Working Safely with Hydrofluoric Acid Guideline

Section 1 - Purpose and Scope

(1) The purpose of this Guideline is to provide information on hydrogen fluoride and hydrofluoric acid to minimise the likelihood of injuries and illnesses occurring from their use and storage.

(2) This Guideline applies to all University of Queensland (UQ) workers and students who use, store, handle, transport and/or dispose of hydrogen fluoride and hydrofluoric acid.

Section 2 - Risk Management

Risk Assessment and Control

(3) Hydrogen fluoride (HF) is a chemical compound that can exist as a colourless gas or fuming liquid. It can also be dissolved in water as an aqueous solution. When anhydrous HF is dissolved in water, it is referred to as hydrofluoric acid ($HF_{(aq)}$).

(4) $HF_{(aq)}$ is used in a wide range of laboratories because of its ability to bind to silicon and silica containing materials forming SiF_x ions which then dissolve in acidic solutions. It is also used to selectively etch and brighten metals. Because of these unique properties it cannot be readily substituted by other less hazardous acids.

(5) Similarly, in university environments, anhydrous HF is used to remove the BOC side chain protecting groups of a solid-phase synthesised peptide and to release the peptide from the resin, a process typically described as 'HF cleavage'. This requires specialised HF resistant Teflon or equivalent apparatus.

(6) Both anhydrous HF and $HF_{(aq)}$ are strongly corrosive and may cause severe, painful burns to the skin, eyes, mucous membranes and severe respiratory irritation. Both readily penetrate the skin and deeper tissues, binding to calcium and causing tissue damage including decalcification of bone. Large burns, or exposure to very concentrated solutions may result in gastrointestinal problems, cardiac arrhythmias and possibly death.

(7) Guidelines on which burns have a high probability of systemic producing toxicity are:

a. exposure of 1% of body surface area to 50% or greater $HF_{(aq)}$ solution
b. exposure of 5% of body surface area to any $HF_{(aq)}$ solution.

> NB: The palm of a hand represents approximately 1% of the body’s surface area.

(8) Persons working with HF and $HF_{(aq)}$ should be aware that delayed pain can occur after skin exposure, and where any direct contact occurs, in addition to immediate first aid, post exposure advice and examination should be sought from a medical doctor.

(9) All workplaces and research laboratories at UQ should ensure that, prior to working with anhydrous HF and $HF_{(aq)}$, a risk assessment is documented in UQSafe, with reference to the safety data sheet (SDS) for the concentration being

used. Consideration should also be given to identification and management HF precursors, such as sodium fluoride or reactions that may generate HF as a by-product.

(10) Control measures to eliminate or minimise exposure must be implemented, with consideration given to the hierarchy of risk control. Controls can include:

a. Replace anhydrous HF and $HF_{(aq)}$ with a less hazardous substance wherever possible.
b. Use a less concentrated $HF_{(aq)}$ solution if possible.
c. Purchase $HF_{(aq)}$ in ready-made concentrations to avoid handling the concentrate whenever possible.
d. Work within a fume cabinet fitted with a scrubber when using HF or $HF_{(aq)}$ for concentrations exceeding 1%.
e. Use an automated dispensing and diluting system if possible.
f. Always add acid to water, never water to acid when diluting HF.
g. Never use glass vessels to hold HF solutions.
h. Do not work alone when working with HF and where there is greater than 10% $HF_{(aq)}$ do not work outside of normal business hours.
i. Place lids on $HF_{(aq)}$ containers.
j. Develop a spills protocol and ensure spills are cleaned up quickly and safely.
k. Alert others in the laboratory that anhydrous HF or $HF_{(aq)}$ is being used in the fume cupboard and place signage to that effect either on the fume cupboard sash or laboratory door. Ideally HF work should be undertaken in a dedicated and restricted facility.
l. Always keep in-date calcium gluconate gel within first aid supplies along with a copy of the 'Advice to Doctor' report and HF 'First Aid' report which is generated via the 'Emergency Report' button in Chemwatch, in areas where anhydrous HF or $HF_{(aq)}$ is used or stored.
m. Use appropriate personal protective equipment (PPE) such as neoprene or natural rubber gloves, face shield or eye protection, lab coat and apron closed in shoes.

(11) Typically, all work with HF or $HF_{(aq)}$ will occur within a fume cabinet. However, where a risk assessment identifies the need for respiratory protective equipment to supplement higher order control measures, use a fit tested respirator with an acid-gas filter as outlined in the SDS e.g., type B.

(12) Careful consideration of storage and spills procedures and suitable controls must be included in the risk assessment.

Training and Competency

(13) Personnel working in laboratories and with chemicals are required to complete online training modules for Laboratory and Chemical Safety.

(14) In addition, prior to commencing any work, UQ workers who handle or use anhydrous HF or $HF_{(aq)}$ must read the SDS, be aware of the associated hazards and receive specific training on:

a. the chemical properties of anhydrous HF or $HF_{(aq)}$;
b. health effects resulting from anhydrous HF or $HF_{(aq)}$ exposure;
c. safe work procedures;
d. correct use and selection of PPE;
e. how and when it is safe to clean up a spill;
f. emergency procedures; and
g. first aid treatment required for exposed workers, including the location of calcium gluconate gel.

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(15) Before allowing work with HF or $HF_{(aq)}$ to proceed in their areas of responsibility, Supervisors should verify and document worker competency. An appropriate level of supervision should be provided.

(16) The local site safety inductions conducted by local Work Health and Safety Coordinators (WHSCs) and/or Laboratory Managers are an important complement to this process and local WHSCs should be notified if any work involving anhydrous HF or $HF_{(aq)}$ is planned for the local area.

(17) Local First Aid Officers are also to be made aware of the use of anhydrous HF or $HF_{(aq)}$ in the area (see clauses 68 and 69 on responsibilities of First Aid Officers).

(18) All of these training elements should be documented in the risk assessment as administrative controls.

Section 3 - Emergency Procedures

Spills

(19) The spills category must be assessed during the risk assessment process and prior to handling these substances. Refer to the UQ Chemical Spill and Response Procedure for further information.

(20) An appropriate spill kit should be on hand where these chemicals are being used, stored and contain absorbents suitable for anhydrous HF or $HF_{(aq)}$ i.e. Chemizorb® HF, magnesium sulphate pad.

(21) Do not use spill sorbents that contain silicon, such as vermiculite or sand, as this can produce silicon tetrafluoride, an odorless toxic gas).

(22) Prior to cleaning up anhydrous HF or $HF_{(aq)}$ spills, the thresholds for minor and major spills should be determined. Spills occurring outside of a fume cupboard of HF vapour or aqueous HF >1% should be treated as a major spill. A major spill response should only be undertaken by appropriately trained personnel with the correct PPE.

Major Spill

(23) In the event of an unexpected major spill of anhydrous HF or $HF_{(aq)}$, evacuate the area of all personnel, contact the emergency number as stated on your UQ Emergency Procedures Card and your local Work Health and Safety Coordinator (WHSC) or Safety Manager for advice. If outside of normal business hours, also contact UQ Security.

(24) Prevent others entering the area. DO NOT attempt to clean up any major spills or touch the spilled material.

(25) If a worker or their clothing have been contaminated, the contaminant must be removed immediately, and contaminated clothing must be taken off as soon as possible. Any clothing that needs to be pulled over the head should be cut off instead. The affected areas must then be drenched with water for at least 1 minute to thoroughly wash off contaminants. Calcium gluconate gel (2.5%) must then be applied to the affected areas, as outlined further under the ‘First Aid’ provisions below.

(26) Place all contaminated items (gloves, clothing, etc.) into a sealed plastic container or plastic bag. Obtain instruction for appropriate disposal from the WHSC or HSW Division Lead.

Minor Spills

(27) Notify lab personnel and surrounding work areas of the incident and cordon off the affected area.

(28) Minor spills should be cleaned up immediately using a suitable spill kit.

(29) Choose appropriate PPE (e.g., goggles, face shield, neoprene or natural rubber gloves, lab coat, apron, respirator

with acid-gas filter as outlined in the SDS).

(30) Anhydrous HF and $HF_{(aq)}$ are highly corrosive to metals, glass and ceramics and must not be washed into drains. Prevent HF and $HF_{(aq)}$ from entering the drains by designing experiments to capture any concentrated HF or $HF_{(aq)}$ wash waste created and/or use of HF spill kit absorbent pads.

(31) Place all contaminated items (gloves, clothing, etc.) into a sealed plastic container or plastic bag. Obtain instruction for appropriate disposal from the WHSC or HSW Division Lead.

(32) All chemical waste should be neutralised if possible and placed into chemical waste containers, prior to sending for waste collection.

(33) Return spill kit to storage location and arrange for used contents to be replaced.

(34) Inform the Laboratory Manager and complete an incident report if appropriate.

First Aid

(35) The severity of anhydrous HF or $HF_{(aq)}$ burns is largely dependent on the surface area contaminated with the substance and the concentration of the acid. For more information on chemical burn first aid, refer to First Aid Treatment for Burns Guideline.

(36) First Aid Officers (FAOs) should avoid contact with contaminated skin, clothing, and equipment. They should also avoid inhalation of vapours or aerosols in the contaminated area by providing first aid to people away from the area of contamination.

(37) FAOs must protect themselves when performing first aid by wearing PPE as outlined in the SDS including:

a. gloves e.g., neoprene or natural rubber gloves (noting glove selection is critical to preventing breakthrough and dermal absorption);
b. eye-protection (goggles or face shield if there is still a splash risk); and
c. lab coat or protective overalls (non-absorbent apron).

(38) A respirator should not be required for FAO treating an injured person away from the accident site.

(39) Obtain urgent medical advice or transport the patient to hospital by ambulance, explaining to emergency staff and the casualty the importance of early treatment and the risk of a delayed reaction. A copy of the SDS and “Advice to Doctor” report for HF should accompany the patient. Keep the patient quiet, warm and comfortable. Advise the patient to not return to work or to go home without a medical examination due to the possibility of delayed symptoms.

Skin Contact

(40) Immediately flush body and clothes with copious amounts of water for at least 1 minute, using a safety shower if available. Scrub under nails if contaminated.

(41) Remove contaminated clothing wearing suitable gloves (e.g., neoprene or natural rubber) and irrigate the area with copious volumes of water for at least 1 minute to remove all contaminant.

(42) Apply calcium gluconate gel (2.5%), to and around the contaminated area and massage in with gloved fingers. White specks appearing around the contaminated area indicate that the desired reaction has taken place.

(43) Continue to massage affected skin with repeated application of gel for at least 30 minutes or until medical treatment becomes available.

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(44) For burns to the hand, place gel in a latex glove and put this on the hand or cover with a gel-soaked dressing and lightly bandage.

(45) Send the patient for medical review and ensure calcium gluconate gel accompanies the patient so that repeat application of the gel can occur during transit as necessary.

(46) If no gel is available, continue flushing with water until medical assistance arrives.

Eyes

(47) Do not wear contacts lenses when working with anhydrous HF or $HF_{(aq)}$. Refer to the Eye Protection Guideline for further guidance on wearing contact lenses in laboratory environments.

(48) Irrigate the eyes immediately with copious amounts of water or normal saline (isotonic, 0.9% sodium chloride in sterile water) until advised to stop by a medical practitioner or Poisons Information Centre or for at least 30 minutes.

(49) Always obtain specialist medical attention and continue flushing during transport to hospital if possible.

(50) Do not apply calcium gluconate gel to eyes.

Inhalation

(51) Move the casualty to an uncontaminated area.

(52) If necessary, resuscitate the casualty. Oxygen should be given by an advanced FAO, medical doctor, nurse or paramedic. Do not give resuscitation breaths if there is a risk of HF or $HF_{(aq)}$ oral exposure to the rescuer.

Section 4 - Roles, Responsibilities and Accountabilities

Supervisors

(53) Make safety data sheets (SDS) available to all staff to provide information on chemical use via Chemwatch.

(54) Ensure that risks from anhydrous HF and $HF_{(aq)}$ are eliminated or minimised as far as reasonably practicable and documented via risk assessment.

(55) Provide supervision and training in the safe use of these materials.

(56) Assist with the risk assessment process and ensure the assessment is comprehensive and accurate, where appropriate seek advice from a suitably qualified person.

(57) Review and approve the risk assessment, and ensure all controls outlined in the assessment are followed by workers.

(58) Ensure the provision of adequate PPE for the work activities and that suitable spill kits are in place.

(59) Ensure the provision of training in the use of PPE and spill management.

(60) Ensure all incidents involving these materials are investigated as soon as possible and that corrective actions (including review and modification of risk assessment and safe working procedures) are implemented to prevent recurrences.

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UQ Workers and Students

(61) Ensure risks are eliminated or minimised as far as reasonably practicable and be aware of the risk assessment in relation to working with anhydrous HF and $HF_{(aq)}$.

(62) Report any incidents and hazards in UQSafe involving anhydrous HF or $HF_{(aq)}$.

(63) Assist with the risk assessment process, assist with ensuring that all known risks are included in the assessment and controls are suitable to the risks identified.

(64) Follow safe operating procedures and use the controls outlined in the risk assessment.

(65) Wear all PPE required and ensure it is maintained in good condition. Report any issues with PPE to the Supervisor.

(66) Report any usage of the spill kit contents so that restocking can be undertaken.

(67) Report any changes to procedures to the Supervisor that may change the risk assessment in place.

First Aid Officers

(68) First Aid Officers, for their area of responsibility, are responsible for:

a. conducting a thorough risk assessment to ensure adequacy of first aid facilities and kits in the workplace as they relate to HF or $HF_{(aq)}$;
b. reporting inadequate emergency equipment or PPE to a Supervisor;
c. maintaining the workplace first aid kit on a monthly basis including:
    i. recording use of its items;
    ii. replenishing items as required, including calcium gluconate gel (2.5%) and the “Advice to Doctor” report for HF;
    iii. ensuring it remains fit for purpose;
d. maintaining current first aid training competencies; and
e. maintaining records of all injuries and ensuring an incident report on UQSafe is written.

(69) Further guidance on first aid responsibilities is available from the First Aid in the Workplace Code of Practice 2021 and the First Aid Management Procedure.

Section 5 - Appendix

(70) Contact for further information: Health, Safety and Wellness Division - hsw@uq.edu.au

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