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MED105HF Completion Record

After completing all modules in Hydrofluoric Acid Safety (MED105HF) fill in the form below and forward to Berta Armijo-Chavez, MS 0653, or fax to (505) 284-2873 in order to receive course credit.

I have completed all the modules in Hydrofluoric Acid Safety (MED105HF).

SNL ID	
Name (Print)	
Org.	
Initials	
Date	



Introduction

An aspirin a day helps keep you healthy but ingesting a bottle of aspirin can certainly kill you. A small amount of fluorine in your drinking water or toothpaste can help keep your teeth healthy. A relatively small spill of diluted HF onto your skin may be too much fluorine for your body and could kill you. Minimizing the absorbed dose through prompt first aid procedures is critical to patient outcome. With an HF exposure, time is of the essence.

Hydrofluoric Acid Safety (MED105HF) is designed to prepare you to safely work near Hydrofluoric Acid through:

- Hazard Awareness
- Accident Prevention
- Emergency Response

Objectives

After completion of this course, you will be able to:

Module 1: Hazard Awareness

- Recognize common names for Hydrofluoric Acid
- Recognize key properties of HF
- Specify the typical concentration limits found at SNL
- Identify the most common types of exposure (or routes of entry) and injuries caused by exposure to HF

Module 2: Accident Prevention

- Identify safety precautions you can take to reduce your risk and prevent accidents
- Identify what you can do to be prepared for any accident or emergency involving HF

Module 3: Emergency Response

- Define basic treatment methods
- Identify emergency response procedures



Resources

- **Chemical Information System**
<https://webprod.sandia.gov/CIS/svStartup>
- **HF Exposure Emergency Procedures/Information**
<https://wfsprod01.sandia.gov/groups/srn-uscitizens/documents/document/wfs387420.pdf>
- **NIOSH Pocket Guide to Chemical Hazards**
<http://www.cdc.gov/niosh/npg/npgd0334.html>
- **Fatal Unintentional Occupational Poisonings by HF in the U.S. Case Report**
<https://wfsprod01.sandia.gov/groups/srn-uscitizens/documents/document/wfs407670.pdf>
- **OOPS Reporting Process**
<http://oops.sandia.gov/index.htm>
- **ES&H Glossary**
<http://www-irn.sandia.gov/corpdata/esh-manuals/mn471001/glossary.htm>

Beware!

Be aware that SNL does not use nebulized Calcium Gluconate. Sandia does not use Benzalkonium Chloride.

Contacts

For further information or for any questions you may have regarding Hydrofluoric Acid exposure, please contact either Dr. Gregory McCarthy or Charles "Jeff" Sillivent.

Contact your ES&H Coordinator for any additional questions you may have.



01 Hazard Awareness

Module Objectives

After completing this module, you will be able to:

- Recognize common names for Hydrofluoric Acid
- Recognize key properties of HF
- Specify the typical concentration limits found at SNL
- Identify the most common types of exposure (or routes of entry) and injuries caused by exposure to HF

Case Study

Incident at Sandia...

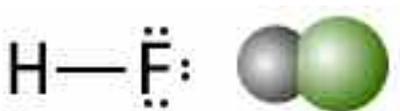
A few years back we had a Sandian who was working with a large vat of diluted Hydrofluoric Acid (HF). The employee apparently had a pin-hole leak near the fingertip of the heavy rubber gloves. The worker underestimated the potential problems associated with a HF exposure. The area was rinsed well but no further action was taken.

The Sandian failed to:

- apply Calcium Gluconate gel
- notify the supervisor of the situation

Hours later, when the Sandian was at home, excruciating pain was felt in the affected finger. When the patient was seen the next day in the SNL clinic, the finger had already been severely injured to include localized tissue death. The physicians used a hypodermic needle to inject a special form of calcium gluconate into the finger in attempts to save the employee from further injury and sickness. Although the finger was not amputated and the patient survived, the recovery was long and difficult.

Background



What are common names for Hydrofluoric Acid?

Hydrofluoric Acid may also be referred to as:

- Hydrogen Fluoride
- Hydrofluoride
- HF

Do not confuse Hydrofluoric Acid with Hydrochloric Acid!



What should you know?

- HF is a hazardous chemical commonly used in industry
- Sandia National Labs uses HF in many different aspects of research and production
- Before you work in an area with HF, you must be educated, protected, and prepared for an emergency
- Most HF exposures are benign when treated immediately
- Hydrofluoric Acid is not just caustic, it's poisonous
- Delayed or inappropriate care can cause a small HF exposure to be fatal



Incidence of Accidents

What's going on out there?

In the United States, there are an estimated 1000 cases of accidental HF exposure annually

- Most are small exposures such as the hands, forearms, and face
- These are typical of the injuries seen at SNL Health Services



Picture of Sandia Employee with HF burns to his finger

HF Properties

What is this stuff?

- Colorless liquid with strong, irritating odor
- Weak mineral acid
- Extremely corrosive acid
- Nonflammable
- Very soluble in water

Attacks glass, concrete, some metals, and organic compounds

How bad is this stuff?

- Inhalation exposure limits
 - OSHA PEL = 3 PPM
 - OSHA STEL = 6 PPM
 - IDLH = 30 PPM





Key

OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit (8hr shift)
STEL = Short Term Exposure Limit (15 min)
IDLH = Immediately Dangerous to Life and Health
PPM = Parts Per Million



Common Uses Of HF

What's it used for?

- Production and purification of radioactive materials
 - Uranium hexafluoride
- Microchip fabrication
 - Silicon etching
- Printed circuit board cleaning
 - Fluorinated solvents
- Glass etching
 - Frosted lamps, bottles
- Plastics production
 - Fluoropolymers





HF Packaging

How is it sold?

- 500 ml, 1000 ml
 - Analytical and research laboratories
- 1 Gallon
 - Small scale industrial use
- 55 Gallon drums
- 1000 Gallon Totes
- 10,000 Gallon ISO Containers



At what Concentration?

- **49% most common**
 - **Typical concentration received at SNL**
- 73% less common
- Some uses here at SNL
- **Diluted to <10%**
 - **Most commonly used at SNL**



Beware!

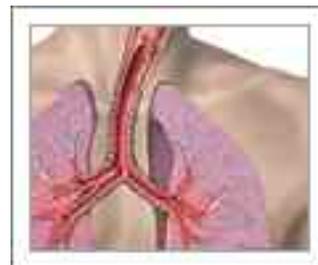
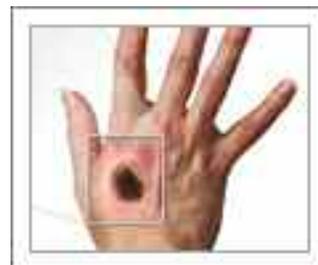
HF may be diluted with other chemicals, which have their own hazardous properties.





Routes of Entry

- Skin (absorption or laceration)
 - **Most frequent form of exposure**
 - Can cause serious painful burns
- Respiratory tract (inhalation)
 - HF Gas is extremely corrosive
 - Can cause rapid fluorine poisoning
- Eyes (exposure)
 - Can cause pain
 - Blindness may result
- Digestive Track (ingestion)
 - Can happen when food and drink are kept in lab areas
 - Can cause rapid fluoride poisoning

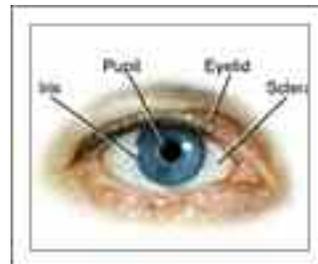


Types of Exposure

How do you get exposed?

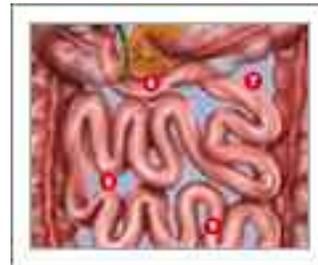
MOST HF exposures are DIRECT such as:

- Liquid exposure (splash)
 - Skin and eye contact
- Gas exposure (fumes or vapors)
 - Inhalation, skin and eyes



FEWER exposures are INDIRECT:

- Contaminated surfaces
 - Improperly cleaned PPE or work surfaces
- Victims exposed to HF liquid
 - May contaminate co-workers and first aid providers



Special Properties

What makes this stuff different

The extent of the burn depends on:

- * HF concentration
- * Temperature
- * Duration of contact
- * Quantity of exposure



HF concentration determines pain onset

- At high concentrations, contact with live tissue produces immediate pain and tissue destruction
- At low concentrations effects are the same, but may have delayed pain sensation and no visual signs of exposure

Concentration	Reaction
<1-20% HF	up to 24 hours
20-50% HF	1-8 hours
50-70% HF	less than 1 hour
>70%	immediate

What makes this stuff different

- HF first aid treatment is not limited to washing off the skin
- HF is readily absorbed into the skin
- HF binds with Calcium and Magnesium
- Hypocalcemia and Hypomagnesemia (lowered serum electrolytes) may occur in the blood
- HF is absorbed and continues its destruction
 - It dissociates into $[HFH]^+$ and F^-
 - This causes further tissue damage
- Once absorbed, HF also forms toxic salts
 - F^- & Na^+ become NaF
 - F^- & K^+ become KF
- Health effects are twofold through electrolyte disturbances and cellular poisoning



Fatal Statistics

- 7ml of anhydrous HF on the skin can bind with all the free Calcium in the body and be fatal
- Inhalation of HF acid fumes from a 60% or stronger solution can be fatal
- Burns over 5% of your body surface area with any HF solution can be fatal
- 1% of your body surface area burned with 49% HF can be fatal



Module 1 Questions:

1. HF will attack organic compounds.
 - a. True
 - b. False
2. Direct exposure to HF such as a liquid splash are the most common exposure.
 - a. True
 - b. False
3. Which statement/s below about HF concentration is/are true?
 - a. Bulk HF most commonly received at Sandia is 49%
 - b. Bulk HF most commonly received at Sandia is 73%
 - c. HF typically used at Sandia is diluted to <10%
 - d. a and c
 - e. b and c
4. HF has one danger, it's only corrosive.
 - a. True
 - b. False

Module 1 Answer Key:

1. b
2. a
3. d
4. a



02 Accident Prevention

Module Objectives

After completing this module, you will be able to:

- Identify safety precautions you can take to reduce your risk and prevent accidents
- Identify what you can do to be prepared for any accident or emergency involving HF

Case Study

Taken from Fatal Unintentional Occupational Poisonings by Hydrofluoric Acid in the U.S. (<https://wfsprod01.sandia.gov/groups/srn-uscitizens/documents/document/wfs407670.pdf>)

Case Study 9

Case 9 occurred on 10 October 1992. A 27-year-old worker was in the process of pouring HF acid from a 55 gallon drum into a 3 gallon pail for distribution. The worker and co-worker had **stacked crates** on top of each other as a **makeshift work platform** in order to raise the work area closer to a ventilation shaft. In the process of pouring the HF, the drum struck the bucket and knocked it from the platform to the floor. One worker jumped free while the other was splashed with 70% HF to approximately 40% of body surface area. The worker who was splashed was **wearing only rubber gloves, work clothes, and goggles**.

Following the incident calcium gluconate gel was applied within 30 min by the company nurse, and he was transferred to a local community hospital. He was later transferred to a regional medical center. At the regional medical center, 3 hours after injury, he developed ventricular fibrillation. **Several doses of calcium chloride were delivered along cardioversion, but he died approximately 4 hours after exposure.**

How do we keep ourselves safe?

- Utilize all appropriate administrative controls
 - Education, safe work practices, standard operating procedures, alternative chemicals, etc.
- Utilize all appropriate engineering controls
 - Personal Protective Equipment (PPE), enclosures, ventilation, detectors, rinse stations, safety valves, etc.
- Make sure every individual working with HF is trained and authorized
- Know the correct procedures for working with, and treating exposure to, HF
- Keep HF containers closed and labeled
- Isolate workers as much as possible with enclosures, PPE, etc.
- Ensure others are safe and aware
- Post danger areas
- Pay attention to early warning systems



- Leak detectors, air monitors, etc.
- Use a buddy system whenever possible
 - It is best to never work alone
 - Ask yourself: Who would help you in the event of an emergency

Contact your ES&H representative if you have questions regarding your Personal Protective Equipment or your procedures

Emergency Preparation

How can we be prepared for an HF emergency?

- Be prepared to take immediate action
- Locate the rinse stations in your work area
- Ensure Calcium Gluconate is available, and it hasn't expired
- Make sure you have easy access to 911 or the site emergency number (from a cell phone, 844-0911 at SNL/NM; 294-2222 at SNL/CA)
- During 7am-5pm work hours, realize SNL has EMT's and hazardous materials responders who can help you with your emergency. Outside of business hours, assistance is limited, and it may be necessary for you to care for yourself
- Know how to locate your manager. As part of Sandia's OOPS process, your management must be notified immediately of any accident - irrespective of the location or time of day
- You may have to educate the responders and hospital workers on the dangers of HF
- Plan to bring additional Calcium Gluconate gel with you to the emergency room
- Be ready to bring the HF chemical MSDS to the emergency room
- Know that follow-up medical care is always necessary. Further treatment with other forms of Calcium Gluconate may be in order. Blood tests and other procedures may need to be performed

What else can we do?

- Sandia Health Services has a HF Exposure Emergency Procedures/Information you may print out to assist you
- Access the Chemical Information System to view all of Sandia's chemical information including MSDS's



Module 2 Questions:

1. Given the case study described at the beginning of this module, what could the two workers have done to prevent the fatality?
 - a. Used appropriate personal protective equipment
 - b. Used safe work practices
 - c. Posted danger areas
 - d. Both a and b

2. What could the two workers in the case study have done to be better prepared for a potential HF emergency?
 - a. Do all of the actions below
 - b. Made sure Calcium Gluconate was handy on-site
 - c. Located rinse stations in their work area
 - d. Wear better protective clothing and design safe engineering controls

Module 2 Answer Key:

1. d
2. a



03 Emergency Response

Module Objectives

After completing this module, you will be able to:

- Define basic treatment methods
- Identify emergency response procedures

Case Study

Incident at Sandia...

A few years back we had a Sandian who was working in the basement of building 858. This person felt something wet dripping onto their uniform. After looking up, it was noticed that one of the acid waste lines was leaking and had dripped a few drops of liquid onto the worker. This waste line carried a multitude of acids including HF.

Proper procedures were followed:

The people working in the area were warned / informed of the dangerous situation.

The worker immediately:

- removed the contaminated clothing, and
- went directly to the emergency shower to flush the area

Co-workers immediately:

- called 911 (OOPS process automatic when 911 is called), and
- prepared to apply the Calcium Gluconate gel

When the employee was removed from the cold shower the Paramedics placed the patient on their gurney and the calcium gluconate gel was applied to the area. The patient was then transported to SNL Medical where the physician interviewed, examined, and cared for the injured person. This worker was able to return to full duty later that day.

If an HF accident DOES occur:

- Keep your cool
- Activate the buddy system
- Do not contaminate others
- Find eyewash/safety shower
- Remove all contaminated clothes, shoes, and jewelry
 - Contaminated clothing must be removed prior to rinsing the area
 - This will remove much of the product and will decrease contamination spread during rinse
- Remove goggles last (face water and pull over head)
- Flush for 10-15 minutes
- Apply Calcium Gluconate gel to infected area



Module 3 Questions:

1. Given the Case Study described at the beginning of this module, what did the injured worker do correctly in response to the HF emergency? He immediately:
 - a. Applied gauze and bandages
 - b. Removed his contaminated clothing
 - c. Went directly to the emergency shower
 - d. Both b and c

2. What did the injured worker's co-workers do correctly in response to the HF emergency? They immediately:
 - a. Called 911
 - b. Provided soap and towels
 - c. Prepared to apply Calcium Gluconate
 - d. Both a and c

Module 3 Answer Key:

1. d
2. d



MED105HF Final Test

Name _____ Org. _____ Date _____

Please send your completed exam to Berta Armijo-Chavez, MS 0653, or fax to (505) 284-2873 for grading and recording into TEDS.

- 1. Which of the following statements are true?**
 - a. Sandia National Labs uses HF in many different aspects of research and production.
 - b. Before you work in an area with HF, you must be educated, protected, and prepared for an emergency.
 - c. Most HF exposures are benign when treated immediately.
 - d. All of the above.

- 2. Hydrofluoric Acid is also commonly known by what other name(s)?**
 - a. Hydrogen Fluoride
 - b. HF
 - c. Hydrochloric Acid
 - d. a and b
 - e. None of the above

- 3. In the United States, how many accidental HF exposures occur annually?**
 - a. Less than 100
 - b. 500
 - c. 1000
 - d. 10000

- 4. At what concentration is HF typically used?**
 - a. Diluted to <10%
 - b. Diluted to <30%
 - c. 49%
 - d. 73%

- 5. A burn on 1% of your body surface area with 49% HF can be fatal.**
 - a. True
 - b. False

- 6. Which of the following type of HF exposure is most common?**
 - a. Skin (absorption or laceration)
 - b. Respiratory tract (inhalation)
 - c. Eyes
 - d. Ingestion



- 7. HF is readily absorbed into the skin**
 - a. True
 - b. False

- 8. Every individual working with HF must be trained and authorized.**
 - a. True
 - b. False

- 9. What is the preferred “antidote” to HF exposure?**
 - a. Calcium Gluconate
 - b. Soap and water
 - c. There is no antidote to HF exposure
 - d. None of the above

- 10. What are some resources you can use to learn about the hazards and emergency preparation of working with HF?**
 - a. MSDS
 - b. Sandia Chemical Information System
 - c. Sandia Health Services HF Exposure Emergency Procedures/Information
 - d. All of the above

- 11. When exposure to HF occurs, it is ok to wait to until you feel burning to seek treatment.**
 - a. True
 - b. False

- 12. What type of HF exposure is characterized by signs and symptoms that can include discomfort and shortness of breath?**
 - a. Absorption
 - b. Ingestion
 - c. Inhalation
 - d. Lacerations

- 13. To what type of HF exposure would you apply Calcium Gluconate gel?**
 - a. Absorption
 - b. Ingestion
 - c. Inhalation
 - d. Minor lacerations
 - e. a and d are both correct



MED105HF Feedback Form

Customer feedback is important to us. Please complete the evaluation form below and forward it to Berta Armijo-Chavez, MS 0653, or fax to (505) 284-2873.

Rate on a scale of 1- 5 (with 1= poor and 5 =excellent):

- The ease of using of this learning tool and/or test? 1 2 3 4 5
- The organization of information presented? 1 2 3 4 5
- The amount of information presented? 1 2 3 4 5
- The usefulness of the information presented? 1 2 3 4 5
- Your level of knowledge related to this topic
BEFORE using this learning tool and/or test? 1 2 3 4 5
- Your level of knowledge related to this topic
AFTER using this learning tool and/or test? 1 2 3 4 5
- The overall quality of this learning tool and/or test? 1 2 3 4 5

Fill in the blanks:

- What was most valuable about this learning tool or test?

- What information needs to be corrected, inserted, removed, or updated?

- What could be done to improve or enhance this learning tool or test?

