National Institutes of Health
Office of Research Services
Division of Occupational Health and Safety

Waste Anesthetic Gas (WAG) Surveillance Program

Technical Assistance Branch

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WASTE ANESTHETIC GAS (WAG) SURVEILLANCE PROGRAM

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Attachment – *DOHS Factsheet & Checklist – Waste Anesthetic Gas (WAG), 2 pages*

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WASTE ANESTHETIC GAS (WAG) SURVEILLANCE PROGRAM

1.0 PURPOSE

This program establishes procedures for evaluating occupational exposures to waste anesthetic gas (WAG) at NIH owned and leased facilities.

2.0 INTRODUCTION

The Office of Research Services, Division of Occupational Health and Safety (DOHS), has established a *Waste Anesthetic Gas (WAG) Surveillance Program* at the NIH to:

A. Identify and quantify occupational exposure levels (through surveys and leak tests) to the anesthetic gases used at the NIH.

B. Provide information and recommendations for engineering controls and work practices that are effective in minimizing exposures.

Some studies have documented adverse health effects (e.g., headaches, fatigue, irritability, birth defects, miscarriages, liver and kidney disease, cancer) from *excessive* exposure to anesthetic gases. These health effects were mainly noted for older anesthetics (e.g., trichloroethylene, methoxyflurane) that are no longer commonly in use. (As one reference on these health effects, see pages 181-187 from *Document 77-140* from the National Institute for Occupational Health and Safety (NIOSH): http://www.cdc.gov/niosh/docs/1970/77-140.html)

Studies are inconclusive on the potential health effects from occupational exposure to some of the newer anesthetics, such as isoflurane, which is currently the most commonly used anesthetic gas at NIH. The limited information available to date has produced little evidence on health effects. Studies are expected to continue.

There are no Occupational Safety and Health Administration (OSHA) regulations or permissible exposure limits (PELs), known as regulatory limits, for anesthetic gases; however, OSHA has advised that "The levels of risk for isoflurane, desflurane, and sevoflurane have not been established. Since there are limited data, occupational exposure limits for these agents have not been determined. Therefore, until more information is available, it is prudent to attempt to minimize occupational exposure to these as with all anesthetic agents…[and] any exposure to waste and trace gases should be kept to the lowest practical level." In light of these findings, the evaluation of occupational exposure to anesthetic gases continues to be a component of the DOHS occupational surveillance activities.

In addition, the surveys and leak tests provide documentation of surveillance activities to *The Joint Commission* (TJC) and also to the *Association for Assessment and Accreditation of Laboratory Animal Care International* (AAALAC).

3.0 OCCUPATIONAL EXPOSURE LIMITS

In January 2012, the DOHS reviewed and updated the personal (worker) occupational exposure limits (OELs) for the anesthetic gases that are commonly in use at NIH. The OEL for isoflurane was updated based on a 2011 DOHS literature and toxicological review. The OELs for nitrous oxide, enflurane and halothane are now referenced from the American Conference of Governmental Industrial Hygienists, or ACGIH. For sevoflurane, the OEL is referenced from NIOSH. These OELs, which are 8-hour time weighted averages (TWA), are listed as follows:

Anesthetic Gas	OEL, in parts per million (ppm)
Isoflurane	2.0 ppm
Enflurane	75.0 ppm
Halothane	50.0 ppm
Nitrous oxide	50.0 ppm

The OEL for sevoflurane is 2.0 ppm, measured as TWA for the duration of the procedure (not an 8-hour TWA).

As stated earlier, OSHA has not established any PELs for any anesthetic gas. The DOHS will periodically review and update the OELs as new and relevant information becomes available.

4.0 OCCUPATIONAL EXPOSURE MONITORING

4.1 General

A survey, or leak test, of each anesthetic breathing circuit (machine, savaging device, tubing, etc.) or location should be performed every two years.

In general, surveys should be performed at new anesthetic breathing circuits/locations, or those not previously surveyed; and, leak tests should be performed at anesthetic breathing circuits/locations that have previously been surveyed with sample results below the personal (worker) OEL.

DOHS recognizes that it may be infeasible (e.g. unscheduled procedures, infrequent use) to perform a survey or leak test at every location throughout NIH that utilizes anesthetic gas for a procedure. Efforts from the WAG surveillance program are focused where there is a greater risk for potential exposure to WAG (active surgical suites, high duration of procedures, etc.).

4.2 Surveys & Leak Tests

4.2.1 Surveys

The following, at a minimum, should be performed during a survey:

1. Obtaining personal (worker's breathing zone) and area samples during an actual procedure.
2. Reviewing current work practices and procedures with previous WAG surveys and/or best practices of representative areas.
3. Performing a leak test on the anesthetic breathing circuit (vaporizer, savaging device, tubing, etc.) with a direct reading instrument.

4. Determining if there have been any significant changes in volume, procedures, equipment, etc.
5. Providing recommendations to further reduce exposure, if applicable.

When feasible, at least two (2) personal samples and 2 area samples will be taken. The 2 personal samples will be collected on those personnel who have the greatest potential for exposure (e.g. anesthesiologist, nurse-anesthetist, surgeon, scrub nurse). For the 2 area samples, one (1) area sample should be taken near the anesthetic breathing circuit and the other one near the surgical team's breathing zone.

For personal and area sampling, the sampling method and number of samples will depend on the length of the procedure. The survey should be designed to assess occupational exposure over the entire period during which anesthetic gas is used.

Personal and Area Sampling Methods

- Procedures at Least 2-hours in Duration

  For procedures lasting at least 2-hours, samples may be obtained using a modified version (utilizing passive dosimeters) of OSHA Method 103. The 3M 3520 passive dosimeter is acceptable to use for isoflurane.

- Procedures Less Than 2-hours in Duration

  For procedures lasting less than 2-hrs, but greater than 24-minutes, samples may be obtained using OSHA Method 103, as an active sampling method. This protocol is appropriate for isoflurane, enflurane, and halothane. OSHA Method 103 is not validated for sevoflurane.

- Procedures Less Than 24 minutes in Duration

  For procedures lasting less than 24 minutes, a direct reading instrument can be used to determine general exposure levels at the surveyed location, as part of a site test.

Per review with DOHS, other chemical sampling and analytical methods, as referenced by OSHA or NIOSH, may be used.

4.2.2 Leak Tests

A leak test may be performed as an alternative to conducting a survey. The following, at a minimum, should be performed during a leak test:

1. Reviewing current work practices and procedures with previous WAG surveys and/or best practices of representative areas.
2. Performing a leak test on the anesthetic breathing circuit (vaporizer, savaging device, tubing, etc.) with a direct reading instrument.
3. Determining if there have been any significant changes in volume, procedures, equipment, etc. that would indicate the need for a survey, if applicable.

4. Providing recommendations on further reducing exposure, if applicable.

4.3 Follow-up

Any problems identified during a survey or leak test (e.g., personal monitoring, direct readings and other observations) that require *immediate* attention will be promptly reported to the supervisor responsible for the operation of the anesthetic breathing circuit in order to implement corrective action. In the Clinical Center, the Department of Perioperative Medicine and also the Clinical Center Safety Office will be notified, if applicable. In other areas, the findings will be brought to the attention of the animal facility supervisor, Principal Investigator, or other point of contact; and, shared with the assigned DOHS Occupational Health and Safety Specialist.

If results indicate exposures exceeding the OEL and/or excessive leaks from the anesthetic breathing circuit, recommendations will be provided to the supervisor responsible for the operation of the anesthetic breathing circuit. Once recommendation are implemented, a follow-up survey or leak test will be performed verify that the corrective actions have been properly implemented.

5.0 LOCATIONS

The DOHS will maintain a database of all known locations where anesthetic gas is used. The database will be periodically reviewed and updated.

The IC personnel, Clinical Center Safety Officer, IC Safety Committee Representative, and the DOHS Occupational Health and Safety Specialist will assist in providing DOHS with locations and/or updates to existing locations.

6.0 REPORTS

Within twenty (20) working days of the completion of the fieldwork for a particular survey or leak test, the DOHS industrial hygiene contractor, *if applicable*, will prepare and submit via e-mail a final report to DOHS. The contractor will also provide DOHS with a hard copy of the final report. The DOHS will forward copies of the final reports to the appropriate contacts. The industrial hygiene contractor will indicate the names of the appropriate contacts on the report, including the supervisor responsible for the operation of the anesthetic breathing circuit.

In the event that a survey or leak test indicates that personal (employee) exposures are exceeding the OEL, those employees will be notified, in writing, of the results of the monitoring within twenty (20) working days of the results being received from the analytical laboratory. The written notification will also outline recommendations that can be implemented to correct the overexposure.

It is the responsibility of the supervisor responsible for operation of the anesthetic breathing circuit to initiate and follow-up on the recommendations made in the final report. Where facility changes are needed, the DOHS Occupational Health and Specialist will provide consultation and will monitor the progress of the project to completion.

In the Clinical Center, the implementation of recommendations shall be coordinated by the Chief of the Department of Perioperative Medicine, with the Clinical Center Safety Office providing consultation and monitoring of progress.

Additional items to include in the final report:

- A sketch of the room layout, showing the locations where samples are taken.
- The directional air flow of the rooms with respect to the corridors.
- The serial number from vaporizer and/or main component of the anesthetic breathing circuit.
- A copy of the *DOHS Fact Sheet & Checklist – Waste Anesthetic Gas (WAG) [see attachment]*

7.0 OCCUPATIONAL MEDICAL SERVICE (OMS)

The NIH Occupational Medical Service (OMS) provides medical services to the NIH community. NIH workers should contact OMS in Building 10, Room 6C306 (301-496-4411) if they experience symptoms that they suspect are related to workplace conditions.

8.0 REFERENCES

National Institute for Occupational Safety and Health (NIOSH). *NIOSH Criteria Document 77-140 [-] Criteria for a Recommended Standard of Exposure to Waste Anesthetic Gases and Vapors*. (March 1977) http://www.cdc.gov/niosh/docs/1970/77-140.html (1 May 2012)

NIOSH. *Waste Anesthetic Gases-Occupational Hazards in Hospitals*. (September 2007) http://www.cdc.gov/niosh/docs/2007-151/ (1 May 2012)

NIH Division of Occupational Health and Safety (DOHS). *Updating the NIH Occupational Exposure Limit (OEL) for Isoflurane* [Internal document (S: Drive … Waste Anesthetic Gas – Isoflurane Review)]. 2011

Occupational Safety and Health Administration (OSHA). *Anesthetic Gases: Guidelines for Workplace Exposures*. (18 May 2000) http://www.osha.gov/dts/osta/anestheticgases/index.html (1 May 2012)

DOHS Fact Sheet and Checklist
Waste Anesthetic Gas (WAG)

National Institutes of Health • Division of Occupational Health and Safety (DOHS) • Technical Assistance Branch (TAB)

What is waste anesthetic gas (WAG)?

Waste anesthetic gas, or WAG, is a term commonly used in relation to the occupational (worker) exposure of anesthetic gas during a medical or surgical procedure. Elements that contribute to WAG include:

- Leakage from tubing, seals and gaskets.
- Work practices/lack of training.
- Poor ventilation.
- Ineffective gas scavenging systems.

What are the health effects of being exposed to WAG ?

Some studies have documented adverse health effects (e.g. headaches, fatigue, irritability, birth defects, miscarriages, liver and kidney disease, cancer) from excessive exposure to anesthetic gases. These health effects were mainly noted for older anesthetics (e.g. trichloroethylene, methoxyflurane) that are no longer commonly in use. As one reference on these health effects, see pages 181-187 from Document 77-140 from the National Institute for Occupational Health and Safety, or NIOSH:

http://www.cdc.gov/niosh/docs/1970/77-140.html

Studies are inconclusive on the potential health effects from occupational exposure to some of the newer anesthetics (e.g. isoflurane [the most common anesthetic gas used at NIH]). The limited information available has produced little evidence on health effects.

The Occupational Safety and Health Administration (OSHA) currently advises that the risks to some of the more common, and newer, anesthetics (e.g. isoflurane, desflurane, and sevoflurane) have not been established and that attempts should still be made to minimize occupational exposure to WAG.

Are there any DOHS programs in relation to WAG ?

The DOHS has established a written WAG Surveillance Program, which primarily entails performing surveys and leak tests to quantify exposure levels and provide recommendations to reduce exposure. A survey or leak test may include: monitoring employees for exposure, performing a leak test of the anesthetic breathing circuit, and providing recommendations to further reduce any potential exposure.

A copy of the current WAG Surveillance Program is posted on the DOHS website:

http://www.ors.od.nih.gov/sr/dohs/HealthAndSafety/IH/Pages/industrial_hygiene.aspx#Waste

Does DOHS Perform a survey or leak test at all locations?

DOHS recognizes that it may be infeasible (e.g. unscheduled procedures, infrequent use) to perform a survey or leak test at every location throughout NIH that utilizes anesthetic gas for a procedure. WAG Surveillance Program efforts are focused where there is a greater risk for potential exposure to WAG (active surgical suites, high duration of procedures, etc.).

A survey or leak test may be requested by contacting DOHS at 301-496-3457.

NIH Division of Occupational Health and Safety (DOHS)
Technical Assistance Branch (TAB)
Building 13, Room 3K04
301-496-3457
09/2014

DOHS Fact Sheet and Check List
Waste Anesthetic Gas (WAG)

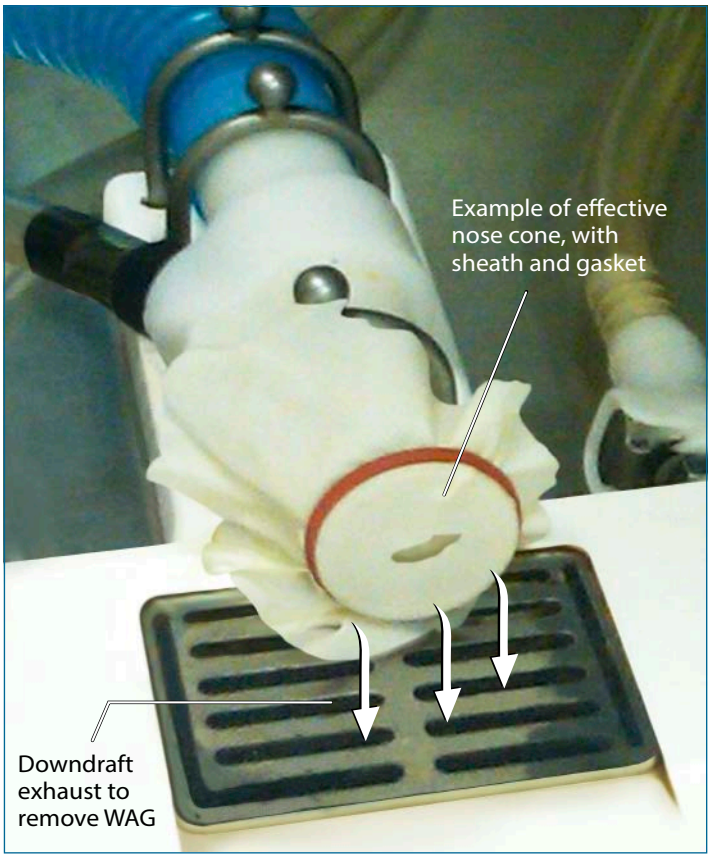
What good work practices should I implement to further reduce the potential for WAG exposure?

Consider posting this Fact Sheet & Checklist in the work area, and perform the following checks each time anesthetic gas is administered:

- ❑ Ensure personnel have received the appropriate documented training on how to use the equipment.
- ❑ Review and understand the manufacturer's instructions for operating the equipment.
- ❑ Ensure induction chamber lids are closed and locked when anesthesic gas is being delivered.
- ❑ Inspect lid gaskets to ensure they have a tight seal to the induction chamber. Replace defective gaskets.
- ❑ Ensure all connections are properly secure.
- ❑ Inspect tubing, valves and fittings for leaks. Seal all leaks.
- ❑ Use the flushing/purge system (if applicable) to flush for 5-10 seconds, or the time period noted by the manufacturer.
- ❑ Use a certified local exhaust ventilation system (chemical fumehood, downdraft table/sink, etc.) as the preferred means to remove WAG. Note that a biosafety cabinet that is NOT ducted to the exhaust system will only recirculate WAG and may not effectively remove it from the room.
- ❑ Maintain downdraft tables free of obstructions.
- ❑ Avoid excessive flow rates.
- ❑ Ensure the ports are sealed/plugged if animals are not in place (when using manifold or multi-port systems, including some imaging units).
- ❑ Use a certified local exhaust ventilation system (chemical fume hood, downdraft table/sink, etc.) when filling the vaporizer.
- ❑ Keep laboratory doors closed when anesthetic gas is in use.
- ❑ Ensure preventative maintenance has been performed on the system annually, or more frequent if recommended by the manufacturer.
- ❑ Create a nose cone for small animals (if applicable) comprised of a sheath and gasket to minimize WAG from escaping around an animal's face (see photo).

Small charcoal canisters:

- ❑ Adhere to the weighing and change-out schedules, as recommended by the manufacturer for the commonly used small charcoal canisters (e.g. F/AIR canisters).
- ❑ Weigh the canisters **before** every use.
- ❑ Avoid the use of any other large charcoal based scavenging systems, as per guidance from the NIH "Ductless Fume Hood Review" document.



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