

Nitrous Oxide Policy

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1. Purpose. The purpose of the nitrous oxide policy is to establish procedures/guidelines to protect the health and safety of all employees of the university community who may be occupationally exposed to nitrous oxide.

2. Scope. This nitrous oxide policy applies to all Virginia Commonwealth University (VCU) or Virginia Commonwealth University Health System (VCUHS) employees in those work areas where there is potential exposure to nitrous oxide. The health system areas covered by this program include, but are not limited to: General Surgery, Oral Surgery, and Ambulatory Surgery. Any other departments in the university or health system which currently use or intend to use nitrous oxide gas and are not addressed in this policy should contact the Office of Environmental Health & Safety (OEHS) to ensure compliance with applicable guidelines.

3. Policy. University policy is set forth to ensure that nitrous oxide gas is handled in the safest manner possible and in compliance with all applicable codes and standards. Engineering controls should be utilized to the maximum extent feasible to maintain exposures below recommended exposure limits, followed by other control methods including work practices, administrative controls, and the use of personal protective equipment.

4. Standard. Waste anesthesia gases, although not yet covered by federal regulations, have long been recognized as health hazards to dental and medical operating room personnel. Many different materials are used along with nitrous oxide to anesthetize patients, but for ease of monitoring, the nitrous oxide component of anesthetic gas mixture is generally regarded as an indicator of exposure. For a normative mixture of waste anesthetic gases, if the concentration of nitrous oxide is less than a 25 ppm (parts per million) time weighted average (TWA), one can assume that the levels of other gases are acceptable.

The Occupational Safety and Health Administration (OSHA) does not currently have a permissible exposure limit (PEL) for nitrous oxide. The National Institute of Occupational Safety and Health (NIOSH) has a recommended exposure limit (REL) of 25 ppm (45 mg/m³) for nitrous oxide (waste anesthetic gas) as a time-weighted average (TWA) over the time exposed. This limit is based upon the risk of reproductive system effects and decrease in audiovisual performance. The Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) also suggests maintaining time-weighted average exposures of 25 ppm or less. Based upon these recommendations, the university has adopted a TWA of 25 ppm as its standard.

5. Definitions and Key Terms.

A. OSHA: Occupational Safety and Health Administration.

B. NIOSH: National Institute of Occupational Safety and Health.

C. JCAHO: Joint Commission on Accreditation of Healthcare Organizations.

D. OEHS: Office of Environmental Health and Safety, Virginia Commonwealth University.

E. Nitrous Oxide: (also known as laughing gas, factitious air, nitrogen oxide, dinitrogen monoxide, hyponitrous acid anhydride, etc.): A colorless, nonexplosive, nonflammable gas with a slightly sweet odor and taste used as an anesthetic agent by medical and dental professions and as a foaming agent for whipped cream and an oxidant for certain organic compounds.

F. TLV/TWA: Threshold Limit Value/Time-Weighted Average. The time weighted average concentration for a normal eight-hour workday and a 40-hour workweek, to which it is believed nearly all workers may be repeatedly exposed, day after day, without adverse effect. These values are published yearly by the American Conference of Governmental Industrial Hygienists (ACGIH).

G. Time Weighted Average (TWA): The actual measured exposure level averaged over an eight-hour time period.

H. Recommended Exposure Limit (REL): Exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH).

6. Nitrous Oxide Hazard Assessment. Operations or occupational activities that may result in nitrous oxide exposure include:

A. Common uses of nitrous oxide include use as an anesthetic gas, a foaming agent (in whipped cream), a leak detecting agent (on natural gas pipelines), an oxidant for the production of organic compounds, in the manufacture of nitrates from alkali metals, or in rocket fuel formulations.

B. Sources of nitrous oxide emissions into the air include uncontrolled emissions or venting with other gases in industrial, medical, and other settings.

C. The general population may be exposed to emissions of nitrous oxide from mobile source combustion from cars, buses, and trucks, and from agriculture sources, primarily fertilizer application or during medical procedures.

7. Exposure Monitoring Strategy.

A. Employees in work areas of the university or health system which may involve exposure to nitrous oxide will be monitored periodically to determine exposure concentrations. Dosimeter badges are the preferred method of personnel monitoring while direct-reading methods are to be used for area surveys. Time weighted average measurements shall be determined through the use of dosimeter badges for personal samples and the Miran 203 infrared spectrophotometer or the Miran SapphIRe for area monitoring of ambient concentrations. The Miran is particularly useful in locating leaks in the N₂O carrier system.

B. Monitoring will be conducted by OEHS in such a manner as to be representative of the eight-hour TWA of each employee. Representative eight-hour TWA employee exposures shall be determined based upon one or more samples representing full-shift exposure for each shift for

each job classification in each work area. The frequency of such monitoring will be determined by OEHS based upon the results of baseline characterization of exposure.

8. Health Effects. Nitrous oxide gas enters the body by inhalation and is readily absorbed through the lungs and transported throughout the body. Short-term or acute exposure to N₂O may cause headaches, dizziness, difficult breathing, nausea, fatigue, and irritability. Long-term or chronic exposure may cause tingling, numbness, difficulty concentrating, and is suspected of causing serious health problems including increased incidence of spontaneous abortion and congenital abnormalities, as well as liver, kidney, and nerve disorders. Liquid nitrous oxide is capable of causing frostbite to skin it comes into contact with.

9. Medical Surveillance. If an employee has been exposed to nitrous oxide in regards to the following conditions, he or she should notify his or her supervisor and seek medical attention from the university's Employee Health Services office.

A. If the employee has been exposed to nitrous oxide in an emergency situation.

B. If the employee may have been exposed to nitrous oxide and shows signs/symptoms of nitrous oxide exposure.

10. Monitoring/Reporting Results. The area supervisor shall report the results of all nitrous oxide monitoring to the person(s) monitored within fifteen calendar days of the date on which the area supervisor receives the results. Posting of the monitoring results is acceptable for this purpose (the results should be posted for a minimum of three days in an area readily accessible to the affected employees). If the TLV has been exceeded, the area supervisor should refer to this document to review and implement any of the applicable control measures which may help reduce the exposure to anesthetic gases. The affected employees should be notified of any corrective action taken.

11. Training Program. All employees with any potential exposure to nitrous oxide must receive training to confirm their understanding of nitrous oxide, its hazards, and methods of protection. Employees should be trained at the time of initial assignment and then at least annually thereafter. The training program shall be conducted in a manner in which the employee is able to understand and apply the following information:

A. The properties of nitrous oxide, its forms, uses, synonyms, and common occurrences work areas at VCU and VCUHS.

B. Recommended exposure limits for nitrous oxide.

C. Nitrous oxide detection by workers.

D. Health effects of nitrous oxide including a description of the potential health effects of exposure and signs and symptoms of various ambient concentrations.

E. Routes of exposure and acute/chronic exposure effects.

F. Monitoring methods to detect the presence and concentration of nitrous oxide in the work area:

1. Initial monitoring.
2. Periodic monitoring.

G. Overview of applicable OSHA standards:

1. Hazard Communication standard (29 CFR 1910.1200).
2. Laboratory Safety Standard (29 CFR 1910.1450).

H. Measures employees must take to protect themselves:

1. Engineering controls.
2. Administrative/work practice controls.
3. Personal protective equipment.

I. Emergency procedures for skin or eye contact.

J. Medical surveillance.

K. Employee responsibilities regarding signs and symptoms of exposure and what to do when potentially exposed or if there are employee concerns.

12. Engineering Controls.

A. The policy of VCU is that managers of all nitrous oxide-related work activities with potential for exceeding the recommended exposure limit shall implement feasible engineering controls. Examples of engineering controls that can be used to control occupational exposure to waste anesthetic gases, including nitrous oxide, are gas scavenging systems and general or dilution ventilation systems.

B. The following considerations should be included in the design and installation process for such equipment:

1. The heating, ventilating, and air conditioning (HVAC) system should contribute to the dilution and removal of waste gas, including nitrous oxide, which is not collected by the scavenging system.
2. Local exhaust systems should be placed close to the working area to remove leaking gas.

3. To minimize nitrous oxide exposure and control the buildup of gases and vapors in the general work area, adequate ventilation must always be provided. Good practice demands the use of fresh air dilution of general room air wherever nitrous oxide is in use.

4. If the facility ventilates containers of contaminated clothing and equipment, the facility shall establish an appropriately labeled storage area for this purpose and locate and arrange the area in such a manner that potential for nitrous oxide exposure is minimized. The facility shall allow only persons trained in recognizing the hazards of nitrous oxide to remove containers from the storage area.

13. Work Practices/Administrative Controls. Work practices and administrative procedures are also an important part of a control system. If an employee is asked to perform a task in a certain manner to limit the exposure to nitrous oxide, it is extremely important that the recommended procedures are followed. The following control/precautionary measures have been documented to reduce the breathing zone concentrations of nitrous oxide and may be implemented in the case of “high” employee exposures:

A. Limit/modify the use of nitrous oxide. Minor modifications in an anesthetist’s work practices can substantially reduce anesthetic exposure.

B. Use an adjustable, well-fitting nose mask.

C. Minimize speech by the patient during dental procedures.

D. Initiate regular preventative maintenance procedures for anesthetic equipment.

E. Perform frequent leak testing of equipment.

F. Monitor for nitrous oxide in the breathing zone of exposed personnel.

G. Provide continuing training/education to personnel.

14. Personal Protective Equipment (PPE). Certain types of PPE are effective in controlling nitrous oxide exposure. In normal work situations, PPE should be used only as a supplement to engineering controls. Employees must not take nitrous oxide-contaminated materials, clothing, or equipment home.

A. Gloves. Cold-insulating gloves should be worn to prevent skin contact with liquid nitrous oxide and to protect workers from frostbite. The selection of gloves should be based upon the employee’s potential exposure to liquid nitrous oxide and factors including material, chemical resistance, and durability should be considered when selecting gloves.

B. Eye and Face Protection. Appropriate eye protection should be worn to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite.

C. Respiratory Protection. If an employee may be exposed to nitrous oxide concentrations where a respirator is warranted, please contact OEHS for guidance on appropriate respirators. When employees are required to wear respirators to reduce exposure, they must be enrolled in VCU's Respiratory Protection Program as required by OSHA.

15. Emergency Situations. In case of a nitrous oxide leak:

A. Personnel should immediately evacuate the effected area and assist injured personnel to safety.

B. Seek medical assistance for injured personnel.

C. Call the OEHS or VCU Telepage Operator immediately.

D. Never re-enter contaminated area without proper PPE and back-up personnel.

16. Housekeeping and Leak/Spill Response. Facilities where nitrous oxide (liquid or gas) is utilized shall create and maintain a program to detect leaks and spills. The equipment leak and spill detection program should include:

A. Regular visual inspections for leaks and spills.

B. Preventative maintenance of equipment, including surveys for leaks conducted at regular intervals.

C. Regular testing of monitoring equipment to assure proper function.

D. Provisions for nitrous oxide leak containment and decontamination in work areas where leakage may occur.

E. Prompt repair of leaks by persons wearing appropriate personal protective equipment and trained in the proper methods for nitrous oxide cleanup and decontamination.

17. Sources & Further Reading:

A. Occupational Safety and Health Guideline for Nitrous Oxide (1999)
<http://www.osha.gov/SLTC/healthguidelines/nitrousoxide/index.html>

B. NIOSH Publication No. 2005-151, NIOSH Pocket Guide to Chemical Hazards (2005)
<http://www.cdc.gov/niosh/npg/npgd0465.html>

C. OSHA, Anesthetic Gases: Guidelines for Workplace Exposures (2000)
<http://www.osha.gov/dts/osta/anestheticgases/index.html#E1>

D. Energy Information Administration/Emissions of Greenhouse Gases in the United States (2005) <ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ggrpt/057304.pdf>