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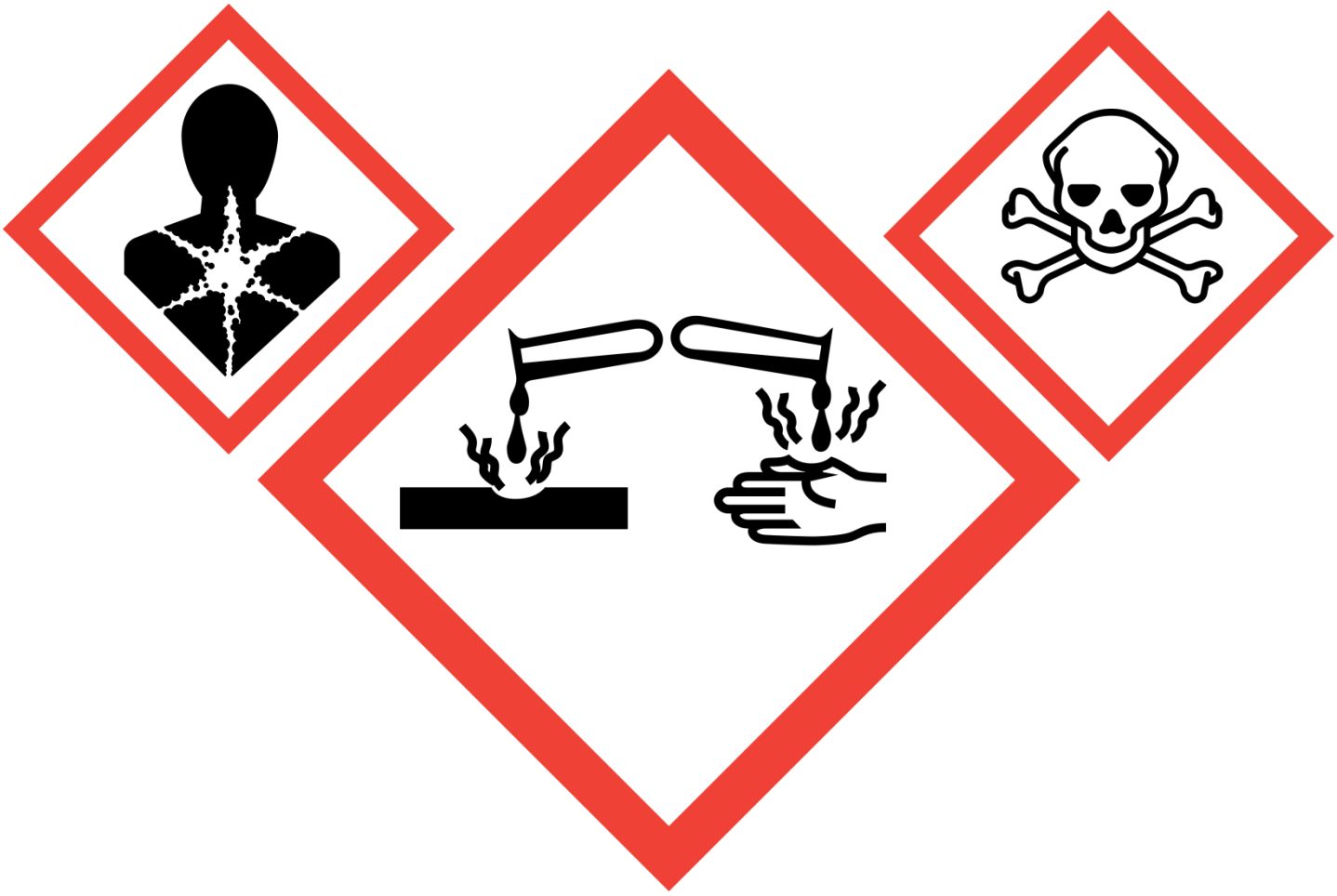
Freelance Paramedic

A Guide to Hydrofluoric Acid

Course Handout



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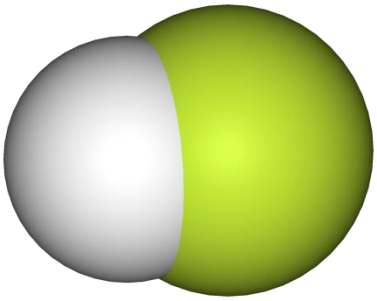
This handout is designed as a learning guide for, **"A Guide to Hydrofluoric Acid"** course and is not intended as an authoritative guide in the use, handling or storage of Hydrofluoric Acid.

Anyone using Hydrofluoric Acid must work strictly within a workplace safe system of work

Hydrofluoric Acid



What is it?

Hydrofluoric acid is a colourless solution of hydrogen fluoride (HF) in water, it is one of the most dangerous acids known, and has been responsible for a significant number of deaths and life changing injuries around the world. As an acid it is considered to be a weak acid (the only hydrohalic acid that is not considered a strong acid) because of its lower dissociation constant compared to the other strong acids (that is, its propensity to break down relatively easily into component molecules).

What makes Hydrofluoric acid so dangerous is its combination with the Fluoride ion. It is this ion that causes destruction to skin, tissues, bone and possible death. Due to the aggressive fast nature of the acid, pain to the affected area(s) can be delayed from 1-24 hours.

Contact exposure can also cause systemic toxicity by being absorbed into the blood, interfering with the body's metabolism of calcium, and can cause hypocalcaemia (low calcium levels), hyperkalaemia (high potassium levels) and/or hypomagnesaemia (low magnesium levels) this can occur when as little as 25 square inches of skin have been exposed and can lead to cardiac arrest.

As a gas Hydrofluoric acid is an acute poison that can immediately and permanently damage lungs and the corneas of the eyes; exposure to the gas can also be fatal.

Hydrofluoric acid is also known as:

- HF
- Hydrofluoride
- Fluoric acid

Related compounds:

- Hydrochloric acid
- Hydrobromic acid
- Hydroiodic acid

Where is it used?

- Petroleum industry
- Dissolving rock samples
- Cleaning antique glass bottles
- Glass etching
- Cleaning process in the production of silicon chips

How is it stored?

Manufacturers' guidelines must always be followed when storing any dangerous or volatile substance, in particular strict compliance with COSHH 2002.

Manufacturers are also responsible for ensuring correct packaging within the European CLP Regulation, which replaced the CHIP regulations 2009.

Acid should be stored in a cool dry place away from any materials that may react with Hydrofluoric acid. HF should avoid contact with:

- Glass
- Concrete
- Metals
- Other acids
- Oxidizers
- Alkalis
- Combustibles
- Organics
- Ceramics

Hydrofluoric acid should be stored in polyethylene or fluorocarbon plastic, lead or platinum containers. The containers should then be placed in polyethylene secondary containment trays.

Hydrofluoric acid should never be stored in glass containers.

New GHS* signs:

Old signs, these will still be in use:

*GHS is an acronym for The **Globally Harmonized System of Classification** and Labelling of Chemicals. The GHS is a system for standardizing and harmonizing the classification and labelling of chemicals. It is a logical and comprehensive approach to: Defining health, physical and environmental hazards of chemical

Complications when using Hydrofluoric acid

Pain associated with the exposure to Hydrofluoric acid may be delayed for 1-24 hours, due to how mobile the Fluoride molecule is and how rapidly it can pass through soft tissue and bone. Any delay in HF being neutralized may result in tissue destruction, loss of limb or loss of life.

Systemic exposure: Systemic fluoride toxicity may result from ingestion, inhalation, or extensive dermal burns. Hypocalcaemia, hypomagnesaemia, hyperkalaemia (potassium), pulmonary oedema, metabolic acidosis, ventricular arrhythmias, and death are possible.

A dermal exposure to 70% Hydrofluoric acid over 2.5% of total body surface area* has resulted in death.

Eye exposure: May result in severe ocular damage with concentrations greater than 0.5%. Fume exposure commonly causes eye irritation and can also cause ocular injury. Signs and symptoms may be delayed.

Oral exposure: Ingestion may result in vomiting and abdominal pain; painful necrotic lesions, haemorrhagic gastritis, and pancreatitis have been reported after significant exposure. Rectal administration has caused acute colitis with perforation.

Death has occurred after ingestion of 1.5 grams of Hydrofluoric acid (concentration unknown) within 6.5 hours of ingestion.

Inhalation exposure: Inhalation of hydrofluoric acid vapours may cause severe throat irritation, cough, dyspnoea, cyanosis, lung injury and pulmonary oedema resulting in death.

Estimates of the lowest lethal concentrations for Hydrofluoric acid range from 50-250 PPM for a 5-minute exposure.

**Palm of hand = 1% total body surface area*

Fire and explosion hazard

Hydrogen fluoride is non-combustible but when exposed to heat from fire or explosion it can cause irritating and corrosive fumes, this can also happen when Hydrogen fluoride is heated or used with steam.

Spills

Within workplaces safe systems of work statements and risk assessments there must be robust measures for dealing with any spillages of Hydrofluoric acid or associated compounds, and spill response kits made available to trained staff.

All workplaces using or storing Hydrofluoric acid must have:

- Trained staff in first aid measures
- Antidote kits
- Access to water for irrigation
- Access to appropriate personal protective equipment
- Decontamination procedures
- Safe systems for dealing with accidental spillages.

Recognition of Hydrofluoric contamination:

- Pain although this can be delayed from 1-24 hours (24h in concentrations <20%)
- Burns
- Erythema - skin redness
- Tissue damage
- Hyperkalaemia (high potassium levels)
- Hypomagnesaemia (low magnesium levels)
- Hypocalcaemia (low calcium levels)

First Aid Treatment

Urgent hospital treatment is essential. 999/112 should be called without delay and emergency services notified of Hydrofluoric acid contamination:

Skin:

- Removal of contaminated clothing. Gloves must be worn (Neoprene or Nitrile 22 Mil)
- Affected area should be flooded with water for at least 5-10 minutes *ref: HSE advice on HF poisoning.*
- Apply calcium gluconate on and around the affected area - massage into skin for **at least 15 minutes or until 15 minutes after pain is relieved.**
- Cover with dressing soaked in **calcium** gluconate.
- Repeat as necessary en-route to hospital.

Eye contact:

- Flush eye with water for at least 20 minutes - continue en-route to hospital.
- Consider evacuation to eye casualty if available.

Gassing:

- Remove casualty from contaminated area and place in fresh air.
- If available give high flow oxygen through non-rebreather mask

Swallowing:

- Never attempt to induce vomiting.
- If casualty is conscious rinse out mouth with water

Extra consideration must be given to the resuscitation of a victim following exposure to Hydrofluoric acid, ensuring that the rescuer is not exposed to the acid; this might include being contaminated by:

- Touching the casualty when performing chest compressions
- Being exposed via rescue breaths if the casualty had been exposed to a gas or ingestion.

Anyone exposed to Hydrofluoric acid must go to hospital.

Case Studies

Release of Hydrofluoric acid from Marathon Petroleum Refinery, Texas, USA. 30th October 1987

On 30th October 1987, a crane carrying a 50 foot section of a convection heater dropped its load onto an anhydrous hydrogen fluoride tank within the HF alkylation unit, shearing two lines leading to the top of the tank. This resulted in an air release of hydrofluoric acid at the Marathon Petroleum Company refinery in Texas City.

One line was a 4-inch acid truck loading line, and the other was a 2-inch tank pressure relief line. The tank was at the normal operating pressure of approximately 125 psi, so that when the incident occurred a cloud of HF was produced which moved with the prevailing wind. The tank originally contained 35,700 gallons of AHF, of which about 6,548 gallons was released over a 44 hour period, although the majority of the release took place during the first two hours as the tank depressurised. The release also included some light hydrocarbons (primarily isobutane) and water vapour.

The first mitigation action was to place stationary fire monitor nozzles and to erect a water spray curtain about 10 feet downwind of the release to control the HF acid vapour plume.

Approximately 4,000 people were evacuated from the residential areas threatened by the plume and the three area hospitals treated 1,037 patients, of which nearly 100 were hospitalised. There was extensive damage to trees and vegetation in the residential area.

Ref: Health and Safety Executive

1994 – A lab tech in Western Australia died from burns sustained when he accidentally spilled concentrated (70%) HF on himself.

On November 12 1994, a 37 year old man died in the Intensive Care Unit of Fremantle Hospital after he accidentally splashed about 100 ml of a 70% solution on his right leg on October 28. It was estimated that the extent of the spill covered about 10% of his total body area. The individual was working as a technician in a small palaeontology laboratory, which was attached to a private residence. HF is used in the industry to digest silicates in ore samples. The victim immediately attempted to remove the spill from his clothing hosing himself down with a hose attached to a sink in the laboratory. He then ran from the laboratory to the swimming pool in the garden, and he remained in the pool until the ambulance arrived within the hour. At the time he appeared confused, possibly as a result of shock. The following week his right leg was amputated, however despite this, the individual eventually succumbed to the toxic effects of the hydrofluoric acid 2 weeks after the initial spill.

Ref: Australian Institute of Occupational Hygienists Newsletter, December 1994

Study of fatal HF poisonings and the use of Calcium gluconate

The following table gives information on 10 year study undertaken by the University of Tennessee from 1984 to 1994, where 9 deaths were investigated from a total of 8 industrial incidents involving HF contact. In all cases unsafe work practices were implicated.

Case no.	Approximate time from exposure to death	Calcium gluconate administered	Approximate time from exposure to administration of Calcium gluconate
1	30 min	No	N/A
2	3 hours 30 min	No	N/A
3	15 hours	Yes	6 hours
4	4 hours	Yes	1 hour 30 min
5	30 min	No	N/A
6	30 min	No	N/A
7	2 hours 30 min	Yes	Unknown
8	4 hours	Yes	1 hour 30 min
9	4 hours	Yes	30 min

Ref Pam Koontz University of Tennessee, Knoxville

Further Studies

1981 – At the Sullivan Park Research Facility of Corning, Inc., an HF tank leaked. A clean-up crew went in without proper respirators and 2 workers died.

1996 – A NYC sanitation worker died of toxic fumes released when HF blew up in the back of his truck.

Glossary

HF	Hydrofluoric acid
GHS	Globally Harmonized System of Classification
Dermal	Skin
HSE	Health and Safety Executive
Hyperkalaemia	High potassium levels*
Hypomagnesaemia	Low magnesium levels[Ŧ]
Hypocalcaemia	Low calcium levels[ψ]
Pulmonary oedema	Fluid in lungs
Metabolic acidosis	Blood pH of less than 7.35
Ventricular arrhythmias	Abnormal heart rhythm

* Normal potassium level in the blood is 3.5-5.0 milliequivalents per litre (mEq/L)

[Ŧ] Normal magnesium level is 1.5-2.3 mEq/L

[ψ] The normal adult value for calcium is 4.5-5.5 mEq/L

References

GHS
http://www.hse.gov.uk/chemical-classification/legal/background-directives-ghs.htm

CHIP
http://www.hse.gov.uk/chemical-classification/legal/chip-regulations.htm

First aid
http://www.hse.gov.uk/search/search-results.htm?q=hydrofluoric%20acid%20first%20aid#gsc.tab=0&gsc.q=hydrofluoric%20acid%20first%20aid&gsc.page=1

COSHH
http://www.hse.gov.uk/coshh/

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