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| Standard Operating Procedure (SOP) |
| Hydrofluoric Acid |

*This is an SOP template and is not complete until: 1) Lab Specific information is entered into the box below 2) Lab Specific information is added to the various sections (orange font), 3) completed SOP has been approved by the PI, and 4) completed SOP has been reviewed, signed and dated by all relevant lab personnel.*

Keep a copy in your lab safety shared folder or binder.

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| Department: | Click here to enter text. | | | |
| SOP Preparation Date: | Click here to enter a date. | SOP Approval Date: | | Click here to enter a date. |
| Principal Investigator: | Click here to enter text. | | | |
| Lab Manager Name: | Click here to enter text. | | | |
| Laboratory Phone: | Click here to enter text. | | Office Phone: | Click here to enter text. |
| Emergency Contact: | Click here to enter text. | | Contact Phone: | Click here to enter text. |
| Laboratory locations covered by this SOP (building / room number): Click here to enter text. | | | | |
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| Type of SOP: |  | Process |  | Hazardous Chemical |  | Hazardous Class |

**Purpose**

Hydrofluoric acid (HF) is a highly corrosive liquid and is a contact poison. It should be handled with extreme care (i.e., beyond what is generally required to handle other mineral acids). Owing to its low dissociation constant, HF as a neutral lipid-soluble molecule penetrates tissue more rapidly than typical mineral acids. Because of the ability of hydrofluoric acid to penetrate tissue, poisoning can occur readily through exposure of skin or eyes, or when inhaled or swallowed. Symptoms of exposure to hydrofluoric acid may not be immediately evident. HF interferes with nerve function, meaning that burns may not initially be painful. Accidental exposures can go unnoticed, delaying treatment and increasing the extent and seriousness of the injury.

HF is a calcium seeker. A person can’t sense when it comes in contact with the skin. But, it dissolves the calcium in the bone. HF burns are not evident until a day later. If not stored, handled and disposed of properly, HF can pose a serious threat to the health and safety of laboratory personnel, emergency responders and waste handlers. Hence, it is important to thoroughly understand the properties of HF and follow all safety protocols to properly store and handle HF.

Uses: HF is used to etch glass. A 5% to 9% hydrofluoric acid gel is also commonly used to etch all ceramic dental restorations to improve bonding. For similar reasons, dilute hydrofluoric acid is a component of household rust stain remover and in car washes in "wheel cleaner" compounds. Because of its ability to dissolve iron oxides as well as silica-based contaminants, hydrofluoric acid is used in pre-commissioning boilers that produce high-pressure steam. Because of its ability to dissolve oxides, hydrofluoric acid is useful for dissolving rock samples (usually powdered) prior to analysis. The ability of hydrofluoric acid to dissolve metal oxides is the basis of several applications. It removes oxide impurities from stainless steel, a process called ‘pickling’*,* and silicon wafers in the semiconductor industry.

**Physical and Chemical Properties / Definition of Chemical Group**

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| CAS: | 7664-39-3 |  |
| Class: | Very toxic & Corrosive |
| Molecular Formula: | HF |
| Form (physical state): | Liquid |
| Color: | Colorless |
| Boiling Point: | Not applicable |

**Potential Hazards / Toxicity**

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| **Potential Health Effects** | |
| *HF removes calcium from the body in affected area (targets the bone).*  **Deaths have been reported from concentrated hydrofluoric acid burns involving as little as 2.5% Body Surface Area (BSA), an area roughly the size of your hand is sufficient to cause death.** | |
| **Target Organs:** | Liver, Kidneys |
| **Inhalation:** | Toxic if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract. |
| **Skin:** | May be fatal if absorbed through skin. Causes skin burns. |
| **Eyes:** | Causes severe eye burns. |
| **Ingestion:** | May be fatal if swallowed. |

**HEIRARCHY OF CONTROLS:**

**Engineering Controls**

**Lab Specific Engineering Controls** (Add your lab’s specific engineering controls in this section).

Click here to enter text.

Work with HF must be conducted in a fume hood unless other controls are designated in the lab-specific Protocol/Procedure section. Sash height must be kept as low as possible to avoid escaping fumes and provide a physical barrier.

**Administrative Controls**

**Lab Specific Administrative Controls** (Add your lab’s specific administrative controls in this section).

Click here to enter text.

Adhere to the processes outlined in this SOP and have the safety data sheet (SDS) readily available prior to working with hydrofluoric acid.

**Personal Protective Equipment (PPE)**

**Lab Specific PPE requirements** (Add your lab specific PPE requirements in this section).

Click here to enter text.

**Hand Protection**

HF Concentration less than 30% to 70% when conducting activities that utilize small quantities of HF (Splash hazard only)

* It is highly recommended that HF users double glove.
* It is recommended hydrofluoric acid (HF) users wear a primary glove that has good to excellent degradation and permeation properties established by the manufacture for HF use. (Example - nitrile, neoprene)
* Primary gloves with good dexterity and good to excellent degradation and permeation properties established by the manufacture for HF use should be worn while conducting fine work that utilizes small qualities of HF regardless of HF concentration.
* Special secondary gloves may be worn over primary gloves when needed, provided the primary glove meets the specific manufactures recommendation for protection from the chemical hazard. (Example - clean room gloves)
* Glove use will be dependent on HF concentration, quantity of HF used, and activities being conducted.
* Gloves that come in contact with HF shall be cleaned and inspected for degradation or shall be replaced with new gloves.
* If utilizing other chemicals with HF, the user should contact the specific glove manufacture to determine if additional chemical(s) may change the primary glove degradation and permeation rating.

HF Concentration less than 30% to 70% when conducting activities that utilize large quantities of HF or dispensing large quantities to small quantities (Splash hazard only)

* All of the following:
* Double glove with gloves that cover the hands, wrists, and forearms.
* It is recommended hydrofluoric acid (HF) users wear a primary glove that has good to excellent degradation and permeation properties established by the manufacture for HF use. (Example - nitrile, neoprene)
* It is recommended for medium to heavy weight gloves be worn over the primary gloves when utilizes large qualities of HF regardless of HF concentration. (Example - barrier gloves (laminate gloves), nitrile gloves, neoprene gloves, butyl rubber gloves, and butyl / viton gloves)
* Glove use will be dependent on HF concentration, quantity of HF used, and activities being conducted.
* Gloves that come in contact with HF shall be immediately replaced with new gloves.
* If utilizing other chemicals with HF, the user should contact the specific glove manufacture to determine if additional chemical(s) may change the primary glove degradation and permeation rating.

**NOTE:** Gloves must be inspected prior to each use. Use proper glove removal technique (without touching outer surface of the gloves) to avoid skin contact with HF on the contaminated gloves. *Dispose of inner nitrile gloves* after use as hazardous waste.

*\*Inner Butyl Viton gloves can be reused carefully* (i.e., without touching the outer surface of the gloves). Wash hands thoroughly with warm water and soap.

**NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with Hydrofluoric acid.

Refer to glove selection chart from the links below:

<http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf>

OR

<http://www.allsafetyproducts.biz/page/74172>

OR

<http://www.showabestglove.com/site/default.aspx>

**Eye Protection**

* Tight fitting, indirectly vented safety goggles and face shield.

**Skin & Body Protection**

* Lab coat
* Natural rubber apron
* Full-length pants
* Close-toe rubber or leather shoes

**NOTE:** If HF is used in a cleanroom, the cleanroom gown will substitute for lab coat and full length pants. In addition, all the other PPE listed in this section is applicable.

**Respiratory Protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Respirators should be used only under any of the following circumstances:

* As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
* When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded. Contact RMS to schedule air monitoring.
* Regulations require the use of a respirator.
* An employer requires the use of a respirator.
* There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL).
* As PPE in the event of a chemical spill clean-up process.

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested. This is a regulatory requirement.

<https://riskmanagement.nd.edu/safety/occupational-health/respiratory-protection-plan/>

**Hygiene Measures**

Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Special Storage & Handling Requirements**

**Storage**

* HF must always be stored in plastic (Nalgene or polyethylene) containers.
* Ensure the container is tightly closed at all times.
* DO NOT store HF in glass bottles / containers.
* Store in corrosive / acid storage cabinet within a secondary containment tub made of Nalgene or polyethylene.
* DO NOT store on the top most shelf of the storage cabinet. NOTE: In general, do not store chemicals at or above eye level.
* DO NOT store with oxides, organic chemicals, bases or metals.

**Handling**

* Verify a tube of at least 30 grams of 2.5% calcium gluconate gel is readily available, in a gel-like condition, and the shelf life has not been exceeded.
* The lab where the material is being handled has an approved / certified emergency eyewash and safety shower.
* Ensure you are wearing the following minimum PPE: tight fitting safety goggles and face shield, lab coat & natural rubber apron, full length pants, close-toe rubber or leather shoes, gauntlet style (or arm length) natural rubber gloves over a pair of nitrile gloves.
* Carefully carry the stock bottle in a rubber bottle carrier / Nalgene secondary container to the chemical fume hood and pour out desired amount into a smaller container.
* Place stock bottle back in corrosive chemical storage cabinet with cap tightly closed.
* The Working Alone procedure prohibits working alone with extremely hazardous materials, extremely hazardous equipment, or extremely hazardous processes (unless authorized by the Principal Investigator or EH&S). A buddy system is required when handling HF.

**EMERGENCY ACTION PLAN (EAP):**

**Lab Specific EAP** (Add your lab’s specific emergency action plan variances in this section).

Click here to enter text.

**First Aid Procedures**

**If inhaled…** Move to fresh air. If the person is not breathing, give artificial respiration. DO NOT use mouth to mouth resuscitation. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**In case of skin contact…** Remove all contaminated clothing. Immediately (within seconds) flush affected area for FIVE (5) minutes. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

Wearing compatible gloves, massage calcium gluconate gel into the affected area. Re-apply every 15 minutes until medical help arrives. Note: Hydrofluoric acid exposure is often treated with calcium gluconate, a source of Ca2+ that sequesters the fluoride ions. HF chemical burns can be treated with a water wash and 2.5% calcium gluconate gel, or special rinsing solutions. However, because it is absorbed, medical treatment is necessary; rinsing off is not enough. Intra-arterial infusions of calcium chloride have also shown great effectiveness in treating burns. In some cases, amputation may be required.

**In case of eye contact…** Use nearest emergency eyewash or 0.9% saline wash immediately and flush for at least 15 minutes (30 minutes is best). DO NOT allow victim to rub eyes or keep eyes closed. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**If swallowed…** DO NOT INDUCE VOMITING. Give large quantities of milk (preferable) or water. Never give anything by mouth to an unconscious person. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**Spill and Accident Procedure**

**Personal precautions**

Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Do not attempt clean-up without PPE (see PPE section).

**Environmental precautions**

Prevent further leakage or spillage – if safe to do so. Do not allow product to enter drains. Discharge into the environment must be avoided.

**Methods and materials for containment and clean-up**

Consider material compatibility prior to clean-up. Verify spill kit contains the following: neutralizing agent (calcium or magnesium hydroxide is recommended), disposable scoop and a compatible waste collection container or plastic bag.

1. Immediately assess amount spilled, follow the Lab Specific Emergency Action Plan procedures for hazardous materials incidents.
2. If a chemical exposure has occurred, call 911 from a campus line or 574-631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.
3. Don compatible gloves and other protective PPE if not already being worn.
4. Secure / restrict access to the area of the spill to prevent spread of the chemical.
5. Slowly add neutralizing agent (aqueous calcium or magnesium hydroxide) to the spilled HF to avoid generating heat. This reaction is exothermic (generates heat) which can vaporize HF increasing the risk of exposure.
6. A liquid binding material (vermiculite, sand, kitty litter) may be used to absorb the liquid.
7. Pick up contaminated material with a disposable scoop into a double-bagged ziplock or other compatible container.

Label and tag as hazardous waste and submit a pick-up request to RMS using the [online Chemical Discard Tag form](https://riskmanagement.nd.edu/safety/environmental/hazardous-waste/).

**NOTE:** Do NOT attempt to neutralize HF with the following:

1. Sodium or Potassium Carbonate (“Soda Ash”, “Caustic Soda”): The reaction of Na2CO3 or K2CO3 with HF generates sodium or potassium hydrogen bifluoride (NaHF2 or KHF2) as intermediates, which release gaseous HF when exposed to heat.
2. Potassium or Sodium Hydroxide (found in many acid-neutralizing kits): The neutralization of HF with potassium or sodium hydroxide is more exothermic than with sodium or potassium carbonate and also generates potassium or sodium hydrogen bifluoride (NaHF2 or KHF2) as intermediates, which release gaseous HF when exposed to heat.

3) Silicon-based absorbent materials (common in most solvent spill kits) react with HF to generate silicon tetrafluoride, which is a toxic and corrosive gas.

**Decontamination / Waste Disposal Procedure**

**Waste Labeling Requirements**

* Label waste container with the term “Hazardous Waste- Hydrofluoric Acid” and “Corrosive” (or toxic GHS pictogram) to all hydrofluoric acid waste containers prior to the first drop of waste being added to the container.

**Store waste**

* Store hazardous waste in closed containers within secondary containment and in a designated storage location.
* Waste must be under the control of the person generating and disposing of it.

**Dispose of waste**

* Dispose of regularly generated chemical waste within 90 days.
* Use the [online Chemical Discard Tag form](https://riskmanagement.nd.edu/safety/environmental/hazardous-waste/) to request a pickup.
* Contact RMS at (574) 631-5037 for waste-related questions.

**Protocol / Procedure**

**Lab Specific Procedures** (Add your lab’s specific procedures in this section).

Click here to enter text.

**IMPORTANT NOTE: Any deviation from this SOP requires advance PI approval.**

**Documentation of Training**

Prior to conducting any work with this material, the following requirements must be met:

* The Principal Investigator must ensure his/her laboratory personnel have calcium gluconate gel and appropriately sized PPE readily available.
* The Principal Investigator or designee must train his/her laboratory personnel on the specific hazards when working with this substance, decontaminating work areas, and during adverse / emergency conditions.
* The Principal Investigator must ensure a copy of this SOP and a copy of the Material Safety Data Sheet (SDS) provided by the manufacturer (should be available in MSDSOnline) are readily available to his/her lab personnel.
* The Principal Investigator must ensure his/her laboratory personnel have completed appropriate / required laboratory safety training or refresher training within the last one year.

**I have read and understand the content of this SOP.**

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| Employee Name | Signature | Date |
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