

# *Chemical Safety Training*

## **Hydrofluoric Acid**

**ALL HYDROFLUORIC ACID EXPOSURES  
SHOULD BE CONSIDERED A MEDICAL EMERGENCY.**

Hydrogen Fluoride (HF) is a corrosive, liquid or gas with a pungent, irritating odor that is extremely hazardous at any concentration. Both liquid and vapor can cause severe burns and complete heart failure. Specialized medical treatment is required for exposures to even very dilute HF. The most common concentrations of HF:

- **49% Hydrofluoric acid** (Aqueous HF): a non-fuming strength, but hazardous, corrosive acid (pH 3.4)
- **70% Hydrofluoric acid:** a highly hazardous, fuming, corrosive acid.
- **Anhydrous Hydrogen Fluoride (AHF):** a clear, colorless, corrosive fuming liquid with an extremely acrid odor that forms dense white vapor clouds when released.

Anhydrous HF is one of the strongest acids known. It reacts with most organic and inorganic substances. It forms fluorides with metals and hydrofluoric acid with water.

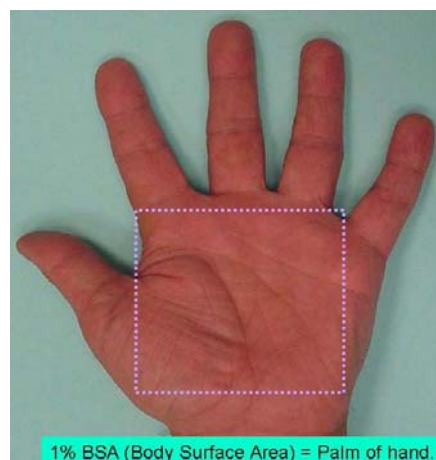
### **Fatal Exposures**

The most serious consequences of exposure to HF are hypocalcemia and hypomagnesemia, the lowering of serum calcium and magnesium, respectively, which can result in complete heart failure. HF binds with calcium whenever contact occurs with skin or other body tissues. Although flushing is effective in removing surface acid, it doesn't affect the fluoride ions that may have already penetrated. Binding of calcium can bring about cell death in a short time since it is necessary for cell life. If exposure occurs over a large area of skin surface, a great amount of calcium may be

#### **Examples of fatal exposures:**

- 7 ml anhydrous HF, untreated, can eventually bind all the free calcium in an adult male
- burns over 25 in<sup>2</sup> (161 cm<sup>2</sup>) can result in fatal hypocalcemia
- concentrated (50% or stronger) HF acid to 1% or more **Body Surface Area (BSA)**
- any concentration HF acid to 5% or more BSA
- inhalation of HF acid fumes from a 60% or stronger solution.

inactivated, so that inadequate amounts of Ca<sub>2</sub><sup>+</sup> are available for body functions. Nerve endings are irritated by increased levels of potassium entering the extracellular spaces to compensate for the reduced levels of calcium. Cell destruction and bone demineralization may progress for several days.



**WORKING WITH HF IS PERMITTED ONLY WHEN THE ANTIDOTE, CALCIUM  
GLUCONATE GEL, IS ON HAND.**

## Symptoms of Exposure

### *Acute Exposure*

Short term exposure in low concentrations will cause irritation of the eyes, nose, upper and lower respiratory tract. This results in tearing, sore throat, cough, chest tightness, and wheezing. **Inhalation** of higher concentrations (>10-15 ppm) can result in serious damage to the lungs, and fatal pulmonary edema after a delay of several hours. Even a brief exposure (5 min) to 50 to 250 ppm may be fatal. **Ingestion** of high doses of fluorides will cause convulsions and cardiac arrhythmias. Severe burning and/or perforation of the digestive system may lead to death. **Skin contact** will cause irritation and severe skin and deep tissue burns. The burns may appear hours after contact, even when no pain is felt at the time of contact. A solution of 50% concentration will cause immediately excruciatingly painful, deep-seated burns and tissue destruction that are slow to heal. Weaker solutions (25-50%) may take a few minutes to be noticed, while dilute solutions (<20%) do not usually become apparent until several hours after exposure. Vapors can dissolve in the moisture on the surface of the eyes and cause irritation. Splashing into the eyes may cause severe and irreversible damage with possible corneal scarring.

**CONTACT LENSES MAY NOT BE WORN WHEN WORKING WITH HF.**

### *Chronic Exposure*

Chronic health effects can occur at a delayed time after exposure and can last for months or years.

**Ingestion** of fluoride through drinking, including drinking water, may cause dental fluorosis or mottling (staining or pitting of teeth). At low levels, fluoride provides the benefits of dental cavity prevention and treatment of osteoporosis. At higher intakes, skeletal fluorosis (i.e., an accumulation of fluoride in the skeletal tissues associated with pathological bone formation) has been noted. At high concentrations, adverse pulmonary effects, kidney damage, thyroid injury, anemia, hypersensitivity, and dermatological reactions may occur.

**Inhalation** of hydrogen fluoride may cause irritation and congestion of the nose, throat, and bronchi at low levels, increased bone density among workers, and damage to liver, kidneys, and lungs. Repeated inhalation may cause bronchitis with cough, phlegm, and/or shortness of breath.

### *Reproductive/Developmental Effects:*

Fluoride may cross the placenta when the mother receives high levels during pregnancy, causing dental fluorosis in the child's teeth. In some animal studies, oral exposure to fluoride has caused impaired reproduction and malformation of fetal bones and teeth. Inhalation of hydrogen fluoride has resulted in degenerative testicular changes in male dogs. Menstrual irregularities have been observed in women occupationally exposed to fluoride.

## Protection from HF Exposure

The best way to reduce HF exposure is to substitute a less toxic chemical. However, if working with HF is the only alternative, take the following steps to protect yourself:

- When appropriate, pump from closed stock or reagent bottles.
- Wear lab coat over long pants and closed toe shoes.
- Protect eyes and face with goggles and face shield.
- Work in a properly functioning fume hood, at least 6" from the edge, with sash drawn to colored dot designating optimum performance.



- Wear an acid resistant apron when pouring from stock bottles or cleaning up a spill.
- Double glove: wear at least **two pairs** of 3.5mm nitrile rubber gloves when working with small quantities. Replace them when they are contaminated with HF. When working with larger quantities or immersing hands in HF, wear outer gloves with a higher breakthrough time. Selection should be based on potential exposure.

Refer to this link <http://www.chemrest.com/hydrofluoricacid%20ranking.htm> or the resistance chart below for glove and chemical protective clothing permeation times for 30% to 70% HF. Breakthrough is expressed in hours of exposure before HF permeates the inside of the glove:

Material	Breakthrough	Material	Breakthrough
Barricade	>8	Natural Rubber	Caution 1 to 4
Chemrel	>8	Neoprene	Caution 1 to 4
Saranex	>8	Polyethylene	Caution 1 to 4
Responder	>8	4H (PE/EVAL)	Caution 1 to 4
Butyl Rubber	>4	Nitrile Rubber	<1(*)
Polyvinyl Alcohol	<1(*)		
Polyvinyl Chloride	<1(*)		

(\*) **Caution**, use for short periods only.

- Wash immediately after exposure to HF and at the end of the procedure involving HF.
- Post warning signs in the work area:
  - On Lab Hazard ID Card: "Extremely Toxic & Corrosive"
  - On Fume Hood: "Hydrofluoric Acid. Danger - High, Acute Toxin"

## Medical Surveillance

Before beginning work with HF, consult with UIC Health Service (6-7420) to discuss the need for medical surveillance and exposure testing.

## Handling & Storage Precautions

- Before beginning work, confirm the location and adequate stock levels of the HF antidote (calcium gluconate gel) and spill cleanup materials.
- At concentrations of 70% or less, HF may be stored in plastic (polyethylene or PVC).
- Store HF separately from metals, concrete, glass, strong bases, sodium hydroxide, potassium hydroxide and ceramics.
- Carbon steel cylinders or lecture bottles of AHF should not be stored for more than five years.



Small HF burn from grease which had absorbed a little HF. Immediate washing with water and application of calcium gluconate gel resulted in full recovery. Photo taken a couple days after exposure.

## First Aid

When you suspect exposure to HF, follow these procedures, even if symptoms do not appear **immediately**. Then, follow up with a visit to UIC Hospital Emergency Room. Bring with you the MSDS and Supervisor's First Report Form

<http://www.legal.uillinois.edu/wc/AccidentReportNew92001uicRevised.pdf> .

- **Inhalation:** Remove person from exposure. Begin rescue breathing if breathing has stopped and CPR if heart action has stopped (if you are trained).
- **Eye Contact:** Immediately flush for at least 30 minutes, occasionally lifting upper and lower lids, rolling around the eye balls.
- **Skin Contact:** Immediately flush for 20 minutes while removing clothing. Massage HF Antidote (calcium gluconate gel) onto and around the affected skin enroute to the hospital.
  - When HF Antidote is unavailable, immerse in **iced 70% Ethanol** to retard absorption.
  - **CAUTION:** Initial exposure may not look like a typical acid burn. Skin may only appear red without feeling pain. Damage may progress over several hours or days, developing into deep, painful wounds if not treated properly. In the worst cases, splashing a significant amount of HF acid can lead to death from fluoride affecting lungs or heart.



Victim reported exposure to approx. 5% HF 48 hours after splash. The hand was treated with a 2.5 % calcium gluconate bath for 1 hour. The patient was sent home with a 2.5 % calcium gluconate gel for further self treatment.

## Spill Clean-up

Notify EHSO at 6-SAFE (6-7233) and follow UIC Spill Procedure <http://www.uic.edu/depts/envh/HSS/ChemSpill.html> . If the spill is large or in an area where there is not adequate ventilation, evacuate the room and await EHSO arrival.

### Recommended HF Spill Kit

- Calcium carbonate or magnesium sulfate (dry) to cover spill
- 3M's Universal Sorbent spill control pads or other absorbent materials that are not reactive with HF.
- Excess sodium bicarbonate or magnesium oxide to be added to absorbent before placing in plastic waste container for disposal.
- Polyethylene container for spill waste
- Sodium bicarbonate solution to decontaminate spill area because it does not react with HF.

## Waste Disposal

Used HF and HF-containing solutions should be collected in a polyethylene container, separate from other types of waste. **Do not mix with solvents, organic acids, oxidizers, or other chemical waste.** The container must be labeled as "Hazardous Waste" with the chemical names and approximate concentrations of the waste. Store the container separate from incompatible materials in a secondary container. Spill clean-up waste should also be collected for disposal as hazardous waste. A Chemical Waste Removal Form should be submitted to EHSO, as per the guidelines at <http://www.uic.edu/depts/envh/HSS/ChemWaste.html>.

## References

- US EPA Fact Sheets <http://www.epa.gov/ttn/atw/hlthef/hydrogen.html>
- OSHA Fact Sheets, <http://www.osha.gov>
- A table of typical alkaline materials (bases) for neutralization of HF can be found at <http://www.honeywell.com/sites/docs/DHCRH33C19WP565JF0MYBKPIR2ERWE8970803114443438.pdf>
- Bronstein, A. and Currence, P. Emergency Care for Hazardous Materials Exposure, 3<sup>rd</sup> Edition, Guideline No. 16 "Hydrofluoric Acid (HF) and Related Compounds" **Copies are available in UIC Hospital Emergency Department and EHSO Offices.**
- 2004 Emergency Response Guidebook: Guide No. 157 **Copies are kept by the City of Chicago Fire Department and EHSO.**

**EHSO Contact for Further Information:** Ausrine Karaitis, 3-3702, [ausrine@uic.edu](mailto:ausrine@uic.edu)

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