POLICY
FOR WORK WITH
OSMIUM TETROXIDE

THE WYSS INSTITUTE
FOR
BIOLOGICALLY INSPIRED ENGINEERING

Wyss Institute

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# LIST OF ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>EH&amp;S</td>
<td>Environmental Health and Safety</td>
</tr>
<tr>
<td>g/L</td>
<td>grams per liter</td>
</tr>
<tr>
<td>MSDS</td>
<td>material safety data sheet</td>
</tr>
<tr>
<td>OSHA</td>
<td>U.S. Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PPE</td>
<td>personal protective equipment</td>
</tr>
<tr>
<td>SOP</td>
<td>standard operating procedure</td>
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<tr>
<td>°F</td>
<td>degrees Fahrenheit</td>
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1.0 INTRODUCTION

It is the policy of the Wyss Institute for Biologically Inspired Engineering at Harvard University (Wyss Institute) to provide a safe and healthy workplace in compliance with the Occupational Safety and Health Act of 1970 and with regulations of the U.S. Department of Labor. The full U.S. Occupational Safety and Health Administration (OSHA) standard can be found at: http://www.osha.gov/comp-links.html.

This standard operating procedure (SOP) will review methods for working safely with osmium tetroxide. It will describe osmium tetroxide’s characteristics, engineering controls/ventilation, personal protective equipment, emergency response, and waste disposal at the Wyss Institute facility located at 3 Blackfan Street in Boston, Massachusetts.

Osmium tetroxide is a pale or yellow colored solid characterized by an unpleasant, acrid, chlorine-like odor; however, be advised that odor alone should not be used to effectively warn of an exposure. Osmium tetroxide sublimes from the solid phase to the gaseous phase, and inhalation of chemical vapors is possible. Users should also be aware that osmium tetroxide is toxic, corrosive, an oxidizing material, and incompatible with hydrochloric acid and easily oxidized materials.

Osmium tetroxide is used as a fixative and as a lipid stain for scanning electron microscopy.
2.0 TRAINING REQUIREMENTS

Training is required to work with osmium tetroxide in the Wyss Institute laboratory.

Platform Leaders must ensure that researchers have job–specific training for handling osmium tetroxide. In addition, the laboratory manager must read this SOP so s/he understands the hazards associated with working with osmium tetroxide. The Wyss Institute Environmental Health and Safety (EH&S) Office requires written training records for laboratory members who are trained to use osmium tetroxide. This training will include reviews of the following:

- This SOP.
- The material safety data sheet (MSDS) for the specific form(s) of osmium tetroxide to be used.

The training will be documented, and the documentation maintained by the Wyss Institute EH&S Office. The Wyss Institute EH&S Office will review planned osmium tetroxide procedures with the researcher(s) in order to ensure that all appropriate safety precautions are incorporated.
3.0 CHARACTERISTICS AND PROPERTIES

The following are some of the characteristics associated with osmium tetroxide.

3.1 CHEMICAL CHARACTERISTICS

The chemical characteristics and degree of chemical hazard vary depending on the physical form and concentration of osmium tetroxide. As a result, it is important that researchers review the MSDS associated with specific material(s) to be used, as outlined in Section 2.0.

- It sublimes, becoming a gas from a solid phase at room temperature.
- Reacts with glazes, enamels, pottery, concrete, rubber, leather, metals, and organic compounds.
- Generates hydrogen gas when it reacts with metals. Hydrogen gas build-up is a potential explosion hazard.

3.2 CHEMICAL AND PHYSICAL PROPERTIES

The following are the chemical and physical properties associated with HF.

- Name: Osmium Tetroxide
- Synonyms: Osmium Tetraoxide
- Chemical Abstracts Service (CAS) Number: 20816-12-0
- Molecular Formula: OsO₄
- Molecular Weight: 254.23
- Physical Form: pale yellow brown crystalline solid with an acrid, chlorine-like odor
- Density: 4.91 g/cm³
- Melting Point: 104.4 degrees Fahrenheit (ºF)
- Solubility: Soluble in water (65 g/L), and in most organic solvents
3.3 TOXICOLOGICAL PROPERTIES

**ACUTE EXPOSURE:** The acute toxicity of osmium tetroxide is high, and it is a severe irritant of the eyes and respiratory tract. Exposure to osmium tetroxide vapor can damage the cornea of the eye and even lead to blindness. Irritation is generally the initial symptom of exposure to low concentrations of osmium tetroxide vapor. Lacrimation, a gritty feeling in the eyes, clouding of the eyes, and the appearance of rings around lights may also be noted. In most cases, recovery occurs in a few days. Concentrations of vapor that do not cause immediate irritation can have a dangerous cumulative effect; symptoms may not be noted until several hours after exposure. Contact of the eyes with concentrated solutions of this substance can cause severe damage and possible blindness.

Inhalation can cause chemical burns to the respiratory tract, headache, coughing, dizziness, lung damage, and difficult breathing, and may potentially be fatal. Contact of the vapor with skin can cause dermatitis, and direct contact with the solid can lead to severe irritation and burns. Exposure to osmium tetroxide via inhalation, skin contact, or ingestion can lead to systemic toxic effects involving liver and kidney damage. Osmium tetroxide is regarded as a substance with poor warning properties.

**CHRONIC EXPOSURE:** Chronic exposure to osmium tetroxide can result in accumulation of osmium compounds in the liver and kidney, and damage to these organs. Osmium tetroxide has been reported to cause reproductive toxicity in animals; this substance has not been shown to be carcinogenic or to show reproductive or developmental toxicity in humans. Repeat exposure to osmium tetroxide may cause sensitization by inhalation or skin contact.
4.0 STORAGE REQUIREMENTS

Based on the chemical and physical properties, it is recommended that researchers store osmium tetroxide in sealed glass containers in unbreakable secondary containers. Rubber stoppers should not be used, since they will react with the osmium tetroxide. In addition, osmium tetroxide should be segregated from organic compounds, which are incompatible with it.
5.0 HAZARD COMMUNICATION

Under the OSHA Hazard Communication Standard 29 CFR 1910.1200, containers of hazardous materials must be labeled with the full name of the chemical (no abbreviations) and the hazard associated with the chemical.

The hazards associated with osmium tetroxide are such that all containers must be labeled with the full chemical name and the hazard(s) associated with the material (i.e., osmium tetroxide, corrosive, toxic).

In addition, the designated chemical fume hood, glove box, or closed system used to store the osmium tetroxide must be labeled with the chemical name and the hazard(s) associated with the material. Refer to Figure 1 for an example.

**Figure 1** Hazard Communication Label

<table>
<thead>
<tr>
<th>Chemical Name: Osmium Tetroxide</th>
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<tbody>
<tr>
<td>Hazards: Toxic, Corrosive</td>
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</table>

In addition, anytime osmium tetroxide materials are left unattended in a fume hood, a contact name and phone number must be posted on the hood so that the responsible researcher may be reached in the event of an emergency.
6.0 HANDLING AND ENGINEERING CONTROLS

Due to the hazards associated with osmium tetroxide, the following steps MUST be followed before/while working with such materials:

- The laboratory must obtain the appropriate personal protective equipment (PPE) for the experiment. Refer to Section 7.0 for specific details.

- Ensure the appropriate engineering controls and waste storage containers are available for the experiment.

- Osmium tetroxide should be purchased in aqueous solution in order to avoid exposure to the powdered form.

- People using osmium tetroxide must have a copy of this SOP and the MSDS available to them while they are using the osmium tetroxide to ensure proper procedures when working this hazardous chemical.

- Remove all unused equipment and flammable materials from the area (including hazardous waste containers).

- All work involving osmium tetroxide must be conducted in a certified chemical fume hood. Ensure the designated chemical fume hood has the Hazard Communication label, which is provided in Section 5.0.

- The designated chemical fume hood’s sash must be used at or below 18 inches to prevent a splash hazard to the researcher.

- Other members of the laboratory and the laboratory manager must be informed of where osmium tetroxide is used and stored.
7.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is required at all times when working with osmium tetroxide. Wyss Institute researchers must be trained in the proper use and limitations of the PPE they are using with respect to osmium tetroxide.

7.1 EYE PROTECTION

Eye protection is required to be worn at all times when working with osmium tetroxide. Safety glasses are adequate as long as there is not a splash hazard associated with the work. If there is a splash hazard, a face shield should be worn. A face shield is required when there is a risk of explosion, large splash hazard, or a highly exothermic reaction.

7.2 HAND PROTECTION

Nitrile and latex gloves provide adequate protection against osmium tetroxide. If gloves become grossly contaminated, they should be changed immediately and disposed of as hazardous waste. For more information regarding appropriate gloves, please contact the Wyss Institute EH&S Office.

7.3 BODY PROTECTION

A laboratory coat must be worn at all times when working with osmium tetroxide.

Per laboratory rules, no open toed shoes are permitted in a laboratory setting.
8.0 EMERGENCY RESPONSE

In the event of an emergency involving osmium tetroxide:

- Wyss Institute tenants should follow the procedures outlined in the Wyss Institute Safety Information and Emergency Response flipchart and provided in the manufacturer’s MSDS.

- Researchers working with osmium tetroxide should be familiar with the MSDS prior to any emergency. Researchers must also be familiar with where the nearest emergency equipment is located in their work area. Be sure appropriate fire extinguishing materials are present prior to work.

8.1 SKIN EXPOSURE

1. Immediately move to an emergency shower or other water source and flush the affected area with large amounts of cool running water for at least 15 minutes. While the victim is flushing with water, they should also remove any contaminated clothing, shoes and jewelry, removing gloves and safety glasses last.

2. Obtain medical treatment immediately. While the victim is being rinsed with water, someone should call 911 to arrange treatment by emergency medical personnel if the victim is unable to safely proceed directly to an emergency room, and also alert the Wyss Institute EH&S Office at 617-432-7222. A copy of the MSDS should be taken to the hospital.

8.2 EYE EXPOSURE

1. Immediately flush eyes at the nearest eyewash for at least 15 minutes with copious cool flowing water, holding eyelids open with clean fingers. The victim should then be transported to a medical facility.

2. Obtain medical treatment immediately. While the victim is rinsing their eyes, someone should call 911 to arrange treatment by emergency medical personnel, and also alert the Wyss Institute EH&S Office at 617-432-7222.
8.3 INHALATION

If osmium tetroxide is inhaled:

1. Immediately remove the victim to clean air. Call emergency medical personnel at 911 and tell the dispatcher the following:

   a. There is a person that has been in exposed to osmium tetroxide and the victim is in this location.
   b. Please send an officer and ambulance.

2. Alert the Wyss Institute EH&S Office at 617-432-7222.

8.4 SPILL RESPONSE

Small Spill

In the event of a small spill of osmium tetroxide, corn oil will neutralize the toxicity of osmium tetroxide and make the spill safer to clean up. A person should only clean up a spill if (s)he is comfortable doing so, and wearing proper PPE (gloves, safety glasses, lab coat). A 2% solution of osmium tetroxide can be neutralized by twice its volume in corn oil (e.g. a 10 mL spill should be treated with 20 mL of corn oil). The spill may then be cleaned up with absorbent materials and collected in a sealed plastic bag for disposal as chemical waste.

Large Spill

In the event of a large spill (>100 ml) of osmium tetroxide, the researcher should close the fume hood sash if the spill is in a hood, evacuate the area of the spill and contact HUPD at 617-432-1212 and the Wyss Institute EH&S Office at 617-432-7222 immediately for assistance in cleaning up the spill. A sufficient quantity of corn oil (labeled “FOR RESEARCH PURPOSES ONLY”) to neutralize the largest potential spill should be kept on hand in the area where work is performed.
9.0 PROPER DISPOSAL

Osmium tetroxide is highly toxic, and waste products must be treated as hazardous waste.

When work with osmium tetroxide is complete, the associated waste must be disposed in a container safe for the hazardous waste contractor to transport to the main accumulation area. The container must be labeled with a hazardous waste tag containing the following information:

- Declare “Hazardous Waste”
- Contents listed with no abbreviations
- Applicable hazards checked off (toxic)
- Dated only when full or if the laboratory personnel are no longer adding waste to the container

Call the hazardous waste pickup line at 617-667-5143 or e-mail tenviron@bidmc.harvard.edu to request removal of the waste by the hazardous waste subcontractor.
10.0 RESOURCES


