1. Purpose

This standard operating procedure (SOP) establishes procedures for the safe handling, transportation, and storage of hydrofluoric acid (HF), which is also known as hydrogen fluoride, fluoric acid, hydrofluoride, or fluorine monohydride (CAS# 7664-39-3).

2. Scope

This SOP addresses only the use of pure HF and its solutions in the laboratory. It applies to all Kennesaw State University (KSU) employees, students, and contractors. It assumes that all the KSU minimum safety requirements, as detailed in the KSU Chemical Hygiene and Safety Plan and other safety programs have been implemented.

3. Personnel Qualifications and Responsibilities

All faculty, staff and students engaged in the use or handling of HF, or working within a laboratory using HF, are responsible for understanding all hazards associated with its use, and for using appropriate personal protective equipment (PPE).

The principal investigator (PI)/laboratory supervisor is responsible for ensuring that their staff has been trained in the use, storage, and handling of HF, and all associated emergency procedures. Records of this training must be retained by the PI, and a copy must be forwarded to the Environmental Health and Safety (EHS) Department.

HF use is restricted to the specific employees or students who have had prior training in proper use, handling and storage, and emergency procedures.

4. Environmental Health and Safety Department Responsibilities

Provide guidance in assessing hazards, establishing engineering and administrative controls, good work practices and selection of PPE.

5. Health and Safety Hazards of Hydrofluoric Acid

HF is a colorless gas or fuming liquid with strong, irritating odor. It is highly soluble in water and is used in laboratory applications primarily for etching glass. It is also used by geologists to dissolve types of rocks, and in dilute solutions, for biological staining procedures.

HF is not flammable; however, reactions with metals can result in the release of hydrogen gas, which creates a fire and explosion hazard.

HF is corrosive, toxic, and is very easily and quickly absorbed into the skin, which means it can cause not only surface burns to the skin but penetrate deep into tissues.

Tissue and cellular damage can occur through inhalation, skin absorption, and ingestion.

- Inhalation exposure can cause extreme irritation of the respiratory tract and mucous membranes. Symptoms include lacrimation, coughing, labored breathing, and excessive sputum production. Extreme inhalation exposure can cause chemical pneumonitis and pulmonary edema, which could be fatal.
- Skin absorption occurs rapidly and causes both surface burns and deep tissue damage. High concentrations of HF produce damage that is painful and can be felt immediately. More dilute concentrations cause damage, but the pain may be delayed (up to a 24-hour delay).
- Concentrations of 20-50% may not produce signs of injury or symptoms for 1-8 hours. Concentrations less than 20% may not be seen for 24 hours.
- Eye exposure to just the fumes of HF can cause stinging, burning, redness, dryness, and increased secretions from the eyes. Splashing of the chemical in the eyes can cause burns to the tissue which are irreversible and can ultimately result in blindness.
- Ingestion can lead to severe burns to the mouth, esophagus, and stomach.

HF, because of its penetrating ability, has the potential to cause systemic damage, including the bones of the skeletal system.

Burns that are larger than 25 square inches could result in serious systemic toxicity.

Fluorine ions can readily bind to calcium, potassium, and magnesium, which causes this systemic toxicity to occur.

The binding of fluoride ions to potassium and magnesium can cause hyperkalemia (high potassium levels) and hypomagnesemia (low magnesium levels), respectively. The binding of fluoride ions to calcium (a very important nutrient in heart and muscle function), can cause hypocalcemia to occur. These conditions can cause the malfunction of internal organs, including the heart, which can result in arrhythmias, heart failure, and ultimately death.

No employee shall be exposed to HF above the permissible limit for the specified period of time. The OSHA permissible exposure limit (PEL) is 3.0 parts per million (ppm) as an 8-hour time weighted average (TWA). The NIOSH ceiling limit (15 minutes) is 6.0 ppm.

6. Requirement for Working with Hydrofluoric Acid

Hydrofluoric Acid is considered a particularly hazardous substance (PHS) due to its corrosivity, toxicity, and its ability to quickly penetrate deep under the skin where it can cause damage to tissue and major organs. It is also particularly hazardous because of its affinity for calcium, an essential element for heart and muscle function. HF binds to calcium, causing levels to become depleted, which can result in heart failure, and ultimately, death. For more information, consult the safety data sheet (SDS) and other sources such as Prudent Practices in the Laboratory, the ATSDR Fact Sheet and EPA Fact Sheet.

A. Hazard and Risk Assessments

The PI/laboratory supervisor must be aware of and approve the work performed under their jurisdiction and must ensure that an appropriate hazard assessment for the use of HF has been conducted. EHS may be consulted to provide assistance in performing hazard assessments.

Each new operation using HF must be evaluated individually; assessment of the level of risk depends on how the substance will be used.

The assessment should ensure appropriate protective measures have been put into place and that the proper level of work authorization has been obtained, before commencing the operation.

B. Hazard Prevention and Control

The hazards of HF can be mitigated by a variety of means including chemical substitution, engineering controls, administrative controls, personal protective equipment, and work practices. The general control measures are discussed in this section. PIs/LSs must develop control measures specific to the particular operation after conducting the appropriate hazards assessment and develop a separate Standard Operating Procedure (SOP) specific to the operation/project.

1. Chemical substitution

Before HF is selected for use in a particular operation/process, the PI/LS should determine if a safer alternative chemical is available and can be used in lieu of HF.

2. Designated Area

Because of its caustic vapors and the possibility of aerosol formation, HF (and its solutions) must be handled in a chemical fume hood with negative pressure ductwork.

The fume hood should have been inspected in the last 12 months and must function properly by removing the hazard and exhausting it outside of the building. Work should be performed with the sash lowered as low as possible, but at a sensible working height.

The SOP for work with HF must be posted in the immediate vicinity.

The area must be posted with a sign that uses such verbiage: “Danger, Hydrofluoric Acid Use.”

3. Chemical Fume Hood Requirements

Due to the corrosive nature of HF and its ability to cause major damage to incompatible materials, it should be used in a special purpose chemical fume hood that meets the following specifications:

- The materials that construct the interior and ductwork must be non-reactive, acid resistant, and relatively impervious (e.g. – PVC, polypropylene lined, porcelain, etc.).
- The sash must not be made of glass (due to the ability of HF and HF vapors to digest glass), but of transparent, durable, acid resistant material (e.g. – polypropylene, plastic, etc.)
- The ductwork should be a stand-alone exhaust system (i.e. – not connected to other hoods or ductwork) and should go from the hood directly to the ceiling.

4. Personal Protective Equipment

Appropriate gloves, lab coat, safety goggles, and a face shield must be worn when working with HF. Wear butyl rubber, neoprene, 4H or Silversheild. Nitrile gloves can be worn when using weaker solutions, but it is highly recommended that double gloves be worn. Most disposable gloves will only provide a contact barrier from the acid; therefore, when contamination of gloves is known or

suspected, change gloves immediately and discard as HF waste. Always wash your hands after wearing gloves and between changing gloves.

5. Work Practice Controls

Use a less dangerous product than HF if possible.

Always transfer the chemical from one container to another inside of the fume hood. When transferring the chemical from one container to another, only pour the amount that is needed. Always use plastic (polyethylene) containers, as HF dissolves glass. Keep all containers of HF closed as much as possible. This chemical produces caustic vapors, and open containers will result in the release of harmful vapors.

Once work is complete, don the appropriate PPE, and wipe down the work area with a sodium bicarbonate solution. Discard all materials used in the decontamination as HF chemical waste.

6. Handling and Storage

HF is incompatible with glass, concrete, metals, water, other acids, oxidizers, reducers, alkalis, combustibles, organics, and ceramics. Store it away from these materials.

HF must always be stored in polyethylene (plastic) containers. HF dissolves glass: therefore, storing it in glass containers will lead to an HF spill, which has the potential to degrade other glass containers, causing subsequent spills and potentially hazardous reactions.

C. Emergency Procedures

Ensure that laboratory personnel are trained in first aid procedures for HF exposure prior to working with it.

Keep a first aid kit in the lab always stocked with 2.5% calcium gluconate gel and antacid (e.g. - Milk of Magnesia or a similar antacid). Check the expiration date of both materials periodically to ensure that it has not expired. A fresh stock must always be on hand.

In the event of an emergency involving HF, initiate immediate care.

Contact the KSU Police Department as follows:

- Kennesaw Campus: Dial extension 6666 or 470-578-6666
- Marietta Campus: Dial extension 5555 or 678-915-5555

If you are assisting in the emergency, be prepared to communicate what the emergency is, how many people are involved, and the extent of their injuries or illnesses. Evacuate the lab and adjoining laboratories as necessary. Notify the lab safety coordinator and the PI of the lab.

1. Immediate Care for Accidental Exposure to Hydrofluoric Acid

Inhalation Exposure

- If HF vapor has been inhaled, move to fresh air immediately.
- Call KSU Police for emergency response.
- Ensure that a copy of the SDS is available for the emergency responders.

Skin Exposure

- If HF has been spilled on the skin or clothing, immediately remove clothing, and wash the affected area with large amounts of water, using a safety shower, sink, or another water source. With HF, time is of the essence; therefore, wash quickly and thoroughly for at least 15 minutes.
- Dial 5555 for emergency response. While waiting for emergency responders, apply 2.5% calcium gluconate to the affected area.
- If you are assisting the exposed individual, ensure that you are wearing splash goggles, a lab coat, and the appropriate gloves to avoid being exposed.
- If calcium gluconate is not available, continue washing the affected area until the emergency responders arrive.
- Ensure that a copy of the SDS is available for the emergency responders.

Eye Exposure

- If exposure to the eyes has occurred, immediately flush affected eye(s) for at least 15 minutes without stopping. Hold upper and lower eyelids open and away from the eyes during irrigation. Do not allow victim to rub eyes or keep eyes closed.
- If contact lenses were being worn, remove them if possible. (Note: contact lenses should not be worn when working with this material).
- **Do not apply calcium gluconate gel to the eyes.**
- **Seek medical attention immediately.**
- Ensure that a copy of the SDS is available for the emergency responders.

Ingestion Exposure

- If HF is ingested, do not induce vomiting, ingest emetics, or baking soda.
- **Call KSU Police and seek medical attention immediately**
    - Extension 6666, or 470-578-6666 (Kennesaw Campus) or
    - Extension 5555, or 678-915-5555 (Marietta Campus)
- While waiting for emergency responders, drink large amounts of water or milk as quickly as possible. This will dilute the acid. If you are assisting and the exposed individual is unconscious, do not administer anything by mouth.
- If medical attention must be delayed, drink several ounces of milk of magnesia or other antacids.

Note: All HF exposure requires immediate first aid and medical treatment. Prompt first aid is essential, even if the victim does not exhibit any signs or symptoms or feel any pain.

2. Spill Clean-up

Spill clean-up must be performed by individuals who are properly trained. Do not attempt to clean up a spill of pure HF or a solution of greater than 1% unless you have had special training. Do not attempt to clean up HF spills if the spill is larger than what you are comfortable cleaning up.

Prior to cleaning an HF spill, don the appropriate PPE (splash goggles, lab coat, and appropriate gloves (see section 6.2.3).

Wipe up solutions with chemical absorbent pads, or absorbent or neutralizers that are HF specific. Some absorbent materials, such as those found in basic acid neutralizing kits, will release HF gas or other toxic gases. Once the spill has been completely absorbed, wipe the area down using a sodium bicarbonate solution, and then using a soap and water solution.

All waste generated from a spill must be handled as hazardous waste and must be disposed of in a plastic container, such as a bucket, and sealed.

7. Waste Management

HF, when being disposed of, is a toxic waste. If it is disposed of as a pure chemical, it carries a waste code of U134. If disposed of as a spent acid or spill cleanup, it will carry D002 waste code and possibly a U134 waste code, as well. As a small quantity generator, KSU is allowed to generate up to 1000 kg of this type of waste per month. Any amount over that will change the generator status to a large quantity generator will all the regulations thereof.

8. Training Requirements

All faculty/staff/students who work with HF are required to complete the OwlTrain online training course "Laboratory Safety" and the course "Globally Harmonized System of Classification and Labeling of Chemicals (GHS)".

They are also required to read and fully comply with this SOP for Hydrofluoric Acid. Use the form in Appendix A below to record training for this SOP.

Appendix A: SOP Review Record Form

To be completed by the employee/student

Hydrofluoric Acid is considered a particularly hazardous substance (PHS) due to its corrosivity, toxicity, and its ability to quickly penetrate deep under the skin where it can cause damage to tissue and major organs. To manage risks associated with use of Hydrofluoric Acid and to ensure the safety of KSU employees and students, the University has established a standard operating procedure (SOP) for the safe handling of Hydrofluoric Acid.

The procedure requires that all faculty/staff/students who work with Hydrofluoric Acid complete the appropriate safety training and read and comply with the SOP for Hydrofluoric Acid. This form, therefore, should be completed and signed by each KSU employee or student who works, or plans to work with Hydrofluoric Acid, as documentation that he/she has read and understood the requirements of the SOP.

Name		☐ Faculty ☐ Staff ☐ Student	
Job Title		Department	
Supervisor's Name			
By signing this form, I certify that I have read, understood, and will comply with the requirements of this SOP.			
Signature		Date	
Note:			