Hydrofluoric Acid (HF) and HF Producing Chemicals

STANDARD OPERTING PROCEDURE (SOP)

Type of SOP: ☐ Process/Equipment ☒ **Hazardous Chemical/s** ☐ Hazardous Class

➢ HAZARD CHEMICAL OVERVIEW

Hydrofluoric acid (HF) is a solution of hydrogen fluoride gas dissolved in water. This mineral acid is highly toxic because of the fluoride ion which can penetrate tissue more rapidly than other mineral acids and cause severe damage to deep tissues, including bones. Exposures to HF may occur through skin, eyes, when inhaled, or ingested. Symptoms of HF exposure may not be immediate so exposure can go unnoticed, delaying treatment. Even minimal exposure can lead to severe medical consequences including death.

In addition to HF, some chemicals containing fluoride anion may react with acid or water to produce HF. Review the Safety Data Sheet (SDS) for compounds containing fluoride anion and ensure the safety precautions are followed to reduce the risk of generating HF. **If you are using conditions that create HF, such as allowing the chemical to react with acid or water, this SOP must be followed.** Some common hydrofluoric acid producing chemicals found in laboratories are shown in Table 1.

Table 1: Common hydrofluoric acid producing chemicals		
Boron trifluoride diethyl etherate	Tetrabutylammonium fluoride	Silver tetrafluoroborate
Tetrafluoroboric acid	Sodium fluoride	Silver hexafluorophosphate
Hexfluorophosphoric acid	Potassium fluoride	Silver hexafluoroantimonate
Phenylmethylsulfonyl fluoride	Ammonium fluoride	Tin fluoride
Tetraethylammonium fluoride	Cesium fluoride	Xenon difluoride
Pyridinium fluoride	Potassium bifluoride	Ammonium bifluoride

REQUIREMENTS

Based on the toxicity and risks associated with the use of hydrofluoric acid the standard operating procedure outlined here are required by all lab research personnel when working with HF.

➢ ENGINEERING/VENTILATION CONTROLS

- All work with HF must be conducted in a fume hood.
- Ensure that safety showers and eye wash stations are within 55 feet of the fume hood work area.

➢ ADMINISTRATION CONTROL/SAFE WORK PRACTICES

- Anyone who works with HF is required to review this SOP and manufacturer's **safety data sheets** (SDS) for HF prior to beginning work.
- Do not work alone when working with HF.
- Prior to beginning work with HF, complete the **laboratory risk assessment tool.** By analyzing each step of the process prior to performing the experiment, this tool will help reduce risk of injuries and incidents.

- Before starting work with HF, be aware of all emergency procedures and first aid treatment (see spill and exposure section). **See Hydrofluoric acid (HF) Emergency Procedures.**
- A 2.5% calcium gluconate gel tube **must** be within reach of the user where HF work is being performed. In the event of user exposure, the responder should wear double 4 mil gloves when administering first aid to prevent secondary contamination.
- As an acute toxicant, limit the amount of HF handled and use the smallest quantity possible.
- Work with HF shall be conducted in a designated fume hood. If a reaction is left unattended, a warning sign must be posted in the fume hood with the sash fully lowered. See **Reaction in Progress.**
- Use HF in polyethylene or Teflon containers. All reactions involving HF must be carried out in plastic containers and transfers should be performed using disposable Pasteur plastic pipettes or a PTFE cannula.
- When diluting, slowly add acid to water.
- Wash hands thoroughly after handling HF.

➢ **PERSONAL PROTECTIVE EQUIPMENT (PPE)**

- **Body Protection** Long pants (or the equivalent) and closed-toe shoes required. Wear a properly fitted lab coat; add an acid-resistant apron (e.g., Neoprene or vinyl) when handling HF.
- **Eye Protection** ANSI approved Z87.1 tightly sealed safety goggles and face protection shield required.
- **Gloves** Double-gloving required when handling HF. Wear medium- or heavy-weight Viton or utility-style neoprene/nitrile outer gloves (recommended thickness ≥ 22 mil) over disposable 4 mil nitrile inner gloves. Verify glove compatibility using the manufacturer's chemical resistance chart. See Table 2 for HF glove performance data.

Table 2: Gloves tested by manufacturers for hydrofluoric acid solutions 48%

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

Glove Rating (see table)
Poor: Provides protection against splashes only. Change frequently, and immediately after exposure.
Fair: Provides short time protection only. Change quickly after exposure.
Good: Good skin protection. Change after exposure to avoid contamination and secondary transfer.
Source: URL: *https://drs.illinois.edu/Page/SafetyLibrary/hydrofluoricacid*

- **STORAGE/HANDLING**

- Do not use glass, metal or other incompatible containers for storage. HF dissolves glass and reacts with metals and must therefore be stored in its original plastic container. In addition, HF must be stored in corrosion resistant secondary containment, such as Nalgene, polypropylene, or polyethylene containment.
- Segregate HF from oxides, organic chemicals, bases, metals, cyanides, and sulfides.
- Do not store above eye level.
- Keep containers tightly closed when not in use.
- Storage areas must be clearly marked and labeled with appropriate hazard warning (e.g., "Corrosive, Acute Toxicity").
- Consult the SDS for chemical specific storage recommendations.

- **SPILL/ACCIDENT EXPOSURE***

Spill Procedure Do not attempt to clean-up a spill if you are unsure of your ability to do so.

Any quantity of HF **spilled outside of a fume hood is considered an emergency**. Follow the emergency spill guidance outlined in Caltech's Chemical Hygiene Plan which is also posted here for quick reference.

- Alert others around you
- Evacuate to fresh air immediately (If possible, close the door behind you to prevent vapors from spreading to other spaces)
- Call X-5000 and notify supervisor
- Consult the SDS
- Seek medical attention

*** ALL HF exposures are considered an emergency and require medical attention. The "Hydrofluoric acid (HF) Emergency Procedure" must be posted where HF is used or stored. Follow the instructions provided on that procedure.**

- **WASTE DISPOSAL AND DECONTAMINATION**

- Any concentration of HF liquid waste must be collected in chemically compatible containers (e.g., polyethylene) and disposed of as hazardous waste and labeled with a Caltech Hazardous Waste Tag. HF waste must be stored in secondary containment.
- HF is an acutely toxic compound and all items contaminated with HF (e.g., stock bottles, pipette tips, disposable gloves) must be collected in a sealable container (e.g. zip lock bags, plastic bottles) and disposed of as hazardous waste.
- Please refer to the Hazardous Waste Management Guide for additional details on Caltech's Hazardous Waste Program and consult the SDS for chemical specific disposal recommendations.
- While wearing proper PPE, decontaminate bench, fume hoods, and equipment with a 10 % sodium carbonate solution. It is recommended that labs handling HF have a clean-up kit specific to HF for decontamination processes. Dispose of all clean-up materials as hazardous waste.