

Chemical Risk Management Protocol

Safe Methods of Use (SMOU)

Hydrofluoric acid

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1 Purpose

This Safe Method of Use (SMOU) applies to principal investigators (PIs), laboratory managers, designated laboratory person (DLPs), and all staff and students who direct or participate in the use of hydrofluoric acid at the University of Auckland.

Note: the word 'shall' denotes a mandatory requirement and the word 'should' denotes a recommendation.

2 Disclaimer

The Safety Data Sheet (SDS) should be consulted for specific information about the specific chemical formulation/concentration you will be using. The Gold FFX SDS Database is available on the Library database. Instructions on how to source this information can be found on the Health, Safety and Wellbeing Databases website:

<https://www.auckland.ac.nz/en/health-safety-wellbeing/health-safety-topics/laboratory-safety/chemical-safety/databases.html>

Please read this SMOU in conjunction with the Chemical Risk Management Guidelines.

Note: 'Shall' denotes a mandatory requirement and 'should' denotes a recommendation.

3 Hydrofluoric acid

Hydrofluoric acid (HF) is a corrosive mineral acid that severely burns skin, eyes, and mucous membranes. Vapours from anhydrous HF or its concentrated solutions can burn these tissues.

HF is like other acids in that the extent of the burn depends on the concentration, temperature, and duration of contact.

HF differs however from other acids because the fluoride ion readily penetrates the skin causing destruction of deep tissue. Unlike other acids which are rapidly neutralised, this process may continue for days if left untreated.

WARNING:

Burns with HF are usually very serious with potential for significant complications due to fluoride toxicity. Concentrated HF solutions or vapour may cause severe burns, tissue necrosis, metabolic imbalances, pulmonary oedema, and life-threatening cardiac arrhythmia.

Burns from dilute solution, if left untreated, may progress to tissue necrosis and medical treatment may involve amputation. HF skin burns are accompanied by severe throbbing pain which is thought to be due the irritation of nerve endings by increase in extracellular potassium to compensate for reduced calcium ion concentration.

Any person exposed to Hydrofluoric Acid MUST be medically evaluated as soon as possible.

Download the Safely Data Sheets (SDS) for HF and be familiar with recommended treatments in case of spillage on skin, contact with eyes, ingestion and inhalation and have these on hand.

All work with concentrated HF shall be conducted in situations where assistance is readily available. It is imperative that any person who is handling HF arrange to have Calcium Gluconate gel on hand (ensure that it is within its use-by date) and another person available to assist if the alarm is raised!

4 Chemical Properties

Hydrofluoric acid solutions are clear and colourless with a density similar to water. HF can etch and dissolve glass. It will also attack glazes, enamels, pottery, concrete, rubber, leather, many metals (especially cast iron) and organic compounds.

Upon reaction with metals, hydrogen gas may be formed.

5 Storage

Use and store HF in polyethylene, polypropylene, and Teflon containers only.

Containers of concentrated Hydrofluoric acid must have prominent warning signs and an appropriately labelled containment vessel. They must be stored in a dangerous good cabinet that is likewise clearly labelled.

6 Toxicological Properties

Fluoride ions are both acutely and chronically toxic. Acute effects of HF exposure include extreme respiratory irritation, immediate and severe eye damage, and pulmonary oedema.

Skin, eye, or lung exposure to concentrated (>40%) HF solutions will cause immediate, severe, penetrating burns.

Exposure to less concentrated HF solutions may have equally serious effects, but the appearance of symptoms can be delayed for up to 24 hours.

If you are exposed to hydrofluoric acid SEEK MEDICAL ATTENTION IMMEDIATELY.

7 Personal Protective Equipment

The WorkSafe exposure standards ceiling limit for hydrogen fluoride is 3 ppm.

Fume hoods shall always be used when working with HF, ideally appropriate scrubbers need to be installed. The sash of the fume hood shall be as low as reasonably practical.

Eye and face protection in the form of a face shield AND enclosed lab glasses shall be used.

Full length or gauntlet Viton/neoprene or butyl neoprene gloves should be worn for general handling (hydrofluoric acid burns around the fingernails are extremely painful, difficult to treat, and may require surgical removal of the nail). When manipulating containers with concentrated HF for transfer into another appropriate container for adding to samples, an appropriate resistance outer glove that allows finger manipulation is essential otherwise there is the risk of spillage. Rated pump dispensers on the HF container are also essential in this case. Research indicates that the breakthrough times for neoprene and nitrile gloves are all ~ 1 hour. Double gloving with an underlayer of chemically resistant (~ 1 hour) single use nitrile or neoprene gloves is recommended.

A full-length acid resistant apron shall be used. High rubber boots are also recommended, with closed footwear and long trousers always worn when handling HF.

8 Using Hydrofluoric Acid Safely

Never use hydrofluoric acid when working alone.

Before beginning work involving HF, another appropriately trained person, shall be always available should assistance be required. This person must be present in the lab whenever concentrated ($>48\%$) HF is dispensed. In other cases, another person does not have to be physically present in the laboratory, but must be readily available.

All lab personnel, not just those who will be using Hydrofluoric Acid, should be informed of and understand the dangers of this chemical and the emergency procedures necessary in case of an accident. A warning system shall be in place to warn and protect others from the hazard of HF when it is in use. This could be by use of a red light, or warning sign that indicates the chemical is in use.

Only experienced persons specifically designated by the Lab Manager who are familiar with its properties, and have undergone a HF use induction process, shall handle HF.

All persons who will be using Hydrofluoric Acid shall be made aware of its properties and have documented training in proper procedures for use and disposal.

Laboratories which keep or use Hydrofluoric Acid gas or solutions of greater than 1% Hydrofluoric Acid shall have emergency procedures on hand as well as HF SDS (download from Gold FFX, the database available from the UoA library).

Laboratories which keep or use Hydrofluoric Acid gas or solutions of greater than 1% Hydrofluoric Acid shall have calcium gluconate gel, an operational safety shower and eye wash available close to their laboratory.

Before beginning any procedure involving Hydrofluoric Acid, make sure the access to the calcium gluconate gel, emergency shower and eyewash is unobstructed.

All procedures involving HF shall be conducted in a fume hood certified for HF use.

Before beginning work involving HF, the following items shall be readily on hand:

- Container of calcium gluconate gel. This gel must be inspected before each use of HF or at least monthly to ensure the gel has not been removed or has not reached the expiration date. If a tube of the gel has been opened, a new container must be purchased and the old container discarded. No work with HF can be done with an expired tube of calcium gluconate gel.
- A small supply of calcium carbonate or calcium hydroxide for spills shall also be kept near the fume hood where the work will be conducted.
- A spare set of HF acid resistant gloves.
- Copy of these procedures and HF SDS to take to the Accident and Emergency clinic.

9 Spills

If a small quantity (100 ml or less) of dilute Hydrofluoric Acid solution is spilled, clean it up by applying powdered calcium carbonate or calcium hydroxide, or use a commercial Hydrofluoric Acid spill kit. Do not use generic acid spill kits that contain sodium hydroxide, sodium carbonate, potassium hydroxide, potassium carbonate, or silica-based absorbent materials.

If a larger amount is spilled, or the acid is concentrated, contain the spill as best you can, evacuate the area, and call 111. Avoid exposure to the vapours.

10 Emergency Response Procedures

10.1 Skin Exposure

Move the victim immediately under an emergency shower or other water source and flush the affected area with large amounts of cool running water for at least 1 minute. While the victim is flushing with water, they should also take off all clothing, shoes and jewellery, removing goggles last. Close your eyes, face water flow and pull goggles overhead. BE EXTREMELY CAREFUL NOT TO CONTAMINATE YOURSELF (use Neoprene gloves).

Remove all contaminated clothing while flushing with water. Some clothing is able to absorb the toxic material and maintain it close to the skin.

While the victim is being rinsed with water, someone should call to arrange treatment by medical personnel. Call Emergency Services (111) and tell the dispatcher that a person that has been in exposed to Hydrofluoric Acid and the location. The hospital will need to be alerted.

Immediately washing off the acid is of primary importance!

After the affected area is flushed with copious amounts of water for at least 5 minutes, 2.5% calcium gluconate gel is to be applied using these guidelines.

In order to prevent cross contamination, the victim should self-apply the calcium gluconate gel.

If the victim is unable to self-apply, anyone present can apply the gel after putting on neoprene gloves.

Note the time when the calcium gluconate gel was first applied to the contaminated site. Provide this information to the Emergency Services team.

A copy of the HF SDS and these emergency procedures must also be also taken to the hospital. It is highly desirable that the victim be escorted to the hospital by the responding person or assisting lab personnel to ensure that all relevant information pertaining to the incident is provided to the clinician in charge of treatment.

10.2 Eye Exposure

Immediately flush eyes for at least 5 minutes with copious cool flowing water.

EMERGENCY SERVICES SHOULD BE NOTIFIED IMMEDIATELY. Tell the dispatcher that a person has been exposed to Hydrofluoric Acid and the location. The hospital may need to be alerted.

If a sterile 1% calcium gluconate solution is available and MEDICAL PERSONNEL are available then following the 5 minutes wash time, 1% calcium gluconate irrigation should be started.

10.3 Inhalation

If a large volume of Hydrofluoric Acid gas is inhaled

Immediately remove the victim to clean air. Call 111.

EMERGENCY SERVICES SHOULD BE NOTIFIED IMMEDIATELY. Tell the dispatcher that a person has been exposed to Hydrofluoric Acid and the location. The hospital may need to be alerted.

Inhalation of Hydrofluoric Acid fumes may cause swelling in the respiratory tract up to 24 hours after exposure. Persons who have inhaled Hydrofluoric Acid vapours may need prophylactic oxygen treatment and must be seen by a physician immediately.