



Standard Operating Procedure

HYDROFLUORIC ACID

Hydrofluoric acid (HF) is one of the strongest and most corrosive acids known. Concentrated hydrofluoric acid is used in the fabrication of electronic components, to etch glass and in the manufacture of semiconductors. It is also used by geologists to dissolve sedimentary rock. Dilute hydrofluoric acid solutions are used in some biological staining procedures. Hydrofluoric acid solutions are clear and colorless with a density similar to that of water.

Potential Hazards

Concentrated HF (>50%) exposure to a small part of the body can cause severe burns, excruciating pain, and death. At lower concentrations, symptoms may be slower to appear and subsequent treatment may be delayed. With direct contact to 20-50% solutions of HF, burns and pain can be delayed for up to eight hours, and at concentrations <20%, pain and redness may not occur for up to 24 hours. HF could eventually cause burns and even death at concentrations as low as 2% if not effectively washed off. Hydrogen fluoride causes such severe burns because as it penetrates the cells it is quickly dissociated into fluoride ions. The fluoride ions then bind with the calcium in the body to form insoluble calcium fluoride, destroying tissues and inactivating calcium that is needed for vital body functions. The heart function becomes diminished, the heartbeat abnormal, and cardiac arrhythmia, as well as liver and kidney damage, may occur. **Hydrofluoric Acid must not be handled while working alone.**

Many chemicals containing fluorine may react with acid or water to produce HF. Review the SDS of all fluoride compounds and ensure the appropriate safety precautions are followed to reduce the risk of creating a HF hazard.

Common hydrofluoric acid (HF) generating chemicals:

Boron trifluoride diethyl etherate	Tetrabutylammonium fluoride	Silver tetrafluoroborate
Tetrafluoroboric acid	Sodium fluoride	Silver hexafluorophosphate
Hexafluorophosphoric acid	Potassium fluoride	Silver hexafluoroantimonate
Phenylmethylsulfonyl fluoride	Ammonium fluoride	Stannous fluoride or Tin Fluoride
Tetraethylammonium fluoride	Cesium Fluoride	Xenon difluoride or Xenon tetrafluoride
Pyridinium fluoride	Potassium bifluoride	Ammonium bifluoride

Personal Protective Equipment (PPE)

The University's Personal Protective Equipment Policy can be found on the EHS website: ehs.yale.edu

Eye Protection

Safety goggles and a face shield must be worn.

Hand Protection

A utility style nitrile glove, worn over an exam-style nitrile glove, must be worn when handling HF. When handling HF in concentrations $\geq 30\%$, a utility style neoprene glove must be worn over an exam-style nitrile glove.

Skin and Body Protection

A rubber apron must be worn over a lab coat. Long pants or clothing that covers the body to the ankles and closed-toe solid top shoes must be worn as well.

Engineering Controls

All work with HF must be done in a designated area inside a fume hood.

Handling/Storage

- Keep all containers of HF in secondary containment at all times.
- Do not heat hydrofluoric acid.
- Do not use glass, ceramic, or other incompatible containers for HF.

Emergency Procedures

- Calcium gluconate gel must be immediately available in the laboratory where HF is used or stored. Extra tubes are available from Environmental Health and Safety.
- The "Hydrofluoric Acid Exposure Emergency Response" procedure must be posted where the HF is used/stored.

Eyewash/Safety Showers

An ANSI approved eyewash station that can provide quick drenching or flushing of the eyes must be immediately available in the laboratory where HF is used. An ANSI approved safety drench shower must also be available within 10 seconds travel time as well. Ensure the locations of the eyewashes and safety showers, and how to activate them, are known prior to an emergency.

First Aid Procedures

Skin Exposure:

Immediately washing off the acid is a priority!

1. Immediately remove all clothing and wash affected areas with water using a drench hose or emergency shower. Ensure that jewelry which could trap HF is also removed.
2. While the victim is being rinsed with water, someone should call 911 and inform them that a person has been exposed to hydrofluoric acid.

3. Rinsing may be limited to 5 minutes if Calgonate® Gel (2.5% calcium gluconate) is available. If 2.5% calcium gluconate gel is not available, continue flushing with water for at least 15 minutes or until medical treatment is given.
4. Apply calcium gluconate gel freely and massage it into the affected site. Apply the gel as soon as the washing is done. Affected area does not need to be dried prior to application.
5. Calgonate® Gel should be reapplied continually every 10-15 minutes and massaged into the skin until medical treatment is given by a physician or EMS.
6. Take note of and provide the following information to the EMS team, and/or physician:
 - a. The concentration of the HF and its SDS.
 - b. Date and time of exposure, duration of exposure, and how it occurred.
 - c. The time when calcium gluconate gel was first applied to the contaminated area, and how many times it was applied in total.
 - d. Body parts exposed, and the percent of body surface area affected.
 - e. Summary of first aid measures given.

Vapor exposures can cause skin and mucous membrane burns, as well as damage to pulmonary tissue. Treat vapor burns the same way as liquid HF burns.

Eye Exposure:

Because HF penetrates deep into tissue, exposure of hydrofluoric acid solution or vapor to the eye can produce more extensive damage than other acids in similar concentrations. Immediate action is critical.

1. Immediately flush eyes for at least 15 minutes with cool flowing water. Hold the eyelids open and away from the eye during irrigation to allow thorough flushing of the eyes.
2. While the victim's eyes are being rinsed with water, someone should call 911 and inform them that a person has had an eye exposure to hydrofluoric acid.
3. Continue to rinse in eyewash until EMS arrives.

Inhalation Exposure:

Immediately move the victim to fresh air and get medical attention.

1. Contact 911 and inform dispatcher that exposure involves HF.
2. Keep victim warm, quiet, and comfortable while waiting for EMS to arrive.
3. Always seek medical attention because inhalation of HF may cause swelling in the respiratory tract up to 24 hours after exposure.

Spills

Small Spill

If a small spill occurs inside a fume hood, lab personnel should be able to safely clean it up by following these spill clean up procedures:

- Alert people in immediate area of spill
- Wear personal protective equipment

- Use hydrofluoric acid spill neutralizer to clean/neutralize spilled solution
- Collect residue, place in container, label and dispose of as hazardous waste

Larger Spill or Spill Outside a Fume Hood

- Call EHS for emergency assistance (203-785-3555)
- Evacuate the spill area
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering
- Stay nearby until emergency personnel arrive and provide them with information on the chemicals involved

Waste Disposal/Decontamination

Hydrofluoric acid solutions/stock materials must be collected as hazardous waste and should never be disposed of down the drain. HF is an acutely toxic (P-Listed) compound and all items contaminated with acutely toxic compounds must be collected as hazardous waste (i.e., stock bottles, pipette tips, kimwipes, etc.).

Once the work with HF is complete, decontaminate the area and any reusable items with a 10% sodium carbonate (Na_2CO_3 , also known as soda ash) solution.