**University of Arizona**

**Hydrofluoric Acid (HF) Standard Operating Procedure**

*[This is a template. Fill in all necessary blanks and delete all highlighted areas when complete. Add any sections necessary for your laboratory. This will be appended to your Laboratory Chemical Hygiene Plan.]*

**Title:**  **Click here to enter the title of your SOP.**

**Approval Holder (AH):** Click here to enter text **Approval #:** Click here to enter text

**Approval Holder Phone Number(s):** Click here to enter text

**Approval Safety Coordinator (ASC):** Click here to enter text

**Approval Safety Coordinator Phone Number(s):** Click here to enter text

**Department:** Click here to enter text

1. **Purpose**

This standard operating procedure (SOP) is intended to provide guidance on how to safely use, store, and work with hydrofluoric acid (HF) in Enter AH’s name’s laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before Describe the procedure or process this SOP will address. If you have questions concerning the requirements within this SOP, contact your Approval Holder (AH) or Approval Safety Coordinator (ASC).

1. **Scope**

*[Describe when this SOP applies and to whom this SOP applies.]*

1. **Hazard Description**

*[Describe the hazards presented by the procedure or process this SOP addresses. What makes it hazardous? Provide an example, if applicable.]*



Hydrofluoric acid (HF) is an extremely corrosive liquid and vapor with a pungent, irritating odor. HF solutions are extremely hazardous and can cause serious health effects by any route of exposure. Unlike other mineral acids, they pose health hazards in addition to acid burns. The HF molecule readily penetrates the skin undissociated and can cause deep tissue damage, including destruction of the bone. Systemic effects can occur when fluoride ions bind to calcium and magnesium, forming insoluble salts. The depletion of calcium (hypocalcemia) or magnesium (hypomagnesemia) can lead to cardiac arrythemias and death. Exposing only 1% of the body surface area (approximately the palm of your hand) to 50% or stronger solutions to can be fatal. Exposure to dilute solutions (<20%) may not cause immediate pain or visible skin damage, but destruction of deeper tissues can continue and remain unnoticed for over 24 hours. Damage to the fingertips is especially painful and difficult to treat and often requires removal of the nail.

1. **Process & Hazard Controls**

*[Describe the steps needed to set up and complete the procedure or process in safe manner following the* [*hierarchy of controls*](https://www.cdc.gov/niosh/topics/hierarchy/default.html)*. Use as much detail as is necessary to ensure all laboratory workers can complete the procedure or experiment safely.]*

* 1. **Elimination/Substitution**

*[Describe any eliminations of hazardous chemicals or processes; alternatively, any substitutions with less hazardous alternatives that could be used to accomplish the task. Delete this section if you are unable to eliminate or substitute.]*

* Less hazardous acids and etchants, such as pirhana, nitric acid, or even TMAH may be substituted for HF.
  1. **Engineering Controls**

*[Describe any engineering controls (e.g. fume hoods, gas cabinets, local exhausts, blast shields, etc.) that are used to safely accomplish the task.]*

* Fume hood
  + All handling of HF solutions must be done in a properly functioning fume hood compatible with acid use to prevent exposure by inhalation. If possible, carry out all work in secondary containment to minimize the likelihood and consequences of a spill. If HF is being used frequently, a work area with low foot traffic/disturbance should be dedicated to HF work.
  + Before starting work:
    - Post a warning sign on the fume hood: “HF in use in this area,”
    - Remove all incompatible material from the hood,
    - Verify that the fume hood is functioning properly.
  1. **Work Practices**

*[Describe any work practices (e.g. staggering schedules, additional cleaning measures for particulates, etc.) that are used to safely accomplish the task.]*

* Always be sure that you have a spill kit and Calcium gluconate (“Calgonate”) gel near storage and use areas.
* Avoid working with HF when alone in the laboratory or outside of normal working hours; use the “buddy system” and notify others before you start using it.
* To minimize the chance of collisions and spills, only one person should use the HF work area at a time.
* Avoid any exposure to HF gas or HF solutions, even at low concentrations. Solutions above 50% HF can cause significant HF evaporation.
  1. **Personal Protective Equipment**

*[Describe the personal protective equipment needed to adequately protect laboratory workers when performing the process or procedure addressed by this SOP. Ensure to specify any personal protective equipment beyond the minimum (i.e. safety glasses, lab coat, gloves, long pants and closed-toed shoes).]*

* **Gloves** 
  + Thin, disposable gloves commonly used in laboratories **do not** provide adequate protection against HF.
  + A thicker glove rated to provide good protection from HF should be worn.
    - Wearing a thinner disposable glove underneath the thicker glove is recommended.
    - Check the glove manufacturers rating for HF resistance and breakthrough before using any glove.
    - The table below gives ratings for gloves tested for HF.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Manufacturer | Glove | Material | Thickness | Breakthrough time [min] | Rating |
| Best Glove | N-DEX 7005 | Nitrile | 4 mil | 30 | Poor |
| Best Glove | N-DEX 8005 | Nitrile | 8 mil | 45 | Poor |
| Best Glove | Nitri-Solve 727 | Nitrile | 15 mil | 60 | Fair |
| North | LA102G | Nitrile | 11 mil | 60 | Fair |
| Ansell | Chemi-PRO 224 | Neoprene / latex blend | 27 mil | 153 | Good |
| Best Glove | Chloroflex 723 | Neoprene | 24 mil | 180 | Good |
| Best Glove | Best Viton 890 | Viton | 28 mil | 185 | Good |
| Ansell | Canners 392 | Natural rubber latex | 19 mil | 190 | Good |
| Best Glove | SOL-VEX 37-165 | Nitrile | 22 mil | 334 | Good |
| North | PNLB1815 | Natural Rubber | 18 mil | 420 | Good |
| Ansell | Neoprene 29-865 | Neoprene | 18 mil | >480 | Good |
| Best Glove | Best Butyl 878 | Butyl | 25 mil | >480 | Good |
| Ansell | Barrier 2-100 | Laminated LCP- Film | 2.5 mil | >480 | Good |
| North | SSG Silver Shield | Silver | 2.7 mil | >480 | Good |

(Source: [North Glove Resistance Guide](https://rgw.arizona.edu/sites/researchgateway/files/north_nitrile.pdf))

* + Many gloves (especially thinner gloves that offer excellent dexterity) provide only short-term protection and must be changed frequently and immediately after exposure. Always check the gloves for holes or other signs of degradation before beginning work and periodically while working.
* **Eye & Face Protection**
  + Splash goggles as eye protection are a minimum. A face shield must be available and should be worn in conjunction with splash goggles whenever there is no physical barrier preventing splashes to the face, e.g., when the sash of the hood is raised.
* **Body & Foot Protection**
  + An apron resistant to acids worn over a lab coat or an acid resistant smock with long sleeves is required to prevent skin contact.
  + Appropriate street attire such as long pants and closed toe shoes are mandatory at all times in a laboratory.
  + Acid resistant shoe covers are optional and may be required when handling large quantities of concentrated solution
  1. **Transportation and Storage**

*[Describe how to safely transport and/or store (e.g. ventilated cabinet, flammable cabinet, under inert blanket, etc.) the hazardous chemical(s) or processes.]*

**Storage**

* Store HF solutions and all HF waste in polyethylene or fluorocarbon plastic containers. NEVER store HF solutions in glass or metal containers.
* Store HF solutions in a cool, dry, and well-ventilated place away from incompatible materials. Use secondary containment. An acid neutralizer such as calcium carbonate can be added to the secondary containment to absorb spilled product.
* Designate a storage area for HF and label it clearly with “Hydrofluoric Acid, extremely corrosive and toxic” (not just “HF”) on the outside of the cabinet.
* HF is *incompatible* with
  + Glass
  + metals
  + strong bases
  + alkalis
  + silica
  + cyanides
  + carbonates
  + reducers
  + ceramics

1. **Spills, Cleanup & Disposal**

*[Describe how to safely end the procedure or process, clean up the process or spills, and/or dispose of any waste generated.]*

**Spills**

Spill response should always follow the [University Chemical Hygiene Plan](https://rgw.arizona.edu/sites/default/files/cs-univeristy_chemical_hygiene_plan.pdf) Section 8.2. Please find general guidance below:

Calcium carbonate is recommended to absorb spills. [New Pig has a pre-made HF spill kit](https://www.newpig.com/pig-hydrofluoric-acid-neutralizing-spill-kit-in-bucket/p/KIT601) that can be purchased or should be replicated to appropriately respond to spills of HF.

* Calcium will form an insoluble salt with fluoride and prevent fluoride absorption through the skin.
* Do not use sand, as HF reacts with it forming toxic tetrafluorosilane.
* Spill kits must contain:
* A plastic container with lid or heavy-duty plastic bag to collect any contaminated material,
* Gloves resistant to HF,
* Dustpan and broom.
* Commercial spill kits are also available; must be rated for HF use, not just acid use.
* Spills inside the fume hood should be neutralized immediately and the area cleaned up thoroughly after neutralization. Never clean an HF spill without informing someone.
* In the case of a spill outside the fume hood, that cannot be neutralized safely, evacuate the area immediately and alert others. If possible, close the door to prevent vapors from spreading to other spaces and call 911 immediately.
* In the case of splashes on clothes, gloves, or shoes with no contact to skin, remove the item carefully, avoiding contact to skin. Put the items into a heavy-duty plastic bag, seal and label the bag. Wash the affected skin area with soap and water even if no skin contact is evident.

**Cleanup and Disposal**

Once work with HF has concluded:

1. Wash reusable gloves with soap and water and remove.
2. Leave disposable gloves on while removing the remaining PPE in the following order: face shield, splash goggles, apron or smock.
3. Remove disposable gloves and wash hands with soap and water.
4. Disposable equipment that is contaminated, and reusable equipment that is contaminated and cannot be safely decontaminated, should be discarded.
5. **Exposures**

**Immediate first aid is critical to avoid or minimize further injury**. **If you are exposed to HF, have someone call 911 immediately.**

* **Any exposure to HF or HF solution should receive first aid treatment and medical evaluation even if no pain is felt.**
* Delayed onset of deep tissue damage, bone damage, or systemic effects can occur up to 24 hours after exposure.

**Exposure Response**

|  |  |  |  |
| --- | --- | --- | --- |
| **Inhalation** | **Ingestion** | **Skin Contact** | **Eye Contact** |
| Remove to fresh air and keep at rest in a position comfortable for breathing. | Drink water or milk.  Do NOT induce vomiting or activated charcoal. | Rinse off affected skin immediately with copious amounts of water for 5 minutes; if necessary, use the safety shower.  Remove contaminated clothes under running water.  Apply calcium gluconate gel to the affected area while wearing a disposable glove.  Repeat the application every 15 minutes until medical assistance arrives. | Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Roll the eyeballs.  If sterile 1% calcium gluconate eye wash solution is available, use the eye wash for a first thorough rinse and then use the solution to repeatedly irrigate the eye. |

1. **Enter Additional Section Title**

*[Add as many sections as necessary to adequately describe how to safely perform the procedure or process addressed by this SOP.]*

1. **References**

* Centers for Disease Control and Prevention (CDC):  
  <https://www.cdc.gov/niosh/npg/npgd0334.html>
* American Chemistry Council HF Emergency Preparedness Guide:  
  <https://www.americanchemistry.com/ProductsTechnology/Hydrogen-Fluoride-2/Emergency-Response-Guidelines-for-AHF.pdf>
* Agency for Toxic Substances and Disease Registry (ATSDR) Medical Management Guidelines:  
  <http://www.atsdr.cdc.gov/mhmi/mmg11.pdf>
* First aid for a unique acid, HF: A sequel, Chemical Health & Safety, January/February 2000:  
  <http://depts.washington.edu/cosmolab/chem/hfsafety.pdf>
* Harvard University: <https://chemistry.harvard.edu/files/chemistry/files/safe_use_of_hf_0.pdf>
* Columbia University, New York City: <http://ehs.columbia.edu/hfPolicy.html>
* Stanford University and National Accelerator Laboratory: <https://www-group.slac.stanford.edu/esh/eshmanual/references/chemsafetyGuideHydrofluoricAcid.pdf>
* University of Illinois Division of Research Safety: <https://drs.illinois.edu/Page/SafetyLibrary/HydrofluoricAcid>