Standard Operating Procedure
For

HYDROFLUORIC ACID

H - F

PURPOSE:
Hydrofluoric acid is extremely corrosive and highly toxic by inhalation, ingestion, and skin absorption. It differs from other acids because it readily penetrates the skin and dissociates into fluoride ions, causing destruction of deep tissue layers, including bone. Hydrofluoric acid vapors are also an inhalation hazard and can cause ocular irritation. This document establishes procedures for the safe handling and use of hydrofluoric acid (CAS# 7664-39-3), also known as HF.

HEALTH EFFECTS:
Hydrofluoric acid is a clear, colorless, corrosive fuming liquid with an extremely acrid odor and forms dense white vapor clouds if released. Both liquid and vapor can cause severe burns to all parts of the body. Specialized medical treatment is required for all exposures.

Skin exposure: Liquid and vapor can cause severe burns which may not be painful or visible. The skin will be penetrated and the deeper tissues will be attacked. Large burns may deplete the body of calcium or induce other toxic effects which may be fatal.

Eye exposure: Liquid and vapor can cause irritation or corneal burns.

Inhalation exposure:
   Mild: Nose, throat, and respiratory irritation. Onset may be delayed for several hours.
   Severe: Nose/throat burns, lung inflammation and pulmonary edema. Other toxic effects such as hypocalcemia may result in death without proper treatment.

Ingestion: Severe mouth, throat and stomach burns and may be fatal if swallowed. Hypocalcemia and systematic toxicity is likely without prompt medical treatment.

Delayed effects: Contact with dilute HF solutions or vapors may be delayed. 0%-20% solutions may be delayed up to 24 hours, 20%-50% from 1-8 hours, and solutions >50% will be immediately apparent. Delayed symptoms may include pain, redness of skin and possible tissue destruction. HF can also cause bone and joint damage.
REGULATORY LIMITS: The Federal Occupational Safety and Health Administration (OSHA) have set a Permissible Exposure Limit (PEL) for hydrofluoric acid of 3 ppm as an 8 hour Time Weighted Average (TWA). The National Institute of Occupational Safety and Health (NIOSH) have established a ceiling limit value of 6 ppm over 15 minutes, and an Immediately Dangerous to Life or Health (IDLH) concentration of 30 ppm over 30 minutes.

REQUIREMENTS:
Based on the risk associated with the use of hydrofluoric acid the safety procedures outlined below are required by all research staff when working with HF.

Administrative Controls:
- Anyone who handles hydrofluoric acid is required to review this SOP and the attached Safety Data Sheet (SDS) prior to work. Do not work with HF alone.
- The antidote must be on hand prior to work being done.
- Storage areas must be separated and clearly marked.

Engineering Controls:
- Hydrofluoric acid must be used in a properly functioning laboratory hood and in an area equipped with an eyewash and safety shower. The sash opening should be minimized to prevent splashes.

Personal Protective Equipment (PPE):
- Goggles
- Face shield (plastic)
- Acid resistant apron
- Long pants and sleeves
- Closed toe shoes
- Gloves: Thin disposable gloves (such as 4, 6, or 8 mil blue nitrile gloves) used in laboratory operations provide a contact barrier only and should be disposed immediately when contamination is suspected. Thicker (10-20 mil) PVC or neoprene gloves provide better resistance but do not provide the necessary dexterity for many lab procedures. Thinner PVC or poly gloves can provide some resistance to HF, but require immediate changing at the first sign of contamination. Do not wear disposable gloves without double gloving because of the potential for exposure through pinholes.

Waste Disposal:
- Hydrofluoric acid waste will be disposed of as a hazardous material through EHS (https://itsapps.unc.edu/HazMat_Pickup/)

Accidents or Injuries:
• In the event of an exposure have someone call 911 immediately. Remove all exposed clothing and wash all exposed areas with copious amounts of water.
  o *Eye exposure:* Rinse eyes for at least 15 minutes
  o *Skin exposure:* Skin should be flushed for 5 minutes followed by treatment with a calcium source. Calcium gluconate is preferred, but calcium carbonate may be used. DO NOT USE CALCIUM CHLORIDE – this may cause further injury.
  o *Inhalation:* Move person into fresh air. Provide artificial respiration if they are not breathing.
  o *Ingestion:* Do NOT induce vomiting. Rinse mouth with water.
• Spill procedures:
  o Do not attempt to clean-up if you feel unsure of your ability to do so or if you perceive the risk to be greater than normal laboratory operations.
  o Small spills (<100mL) can be neutralized with dry magnesium sulfate and absorbed with absorbent materials or spill control pads. Sodium bicarbonate or magnesium oxide should be added to any absorbent and placed in a plastic container for disposal. Wash the spill site with sodium bicarbonate solution.
  o Do not use sorbents that contain silicon like vermiculite or sand. This can produce silicon tetrafluoride, which is an odorless toxic gas.
  o If there is a large spill or a spill in a confined area, notify others in the area and evacuate the room immediately. Contact EHS (919-962-5507) during working hours and 911 if after hours.
1. PRODUCT AND COMPANY IDENTIFICATION

Product name: Hydrofluoric acid
Product Number: 695068
Brand: Sigma-Aldrich
Supplier: Sigma-Aldrich Corporation
3050 Spruce Street
SAINT LOUIS MO  63103
USA
Telephone: +1 800-325-5832
Fax: +1 800-325-5052
Emergency Phone #: (314) 776-6555
Preparation Information: Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Target Organ Effect, Toxic by inhalation., Highly toxic by ingestion, Highly toxic by skin absorption, Corrosive

Target Organs
Liver, Kidney

GHS Classification
Acute toxicity, Oral (Category 2)
Acute toxicity, Inhalation (Category 2)
Acute toxicity, Dermal (Category 1)
Skin corrosion (Category 1A)
Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)
H300 + H310  Fatal if swallowed or in contact with skin
H314  Causes severe skin burns and eye damage.
H330  Fatal if inhaled.

Precautionary statement(s)
P260  Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264  Wash hands thoroughly after handling.
P280  Wear protective gloves/ protective clothing/ eye protection/ face protection.
P284  Wear respiratory protection.
P302 + P350  IF ON SKIN: Gently wash with plenty of soap and water.
P305 + P351 + P338  IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310  Immediately call a POISON CENTER or doctor/ physician.
HMIS Classification
Health hazard: 4
Chronic Health Hazard: *
Flammability: 0
Physical hazards: 0

NFPA Rating
Health hazard: 4
Fire: 0
Reactivity Hazard: 0

Potential Health Effects
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 eye burns. Causes severe eye burns.

Ingestion
May be fatal if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula: HF
Molecular Weight: 20.01 g/mol

<table>
<thead>
<tr>
<th>Component</th>
<th>Classification</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrofluoric acid</td>
<td>Acute Tox. 2; Acute Tox. 1; Acute Tox. 2; Skin Corr. 1A; H300, H310, H314, H330</td>
<td>30 - 60 %</td>
</tr>
<tr>
<td>CAS-No.</td>
<td>7664-39-3</td>
<td></td>
</tr>
<tr>
<td>EC-No.</td>
<td>231-634-8</td>
<td></td>
</tr>
<tr>
<td>Index-No.</td>
<td>009-003-00-1</td>
<td></td>
</tr>
</tbody>
</table>

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Hydrofluoric (HF) acid burns require immediate and specialized first aid and medical treatment. Symptoms may be delayed up to 24 hours depending on the concentration of HF. After decontamination with water, further damage can occur due to penetration/absorption of the fluoride ion. Treatment should be directed toward binding the fluoride ion as well as the effects of exposure. Skin exposures can be treated with a 2.5% calcium gluconate gel repeated until burning ceases. More serious skin exposures may require subcutaneous calcium gluconate except for digital areas unless the physician is experienced in this technique, due to the potential for tissue injury from increased pressure. Absorption can readily occur through the subungual areas and should be considered when undergoing decontamination. Prevention of absorption of the fluoride ion in cases of ingestion can be obtained by giving milk, chewable calcium carbonate tablets or Milk of Magnesia to conscious victims. Conditions such as hypocalcemia, hypomagnesemia and cardiac arrhythmias should be monitored for, since they can occur after exposure. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Continue rinsing eyes during transport to hospital.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

**Special protective equipment for firefighters**
Wear self-contained breathing apparatus for fire fighting if necessary.

**Hazardous combustion products**
Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride

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**6. ACCIDENTAL RELEASE MEASURES**

**Personal precautions**
Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

**Environmental precautions**
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

**Methods and materials for containment and cleaning up**
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

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**7. HANDLING AND STORAGE**

**Precautions for safe handling**
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

**Conditions for safe storage**
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

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**8. EXPOSURE CONTROLS/PERSONAL PROTECTION**

**Components with workplace control parameters**

<table>
<thead>
<tr>
<th>Components</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrofluoric acid</td>
<td>7664-39-3</td>
<td>STEL</td>
<td>6 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
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<tr>
<td></td>
<td></td>
<td>TWA</td>
<td>0.5 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
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</tbody>
</table>

Remarks
Fluorosis Upper Respiratory Tract, Lower Respiratory Tract, skin & eye irritation Substances for which there is a Biological Exposure Index or Indices (see BEI® section)

<table>
<thead>
<tr>
<th>Components</th>
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<th>Control parameters</th>
<th>Basis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>2 ppm</td>
<td>USA. ACGIH Threshold Limit Values (TLV)</td>
</tr>
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</table>

Fluorosis Upper Respiratory Tract, Lower Respiratory Tract, skin & eye irritation Substances for which there is a Biological Exposure Index or Indices (see BEI® section)

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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TWA</td>
<td>3 ppm</td>
<td>USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000</td>
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<td></td>
<td>TWA</td>
<td>3 ppm</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z2</td>
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Z37.28-1969

<table>
<thead>
<tr>
<th>Components</th>
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<th>Control parameters</th>
<th>Basis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TWA</td>
<td>2.5 mg/m3</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TWA</td>
<td>2.5 mg/m3</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants</td>
</tr>
</tbody>
</table>

Varies with compound

<table>
<thead>
<tr>
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<th>Control parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TWA</td>
<td>3 ppm</td>
<td>USA. NIOSH Recommended Exposure Limits</td>
</tr>
</tbody>
</table>
Personal protective equipment

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).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

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

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance
- Form: liquid
- Colour: no data available

Safety data
- pH: no data available
- Melting point/freezing point: no data available
- Boiling point: no data available
- Flash point: no data available
- Ignition temperature: no data available
- Autoignition temperature: no data available
- Lower explosion limit: no data available
- Upper explosion limit: no data available
- Vapour pressure: no data available
- Density: no data available
- Water solubility: no data available
- Partition coefficient: n-octanol/water: no data available
- Relative vapour density: no data available
10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
Strong oxidizing agents

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Hydrogen fluoride
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
Eyes: no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available
Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

<table>
<thead>
<tr>
<th>Inhalation</th>
<th>Toxic if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingestion</td>
<td>May be fatal if swallowed.</td>
</tr>
<tr>
<td>Skin</td>
<td>May be fatal if absorbed through skin. Causes skin burns.</td>
</tr>
<tr>
<td>Eyes</td>
<td>Causes eye burns. Causes severe eye burns.</td>
</tr>
</tbody>
</table>

Signs and Symptoms of Exposure
Fluoride ion can reduce serum calcium levels possibly causing fatal hypocalcemia., Material can cause severe burns and blistering which may not be immediately painful or visible. The full extent of tissue damage may not exhibit itself for 12-24 hours after exposure., Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., necrosis of the skin

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity
no data available

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects
no data available

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1790     Class: 8 (6.1)     Packing group: II
Proper shipping name: Hydrofluoric acid
Reportable Quantity (RQ): 208 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1790  Class: 8 (6.1)  Packing group: II  EMS-No: F-A, S-B
Proper shipping name: HYDROFLUORIC ACID
Marine pollutant: No

IATA
UN number: 1790  Class: 8 (6.1)  Packing group: II
Proper shipping name: Hydrofluoric acid

15. REGULATORY INFORMATION

OSHA Hazards
Target Organ Effect, Toxic by inhalation., Highly toxic by ingestion, Highly toxic by skin absorption, Corrosive

SARA 302 Components
The following components are subject to reporting levels established by SARA Title III, Section 302:

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7664-39-3</td>
<td>1993-04-24</td>
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</tbody>
</table>

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

<table>
<thead>
<tr>
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<tr>
<td>7664-39-3</td>
<td>1993-04-24</td>
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</tbody>
</table>

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7664-39-3</td>
<td>1993-04-24</td>
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</tbody>
</table>

Pennsylvania Right To Know Components

<table>
<thead>
<tr>
<th>CAS-No.</th>
<th>Revision Date</th>
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<tbody>
<tr>
<td>7732-18-5</td>
<td>1993-04-24</td>
</tr>
<tr>
<td>7664-39-3</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

New Jersey Right To Know Components

<table>
<thead>
<tr>
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<tr>
<td>7732-18-5</td>
<td>1993-04-24</td>
</tr>
<tr>
<td>7664-39-3</td>
<td>1993-04-24</td>
</tr>
</tbody>
</table>

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Text of H-code(s) and R-phrase(s) mentioned in Section 3

<table>
<thead>
<tr>
<th>Acute Tox.</th>
<th>Acute toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>H300</td>
<td>Fatal if swallowed.</td>
</tr>
<tr>
<td>H310</td>
<td>Fatal in contact with skin.</td>
</tr>
<tr>
<td>H314</td>
<td>Causes severe skin burns and eye damage.</td>
</tr>
<tr>
<td>H330</td>
<td>Fatal if inhaled.</td>
</tr>
</tbody>
</table>

Further information
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