspections, risk assessments, personal protective equipment, standard operating procedures, engineering controls, work practices, administrative controls, chemical spills, air monitoring, and hazard communication. The training shall be conducted upon initial assignment and whenever there is a change in process or procedure. An annual refresher shall be conducted as well.

Standard Operating Procedure (SOP)
Laboratories working with anesthetic gases shall develop a Standard Operating Procedure (SOP) specific to the anesthesia apparatus used in the lab. All employees working with or supervising work with anesthetic gases shall be trained how to operate the anesthesia apparatus using the SOP. An SOP example and template can be found on the EH&S web page at: https://cfo.asu.edu/ehs-occupationalssafety

Personal Protective Equipment (PPE)
PPE is required to be used at all times while in the laboratory includes, but may not necessarily be limited to:
- Safety goggles or face shield
- Laboratory coats, aprons, or other suitable clothing (shirt and long pants)
- Closed-toe shoes
PPE required to be used at all times when handling particularly hazardous chemicals, reproductive toxins, carcinogens, and sensitizers in the laboratory includes, but is not limited to:
- Appropriate gloves
- Safety goggles or face shield
- Laboratory coats, aprons, or other suitable clothing (shirt and long pants)
- Closed-toe shoes

Exposure Monitoring
EH&S can perform air monitoring to determine anesthetic gas concentrations in the work area. Two types of monitoring can be performed, personal and area. Personal monitoring is conducted at the employee’s breathing zone to determine WAG exposure for the employee. The monitoring is performed using a standard size Anasorb Carbon Molecular Sieve (CMS) tube and analyzed by a certified laboratory. Area monitoring is conducted in the work area to determine WAG concentrations in work areas. Comprehensive leak testing on the equipment to determine if gas is escaping from various locations in the machine shall be performed by a qualified contractor.
Preventive maintenance should be performed by trained individuals according to the manufacturer's recommendations and at intervals determined by equipment history and frequency of use.

**Information**
Additional information regarding the ASU Anesthetic Gas Use Program is available by contacting EH&S at 480-965-1823.

**References**
OSHA Waste Anesthetic Gas Safety and Health Topic [OSHA Waste Anesthetic Gases Safety Health Topic](#)
OSHA Technical Guideline, *Anesthetic Gases: Guideline for Workplace Exposures*
[Anesthetic Gases: Guidelines for Workplace Exposures](#)
ASU Chemical Hygiene Plan [ASU Chemical Hygiene Plan](#)
ASU Hazard Communication Plan [ASU Hazard Communication Plan](#)
ASU EH&S Hazard Communication Policy [EHS 103: Hazardous Communication Program](#)
ASU EH&S Personal Protective Equipment Policy [EHS 105: Personal Protective Equipment](#)
ASU EH&S Health and Safety Training Policy [EHS 108–01: Health and Safety Training](#)
ASU EH&S Hazardous Waste Management Policy [EHS 401: Hazardous Waste Management](#)