EMERGENCY PREPAREDNESS AND
RESPONSE GUIDELINES FOR

ANHYDROUS HYDROGEN FLUORIDE (AHF) and HYDROFLUORIC ACID (HF)

October 2018

Hydrogen Fluoride Panel
American Chemistry Council 700 Second Street, NE, 20002
Washington, DC

Table of Contents

1.0 Introduction	**4**
1.1 Legal Notice	4
1.2 To the Reader	5
1.3 Purpose and Use of Guidelines	5
2.0 Chemical Identification, Production, and Use	**6**
2.1 Chemical Identification	6
2.2 Production of HF	6
2.3 Uses for HF	7
3.0 Environmental Fate and Effects	**7**
4.1 Health Factors	8
4.1.1 General Health Information	8
4.0 Health Factors, Industrial Hygiene, and First Aid	**8**
4.1.2 Acute Inhalation Exposure	9
4.1.3 Skin Exposure	9
4.1.4 Eye Exposure	9
4.1.5 Chronic Hazard	9
5.0 Personal Protective Equipment	**11**
5.1 Protective Clothing	11
5.2 Respiratory Protection	11
5.3 Decontamination	11
6.1 Specific Emergency Response Considerations	12
6.0 Emergency Response	**12**
6.2 Reporting Requirements	14
7.0 Damage Assessment	**16**
7.1 Introduction	16
7.2 Primary Assessment	16
7.3 Secondary Assessment	16
8.0 Leaks	**18**
8.1 Type of HF Leak (Vapor or Liquid)	18
8.2 Leak Locations	18
8.3 Compatible Equipment and Materials	18
8.4 Techniques/Equipment Used to Address Leaks	18
9.0 Emergency Transloading	**20**
9.1 Introduction	20
9.2 Using Existing Valves and Fittings on Non-leaking Containers	20
9.3 Hot/Cold Taps	21
9.4 Venting/Field Scrubbing	21
10.0 Decontamination of Transfer Equipment	**22**
10.1 Purging/Evacuating to Non-Fuming Condition	22
10.2 Flushing with Neutralizing Solutions	22
10.3 Sealing Equipment for Transportation	22
10.4 Transporting Cleaning Effluents	22
10.5 Decontamination of PPE	22
APPENDIX A	**23**
Physical Properties and Characteristics of AHF, 70% HF, and 49% HF	23
APPENDIX B	**24**
Examples of Specific HF Product Applications	24
APPENDIX C	**25**
Description of AHF Tank Car	25
APPENDIX D	**26**
Description of AHF Tank Trailer	26
APPENDIX E	**27**
Description of Hydrofluoric Acid Solution (Aqueous HF) Cargo Tank	27
APPENDIX F	**28**
Description of ISO Containers	28
APPENDIX G	**29**
References to Regulations and Other Guidance	29
APPENDIX H	**30**
Typical Exposure Management Flowcharts (Decontamination, Evaluation, First Aid and Medical Treatment)	30
APPENDIX I	**35**
Personnel Decontamination Procedures	35
APPENDIX J	**37**
Definitions and Acronyms	37
Hydrogen Fluoride Panel	40

1.0 Introduction

1.1 Legal Notice

The Emergency Preparedness and Response Guidelines for Anhydrous Hydrogen Fluoride and Hydrofluoric Acid (Guidelines) were prepared by the American Chemistry Council's (ACC) Hydrogen Fluoride Panel (Panel). This document is intended to provide general information to persons addressing an emergency response in the course of handling and transporting anhydrous hydrogen fluoride (AHF) or hydrofluoric acid (HF). It is not intended to serve as a substitute for in-depth training or specific requirements, nor is it designed or intended to define or create legal rights or obligations. It is not intended to be a "how-to" manual, nor is it a prescriptive guide. All persons involved in handling and transporting AHF or HF have an independent obligation to ascertain that their actions are in compliance with current federal, state and local laws and regulations and should consult with legal counsel concerning such matters. The Guidelines are necessarily general in nature and individual companies may vary their approach with respect to particular practices based on specific factual circumstance, the practicality and effectiveness of particular actions, and economic and technological feasibility. Any mention of specific products in these Guidelines are for illustration purposes only, and are not intended as a recommendation or endorsement of such products.

Neither the American Chemistry Council, nor the individual member companies of the Hydrogen Fluoride Panel, nor any of their respective directors, officers, employees, subcontractors, consultants, or other assigns, makes any warranty or representation, either express or implied, with respect to the accuracy or completeness of the information contained in this manual; nor do the American Chemistry Council or any member companies assume any liability or responsibility for any use or misuse, or the results of such use or misuse, of any information, procedure, conclusion, opinion, product, or process disclosed in this manual. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

For more information on material presented in this manual, please contact an AHF or HF supplier.

1.2 To the Reader

As members and affiliated companies of the American Chemistry Council, the Hydrogen Fluoride Panel supports efforts to improve the industry's responsible management of chemicals. To assist in this effort, The Panel supported the creation and publication of these Guidelines. The Panel is composed of the following companies:

Arkema Inc.	3M
Chemours	Honeywell
Daikin America, Inc.	Mexichem SA de CV
DuPont	Solvay Fluorides, LLC

1.3 Purpose and Use of Guidelines

These Guidelines have been developed for use by producers and industrial users of AHF or HF, chemical companies and independent or contractor emergency response personnel, ACC's CHEMTREC®, Local Emergency Planning Committees (LEPCs), and transporters of AHF or HF and their emergency response personnel.

The purpose of this product stewardship document is to provide the reader with a better understanding of the properties of AHF or HF to serve as a resource in the development of producers' and users' design, operation, maintenance, training and emergency response practices. References to applicable regulations and industry practices are made in the text, tables, figures, and appendices, as appropriate. Contact an AHF or HF supplier for further information as necessary.

This edition of the Guidelines, issued in 2018, is the third edition. It is available on the internet at www.americanchemistry.com/hydrogenfluoride. It may also be available through an AHF or HF supplier on its individual company website. This document may be updated. Readers should stay abreast of new developments and information about AHF or HF, including but not limited to physical properties, handling technology, medical treatment, and regulatory requirements that occur after the date of publication of this document.

Contact an AHF or HF supplier or visit https://www.americanchemistry.com/hfpanel/ to obtain the most current version of these Guidelines, for questions, or to get more information about any information presented in this document. The Hydrogen Fluoride Panel encourages comments on the content of this document and a more in-depth dialogue concerning the issues presented.

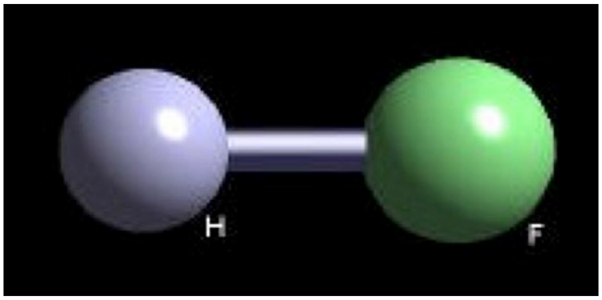
2.0 Chemical Identification, Production, and Use

2.1 Chemical Identification

Hydrogen fluoride (HF)[1] is a colorless gas at temperatures above about 67°F (19.5°C), and a clear, colorless, corrosive, fuming liquid at lower temperatures. It has an extremely acrid odor. Released AHF will quickly volatilize in air at room temperature, forming dense white vapor clouds that may rise or fall.[2] Released 50% or > HF will quickly form a white vapor cloud.

HF readily dissolves in water to form colorless hydrofluoric acid solutions; dilute solutions are visibly indistinguishable from water. It is highly soluble in alcohol and many organic compounds.

Undiluted, or pure, HF is often referred to as anhydrous hydrogen fluoride[3] or AHF, while solutions of HF in water are generally referred to as hydrofluoric acid or by the percentage of HF in the solution, such as "70% HF" or "49% HF." 70% and 49% HF are the most commonly available commercial concentrations in North America. See Appendix A for more information on the physical properties and characteristics of AHF, 70% HF, and 49% HF.



Source: Web Elements http://www.webelements.com

HF is highly reactive with many substances. It is highly corrosive, and contact between HF and metals, glass, concrete, silica, strong bases, sodium hydroxide, potassium hydroxide, ceramics, leather, natural rubber, and other materials may result in violent reactions. Due to these properties, safety considerations, and extensive industry experience, AHF is usually shipped in steel cylinders and other pressure rated bulk containers. See Appendices C and D for specific recommendations. If stored, it is stored in corrosion-resistant containers. It should also be noted that the corrosive action of HF on metals can result in the formation of hydrogen gas.

Substance	Hydrogen Fluoride
Chemical Abstract Service Registry Number (CASRN)	7664-39-3
Group	Inorganic Corrosive
Synonyms	anhydrous hydrofluoric acid aqueous hydrogen fluoride antisal 2B hydrofluoride hydrofluoric acid fluorhydric acid fluorohydric acid fluoric acid fluoride HF HF-A AHF
RTECSClaire confirmed number	MW7875000
UN#	1052 (anhydrous); 1790 (solution)
DOT ID (Guide #)	1052 (125) (anhydrous) 1790 (157) (solution)

2.2 Production of HF

In industrial settings, HF is generally derived from the reaction of concentrated sulphuric acid (H2SO4) on fluorspar (CaF2). The process generally used is to react 93 to 99 percent sulfuric acid and pulverized acid grade fluorspar (calcium fluoride). The reaction occurs in a heated rotary kiln at a controlled temperature for approximately 30 to 60 minutes. The reaction products are hydrogen fluoride gas and calcium sulfate.

Once it is produced, AHF can be shipped by a variety of methods. As noted above, due to the reactivity of the material, it is generally shipped in a steel container or vessel. In North America, approximately

1 The chemical structure of hydrogen fluoride is H-F, molecular weight 20.01. HF may exist in complexes or polymers, such as HF, due to hydrogen binding.
2 The NIOSH Pocket Guide to chemical hazards describes HF as a colorless gas or fuming liquid below 67°F. http://www.cdc.gov/niosh/npg/npgd0334.html. (Note that solutions containing HF will also fume in air, with fuming reported for HF concentrations of at least 48%).
3 "Anhydrous" means "without water."

85 to 90 percent of AHF is shipped in rail cars, with the remainder shipped in tank trucks (cargo tanks), portable tanks, and cylinders. The majority of AHF produced in the United States originates from two Gulf Coast area facilities. Significant quantities are also imported into the United States from Mexico.

2.3 Uses for HF

HF is an essential commercial chemical that serves as a raw material, catalyst or processing agent for manufacture of the following materials: refrigerants, high-octane gasoline, aluminum, herbicides, pharmaceuticals, plastics, electronic components, and incandescent light bulbs. It is also used for etching glass and metal. In low concentrations (e.g., 2.5 to 12 percent), it is present in a variety of over-the-counter products available to consumers. See Appendix B for examples of specific product applications for HF.

3.0 Environmental Fate and Effects

HF is very reactive in the environment and quickly forms salts. When HF is released into the atmosphere, it will react and dissociate on contact with soils, water, structures and all living matter. Plants and some wildlife are susceptible to HF exposure. Very low HF vapor concentrations (0.1 to 0.5 ppm) can injure or kill vegetation. Birds are very susceptible due to their high respiratory rates. Fish can be affected with very low fluoride concentration in water.

4.0 Health Factors, Industrial Hygiene, and First Aid

4.1 Health Factors

This section provides a brief overview of information pertaining to potential acute (short term) health hazards associated with exposure to HF. A comprehensive discussion of health effects information pertaining to HF is beyond the scope of these guidelines. For more information, contact a supplier of HF. Additional information, including first aid information, also may be found in the supplier's Safety Data Sheet (SDS).

There are many excellent resources available for developing a plan to treat HF exposures. For example, ATSDR's Medical Management Guidelines for Hydrogen Fluoride can be a useful guidance tool,[4] and the Australian National Occupational Health and Safety Commission has also published a useful resource tool. The HF manufacturer's Safety Data Sheet (SDS) will also include specific first aid instructions; first aid instructions on an SDS accompanying HF should be followed.

Development of a first aid plan should be done in consultation with appropriately trained medical personnel. To facilitate proper and timely first aid treatment, it can be useful to arrange in advance and have available medical receiving facilities and names of physicians (backup as well as primary) trained in HF emergency treatment.

It is noted that specific first aid procedures may vary based on fact-specific circumstances, recommendations of trained medical personnel, and other factors. Another useful component of a first aid program can be to develop exposure route flowcharts. Several examples are reproduced in Appendix I. Personal decontamination procedures used by some HF manufacturers are included in Appendix J.

For more general information about potential health effects of hydrogen fluoride, consult resources such as the U.S. Center for Disease Control's Fact Sheet about Hydrogen Fluoride[5]; ATSDR's Toxicity Profile on Fluorides[6], European Union HF Risk Assessment[7], and Australian National Occupational Health and Safety Commission's Guide to Hydrogen Fluoride[8].

4 ATSDR's Medical Management Guidelines for Hydrogen Fluoride

5 U.S. Center for Disease Control's Fact Sheet about Hydrogen Fluoride

6 ATSDR's Toxicity Profile on Fluorides

7 European Union HF Risk Assessment

4.1.1 General Health Information

Hydrogen Fluoride or HF is extremely hazardous in both liquid and vapor states. See Appendix I for details on emergency first aid procedures. Contact with HF requires specialized treatment. It can cause severe injury to any tissue with which it comes in contact (chemical burn). Exposure by contact with skin, or by inhalation or ingestion, can lead to severe toxic systemic effects (Acute Fluoride Intoxication) and potentially death. Eye contact from vapor or liquid can result in blindness if not treated immediately. Death can occur from severe electrolytic imbalance (hypocalcemia and hypomagnesemia) that leads to cardiac arrhythmia (fibrillation), which, in turn, can lead to cardio-respiratory arrest.

HF penetrates tissue quickly and can penetrate all levels of the skin within a few minutes. HF rapidly dissociates into hydrogen and fluoride ions. Within the body, the disassociated fluoride ion will preferentially bind to calcium (and to a lesser extent magnesium). Depletion of serum calcium and magnesium may cause serious toxic systemic effects. Washing the exposed tissue with water does not neutralize HF and cannot reverse the skin penetration. While prompt water washing is required for initial decontamination, HF-specific first aid treatments bind the fluoride to calcium, and rapidly starting such treatments is critical to stopping further tissue damage.

The local (harm to the part of the body a substance comes into contact with) and systemic (harm that changes the function of other organs) toxic effects that can occur following exposure to HF will vary widely depending on the concentration of HF, duration and route of exposure. Effects may range from mild and reversible, such as mild irritation of the skin, eyes and respiratory tract, to serious and potentially life- threatening.

Hyperkalemia (excessive concentration of potassium in the exposed area) is often cited as the cause of intense pain.

8 Safety Commission's Guide to Hydrogen Fluoride

4.1.2 Acute Inhalation Exposure

Inhalation of HF results in upper airway irritation in the nose and throat. More significant exposures may result in coughing and pain under the sternum. Exposure to low concentrations of HF can result in irritation of nasal passages, dryness and bleeding from the nose. While continued exposure to low concentrations can result in an ulcerated and perforated nasal septum, due to the irritant effects of HF, employees are unlikely to tolerate this repeated exposure.

Significant inhalation exposures will almost always result in signs or symptoms of upper airway irritation, so deep lung injury is unlikely in the absence of upper airway irritation. The risk is in failing to recognize the seriousness of an inhalation exposure as laryngeal and pulmonary edema may have delayed onset. Failure to recognize and treat an inhalation exposure may result in discharging a patient who then progresses to laryngeal and/or pulmonary edema.

In addition to the direct local effects on the lung, inhalation exposures pose a significant risk for systemic toxicity. Close observation for respiratory effects and signs of systemic toxicity is warranted.

4.1.3 Skin Exposure

Exposure to anhydrous or aqueous HF solutions above 50% will produce immediate burns. Less concentrated solutions may result in delayed burns which become apparent several hours following exposure. With dilute solutions (5% or less), burns may not be immediately painful or visible, but may be displayed 24 hours or more after exposure.

4.1.4 Eye Exposure

Eye contact with HF results in a feeling of burning, redness, and secretion. Even a splash of a dilute HF solution can quickly result in conjunctivitis, keratitis, or more serious destruction of eye tissue.

4.1.5 Chronic Hazard

Due to the high corrosivity and irritant effects of HF, chronic exposures and associated health effects are unlikely.

The U.S. Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 3 ppm, 8-hour, time-weighted average for HF. 8 The threshold limit value (TLV®) established by the American Conference of Governmental Industrial Hygienists (ACGIH®) for HF is 2 ppm (Ceiling), 0.5 ppm 8 hr. TWA . The TLV refers to the airborne concentration and represents the condition under which ACGIH believes that nearly all workers may be repeatedly exposed, day after day, without adverse health effects. The value is a time-weighted average (TWA) concentration for an 8-hour workday and 40-hour work week. It only serves as a guide in the control of health hazards, and not as a fine line to distinguish between safe and dangerous concentrations. It should be noted that where the TLV is lower than the PEL, OSHA has taken the position in the past that it will embrace the more restrictive limit and use it in conjunction with the general duty clause in its enforcement role. TLVs, RELs, and PELs are subject to change by their associated peer review groups. As with other references in these Guidelines, users must check the current reference for up-to-date information.

EPA has issued Acute Exposure Guideline Levels, or AEGLs, for HF. AEGLs describe the risk to humans (general public) resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals. The National Advisory Committee for AEGLs develops these guidelines to help both national and local authorities, as well as private companies, deal with emergencies involving spills, or other catastrophic exposures. Acute exposures are defined as single, non-repetitive exposures (emergency exposure periods) for not more than eight hours.

- AEGL 1 is the airborne concentration (expressed as ppm and mg/m3) of a substance at or above which it is predicted that the general population, including “susceptible” but excluding “hyper susceptible” individuals, could experience notable discomfort. Airborne concentrations below AEGL 1 represent exposure levels that could produce mild odor, taste or other sensory irritations.
- AEGL 2 is the airborne concentration (expressed as ppm and mg/m3) of a substance at or above which it is predicted that the general population, including “susceptible” but excluding “hyper susceptible” individuals, could experience irreversible or other serious, long-lasting effects or impaired ability to escape.
- AEGL 3 is the airborne concentration (expressed as ppm and mg/m3) of a substance at or above which it is predicted that the general population, including “susceptible” but excluding “hyper susceptible” individuals, could experience life-threatening effects or death.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGLs) for HF

Issued by EPA National Advisory Committee

Classification	10-Minute	30-Minute	60-Minute	4-Hour	8-Hour
AEGL-1 (Nondisabling)	1 ppm (0.8 mg/m3)	1 ppm (0.8 mg/m3)	1 ppm (0.8 mg/m3)	1 ppm (0.8 mg/m3)	1 ppm (0.8 mg/m3)
AEGL-2 (Disabling)	95 ppm (78 mg/m3)	34 ppm (28 mg/m3)	24 ppm (20 mg/m3)	12 ppm (9.8 mg/m3)	12 ppm (9.8 mg/m3)
AEGL-3 (Lethal)	170 ppm (139 mg/m3)	62 ppm (51 mg/m3)	44 ppm (36 mg/m3)	22 ppm (18 mg/m3)	22 ppm (18 mg/m3)

The American Industrial Hygiene Association (AIHA) publishes Emergency Response Planning Guidelines (ERPGs). These guidelines set one-hour exposure limits for effects on the general public for use in emergency response situations. ERPG-1 is the allowable concentration for mild transient effects or objectionable odor (discomfort). ERPG-2 is the concentration for serious health effects or impaired ability to take protective action (disability). ERPG-3 is the allowable concentration for life-threatening effects (death).

The National Institute for Occupational Safety and Health (NIOSH) has set an IDLH (immediately dangerous to life or health) level for HF at 30 ppm. The current NIOSH definition for an immediately dangerous to life or health condition is a situation "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." NIOSH's intention in setting an IDLH is to "ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment." NIOSH's respirator decision logic uses IDLH criteria to aid in the selection of respirators for emergency and certain other situations.

EMERGENCY RESPONSE PLANNING GUIDELINES (ERPGs) for HF

Issued by the American Industrial Hygiene Association

ERPG 1 (60 min)	2 ppm	ERPG 1 (10 min)	2 ppm
ERPG 2 (60 min)	20 ppm	ERPG 2 (10 min)	50 ppm
ERPG 3 (60 min)	50 ppm	ERPG 3 (10 min)	170 ppm

5.0 Personal Protective Equipment

Personal protective equipment (PPE) serves to complement but not substitute for engineering controls including safe working conditions, adequate process control, ventilation and proper conduct by employees working with HF. The appropriate selection and use of personal protective equipment will normally consider the total and fact-specific situation in addition to the toxic properties of compounds to which a worker may be exposed. These situations may involve the presence of other materials that can magnify potential concerns associated with HF. Therefore, the information presented in this section with regard to PPE selection is to be considered as a potential reference point for general guidance. Users need to select appropriate personal protective equipment based on their specific needs and circumstances. Other chemicals or factors may require the use of additional protection. Except in extreme emergencies, no one should be given personal protective equipment without suitable training.

Location, care and selection of appropriate PPE are dictated by the proposed use of the equipment. Companies have assigned personnel, facilities and programs for suitable care, decontamination and repair of all equipment. These programs include a process to check with the PPE manufacturer regarding the suitability of the PPE and materials of construction for a particular use; in addition, they check the specific use instructions and restrictions of the PPE manufacturer. Companies provide training so that employees using PPE in HF service are extensively experienced in the use of the relevant PPE prior to its use in HF service. Consult the manufacturer's product use recommendations where provided.

5.1 Protective Clothing

HF is highly corrosive and reactive, and rapidly penetrates tissue with which it comes into contact. Workers in contact with HF should be aware of the permeation, penetration, and degradation characteristics of HF on PPE and take appropriate precautions. In particular, workers should be aware of the limits of PPE in HF service. For example, such PPE may not be designed to come into contact with liquid streams of HF. Please contact your PPE supplier for additional information.

For HF, NIOSH's recommendation for skin protection is to prevent skin contact, and the recommended protective clothing barriers are Tychem™ (8 hour) and Teflon™ (4 hour). *The Quick Selection Guide to Chemical Protective Clothing* also provides that the following PPE designations would be appropriate where contact with HF is anticipated:

- Level A (fully encapsulating suit - highest level of respiratory, skin and eye protection).

The Level A suit is ordinarily used in most emergency response situations. Level A protection, when used in compliance with the manufacturer's instructions and recommendations, should provide adequate gaseous HF resistance (adequate penetration and permeation times).

The definitions of the four levels of PPE may be found in the Hazardous Waste Operations and Emergency Response (HAZWOPER) regulations, 49 CFR §1910.120, Appendix B. More information is available in the Hydrogen Fluoride Industry Practices Institute's (HFIPI) "Personal Protective Equipment Guideline For Anhydrous Hydrogen Fluoride," most recent edition.

5.2 Respiratory Protection

The Occupational Safety and Health Administration (OSHA) provided requirements for respiratory protective equipment. (See Title 29 CFR 1910.134 as amended). Such equipment is carefully maintained, inspected, cleaned and disinfected at regular intervals and before use by another person. Consult a reliable safety equipment dealer for details on the proper use of approved equipment.

In its *Pocket Guide to Chemical Hazards*, NIOSH makes respirator recommendations for HF.

5.3 Decontamination

Decontamination of PPE following a response is an important part of any Emergency Response Plan (ERP). For more detailed discussion, see Section 10.6, Decontamination of PPE.

6.0 Emergency Response

Every emergency situation will be different. It is not the intention of these Guidelines to address every potential emergency situation; it is intended to help producers, users, and others as a resource in the development of their own emergency procedures for responding to an HF incident.

Emergency responders must be properly trained and equipped in accordance with OSHA standards on emergency response and emergency fire protection (29 CFR 1910.38, 1910.120 and Subpart L). The first priority in responding to an emergency situation is the safety of the emergency responders, employees, and people in the surrounding community. The second priority is to determine the incident's impact on the surrounding environment, and to set a strategy to stabilize the situation and minimize the impact. The third priority is the conservation or protection of equipment and property.

6.1 Specific Emergency Response Considerations

6.1.1 Establishing Response Perimeter

Establishing an emergency response perimeter is a common feature of an emergency response plan. The DOT *North American Emergency Response Guidebook* provides the following guidance for incident isolation:

6.1.2 Monitoring Wind Direction

After noting wind and weather conditions and whether fumes are visible from HF container, place the hot zone perimeter at an appropriate distance away from visible fumes.

Monitoring wind and weather conditions is important so that the hot zone perimeter can by appropriately identified.

***Caution* The Emergency Response Guidebook was written for transportation emergencies. The isolation and perimeter recommendations may not be sufficient for releases that occur in from storage vessels or process equipment that could contain a higher volume of material that**

HF vapor is heavier than air. However, the initial release may result in an exothermic reaction causing the vapor cloud to temporarily rise.

6.1.3 Exposure Limits

Some known HF exposure limits are displayed below.

Exposure Limits for HF	
OSHA (PEL)	3 ppm, 8 hr TWA
ACGIH (TLV)	2 ppm (1.7 mg/m3), Ceiling
ACGIH (TLV)	0.5 ppm (0.4 mg/m3), 8 hr TWA

6.1.4 Air Monitoring Equipment for HF

6.1.1 Establishing Response Perimeter

	First ISOLATE in all Directions		Then PROTECT persons Downwind during											
			Day						Night					
			Low wind (<6 mph = <10 km/h)		Moderate wind (6-12 mph = 10-20 km/h)		High wind (>12 mph = >20 km/h)		Low wind (<6 mph = <10 km/h)		Moderate wind (6-12 mph = 10-20 km/h)		High wind (>12 mph = >20 km/h)	
	Meters	(Feet)	km	(miles)	km	(miles)	km	(miles)	km	(miles)	km	(miles)	km	(miles)
Transport Container	**UN1052 Hydrogen fluoride, anhydrous: Large Spills**													
Rail Tank Car	400	(1250)	3.1	(1.9)	1.9	(1.2)	1.6	(1.0)	6.1	(3.8)	2.9	(1.8)	1.9	(1.2)
Highway tank truck or trailer	200	(700)	1.9	(1.2)	1.0	(0.7)	0.9	(0.6)	3.4	(2.2)	1.6	(1.0)	0.9	(0.6)
Multiple small cylinders or single ton cylinder	100	(300)	0.8	(0.5)	0.4	(0.2)	0.3	(0.2)	1.6	(1.0)	0.5	(0.3)	0.3	(0.2)

6.1.4a Air Monitoring Equipment for HF

Detector Tubes		Gas Meter (Electrochemical)	
Advantages	Disadvantages	Advantages	Disadvantages
Portable No batteries or power source required	One time use detector tubes Not continuous, gives only a "snapshot in time" Large number of detector tubes may be needed Tubes have limited shelf life Qualitative measurements based on color change in tubes Correction factor required for temperature and humidity Glass tubes are potential puncture hazard ("sharps") Potential false positive readings due to other chemical interactions	Portable Continuous Data logging capabilities Direct reading instrument (quantitative measure)	HF exposure higher than range will require recalibration Power source (battery/electric) required 1-5 minute response lag time Limited range (based on sensor) Maintenance requirements Potential false positive readings due to other chemical interactions

6.1.5 Mitigation of HF with Water Spray

AHF fumes appear as a white fog and can significantly impede visibility. HF fumes are very water-soluble. Water sprays may reduce acid and vapor. A spray volume adequate to manage fumes is used in mitigation; spray volume from 500 to 1,000 gallons per minute (gpm) per nozzle is generally used. The number of nozzles used is dependent on leak size and the amount of visible fumes. HF removal efficiencies of 90+% have been demonstrated with water to HF ratios of 40 to 1. High velocity water spray may create its own draft, inducing additional air movement.

As for mitigation of HF fumes from 50 to 70% HF liquid solutions consideration must be made on the ability to contain and treat run off versus human exposure to the fumes.

CAUTION: Water runoff will contain weak acid solutions. Contact with these dilute solutions may still result in burns and may not be evident until several hours after contact.

Insufficient water on liquid spills is likely to cause increased vapors and extreme heat; copious water amounts are recommended. Liquid HF that has been diluted to below 40% is less likely to emit significant vapors.

Supplying water in the form of a spray or fog (rather than a stream) on the fume cloud or downwind of the source can help reduce acid and vapor. As noted above, the water supply will create runoff containing weak acid solutions, so it is important to contain or appropriately manage the runoff. Proper waste disposal concerns and environmental impacts should be considered.

CAUTION: Spraying mitigation water onto the damaged container or directly onto the container should be avoided where possible because this can accelerate corrosion and make the leak larger.

6.1.6 Neutralization

HF solutions can be neutralized with alkaline materials. Runoff containing HF can be neutralized with alkaline materials such as lime, soda ash, bicarbonate of soda, sodium hydroxide or potassium hydroxide. Alkaline chemical neutralization may result in significant heat or gas generation and will result in inorganic salt formation. Some inorganic salts may be environmental toxins. Use of calcium-based compounds yields salt neutralization products with less environmental impact.

HF contaminated soil can be neutralized using lime slurry or ground limestone slurry. Contaminated soil must be removed and disposed of in compliance with applicable state and federal environmental regulatory requirements, such as appropriately labeled containers and disposal in approved facilities (e.g., RCRA TSD facility).

CAUTION: Most neutralizing agents have high heats of dilution/reaction; use appropriately diluted neutralizing agents.

6.1.6a Typical alkaline materials used for neutralization of HF.

Alkaline Material	Common Name(s)	Form(s) Available	Hazards/ Reaction	Lb 100% Base per Lb. 100% HF	Salt Properties
Calcium Carbonate ($CaCO_3$)	Limestone	Pebbles	• Slow Reaction • Slow Evolution of Carbon Dioxide Gas (CO_2) • Pebble Surface Can Become Passivated	2.50 lb / lb HF	Calcium Fluoride (CaF_2) Non-hazardous Sol. In Water = 0.004%
Calcium Hydroxide [$Ca(OH)_2$]	Hydrated Lime	Dry Powder Slurry in Water	• High Heat of Neutralization • Slippery When Wet	1.85 lb / lb HF	Calcium Fluoride (CaF_2) Non-hazardous Sol. In Water = 0.004%
Calcium Oxide (CaO)	Quicklime	Dry Powder	• DOT Class 8 (Corrosive) • Very High Heat of Hydration and Neutralization	1.40 lb / lb HF	Calcium Fluoride (CaF_2) Non - hazardous Sol. In Water = 0.004%
Potassium Hydroxide (KOH)	Caustic, Potash	85% Solid Beads or Flake <45% Solution	• DOT Class 8 (Corrosive) • Very High Heat of Dilution and Neutralization • Poison	2.80 lb / lb HF	Potassium Fluoride (KF) DOT Class 6 (Poison) Sol. in Water >40%
Sodium Bicarbonate ($NaHCO_3$)	Bicarb, Baking Soda	Dry Powder	• Rapid Evolution of Carbon Dioxide Gas (CO_2) • Poison	4.20 lb / lb HF	Sodium Fluoride (NaF) DOT Class 6 (Poison) Sol. in Water = 4.0
Sodium Carbonate (Na_2CO_3)	Soda Ash	Dry Powder	• Rapid Evolution of Carbon Dioxide Gas (CO_2) • Poison	2.65 lb / lb HF	Sodium Fluoride (NaF) DOT Class 6 (Poison) Sol. in Water=4.0%
Sodium Hydroxide (NaOH)	Caustic Soda	100% Solid Beads or Flake <50% Solution	• DOT Class 8 (Corrosive) • Very High Heat of Dilution and Neutralization • Poison	2.00 lb / lb HF	Sodium Fluoride (NaF) DOT Class 6 (Poison) Sol. in Water = 4.0%

6.1.7 Run-off Control

Run-off is generally isolated away from the mitigation area so it can be treated. Clay, other non- sand containing soils, or some absorbent socks can be used to control run-off. Quantities of run-off can be substantial, because mitigation can generate run-off at a rate of 500 to 1,000 gallons per minute. Where possible, avoid isolating run-off where metal is exposed, because aqueous hydrogen fluoride reacts with metal and forms hydrogen gas, which can be explosive. In addition, HF contact with metal creates a scale of iron fluoride, and this scale produces HF again when exposed to water.

6.2 Reporting Requirements

6.2.1 Federal and State Requirements

Report releases as required by federal, state and local authorities. Federal law requires prompt notification to the National Response Center (800-424-8802) for reportable quantity (RQ) releases.

The RQ for AHF is 100 pounds, measured as 100% HF. Consult state and local officials for other reporting requirements.

6.2.2 CHEMTREC® and HF Mutual Aid Network

CHEMTREC® is an American Chemistry Council public service that provides 24-hour services to callers needing information and assistance for emergencies involving chemicals and hazardous materials. CHEMTREC's service is also used by thousands of companies that ship hazardous materials to help meet the DOT regulations requiring a 24-hour emergency telephone number.

CHEMTREC: (800) 424-9300 or (703) 527-3887 (collect).

The member companies of the American Chemistry Council have entered into a Mutual Aid Agreement for HF. To activate the network, call CHEMTREC.

Procedures for activating the Hydrogen Fluoride Mutual Aid Network are on page 14. An example flowchart for emergency response is on page 15.

Procedures for activating the Hydrogen Fluoride Mutual Aid Network

If the Shipper is known - CHEMTREC will:

- Call Shipper.
- Provide details of emergency, location, contact names, other relevant information.
- Provide Shipper with company name, phone number(s) and location of the nearest Response Team.
- Advise the Shipper that CHEMTREC is available for additional assistance if required.

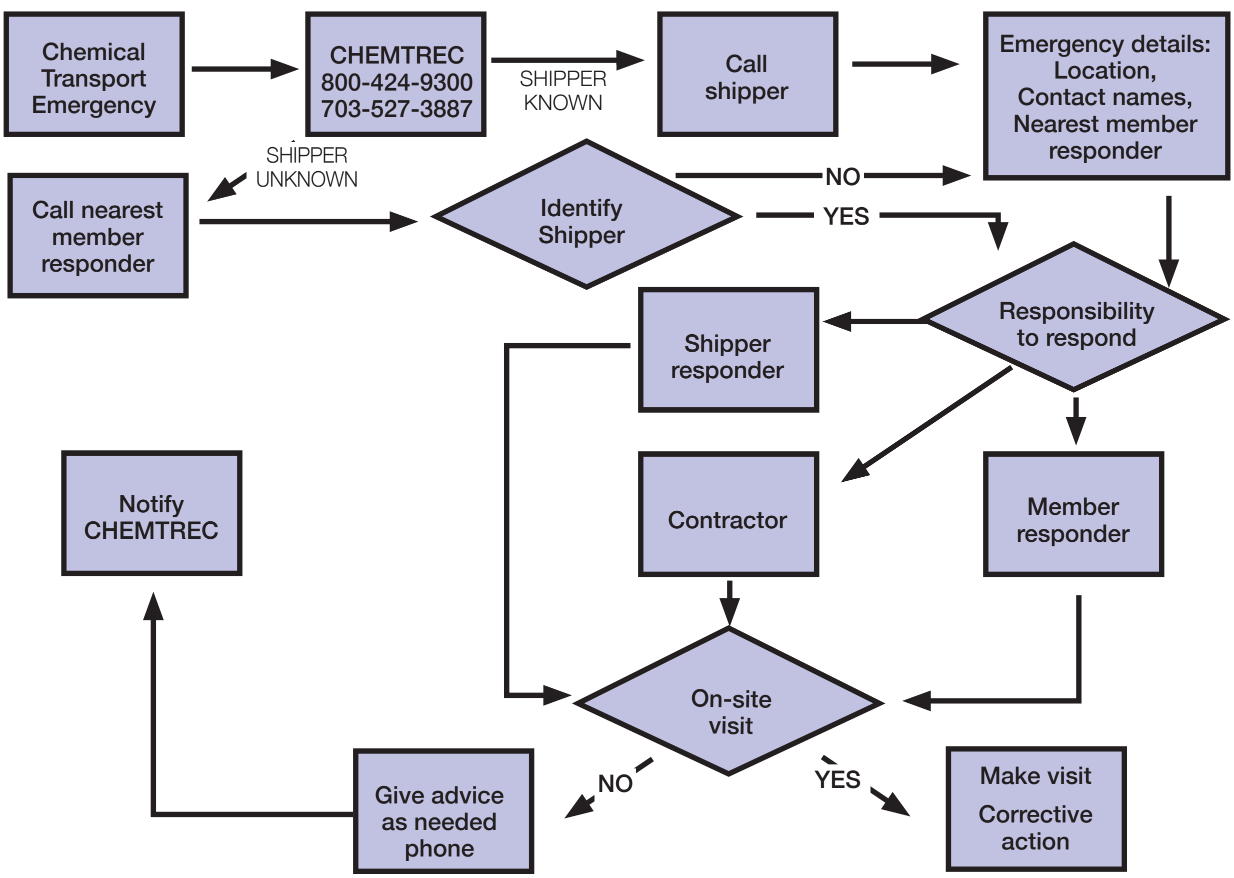
If the Shipper is Unknown - CHEMTREC will:

- Call the nearest Member Responder.
- Advise the Contact that the Shipper is unknown, provide details of the emergency and request assistance.
- If the Shipper is subsequently established, CHEMTREC will contact Shipper, provide details of emergency and actions taken, including company name and phone numbers of the Response Team called by CHEMTREC.

HF Mutual Aid Network Understandings and Practices

- Shipper has primary responsibility for incident response.
- Member's Responder(s) is expected to provide assistance until the Shipper assumes responsibility.
- However, the Mutual Aid Network Agreement does not require a Member's Responder to stay at the HF Distribution Incident scene any longer than 24 hours. Assistance is designed to protect "life and the environment" and reduce any public inconvenience.
- A shipper may find it timely to fly to an incident if other Member Responder(s) are over 200 miles from an incident. Emergency response teams, equipment, procedures and decisions must be established in advance of an incident. These Guidelines may assist in establishing such protocols.
- The HF Mutual Aid Network encourages periodic and systematic review and practice of plant emergency response procedures.

Example Flowchart for Emergency Response



7.0 Damage Assessment

7.1 Introduction

This section is intended to assist first responders with the evaluation of the extent of AHF railcar or tank truck damage. (See also Appendices C-F, Descriptions of HF Containers, for typical descriptions and orientations.) Assessment of equipment damage helps inform the decision whether to proceed with immediate AHF transloading or to move (e.g., dragging, lifting with a crane) the damaged railcar or tank truck a short distance in order to place it in an upright position or otherwise position it in a manner suitable to support more detailed damage assessment. This section does not address every possible scenario of damage to a railcar or tank truck. Transloading AHF is inherently dangerous and should only be performed by properly trained, equipped and protected personnel. Although any damage assessment should be conducted only by personnel with appropriate training and experience, for significant incidents, an on-site damage assessment conducted by highly trained personnel is often made before moving the railcar or tank truck from the incident scene.

This section addresses damage assessment of AHF transportation equipment, specifically:

- AHF railcars (per AAR Terminology); made from A-516 grade 70 carbon steel, post weld heat treated, with head shields;
- AHF tank trailers; made from 316 stainless steel with relief valve settings at 195 psig; and
- AHF tank trailers; made from A-516 grade 70 carbon steel and relief valve settings at 150 psig.

The damage assessment will be dependent on the fact-specific circumstances of the incident. Some first responders may find it helpful to think of the damage assessment in two phases: primary assessment and secondary assessment, and this section is structured accordingly. Some damage assessments may have one phase; others two or three, depending on the complexity of the incident, the urgency of the response needed, and other factors.

7.2 Primary Assessment

A primary assessment is generally conducted from a safe upwind vantage point. Consider making the following observations or collecting the following information to help inform the primary assessment:

- Equipment for fumes or leakage at manway, nozzles, valves, relief devices, tanks, heads for punctured or damaged areas
- Pressure tank for cracking at welds, scores, gouges, dents, rail and wheel burns, and stub sill underframe attachments
- Tank position (on end, on side, upside-down, upright) whether the tank is or was exposed to fire or heat
- Whether any hazardous situations or products are present that could threaten emergency response personnel
- Other relevant information, as appropriate for the site-specific circumstances

7.3 Secondary Assessment

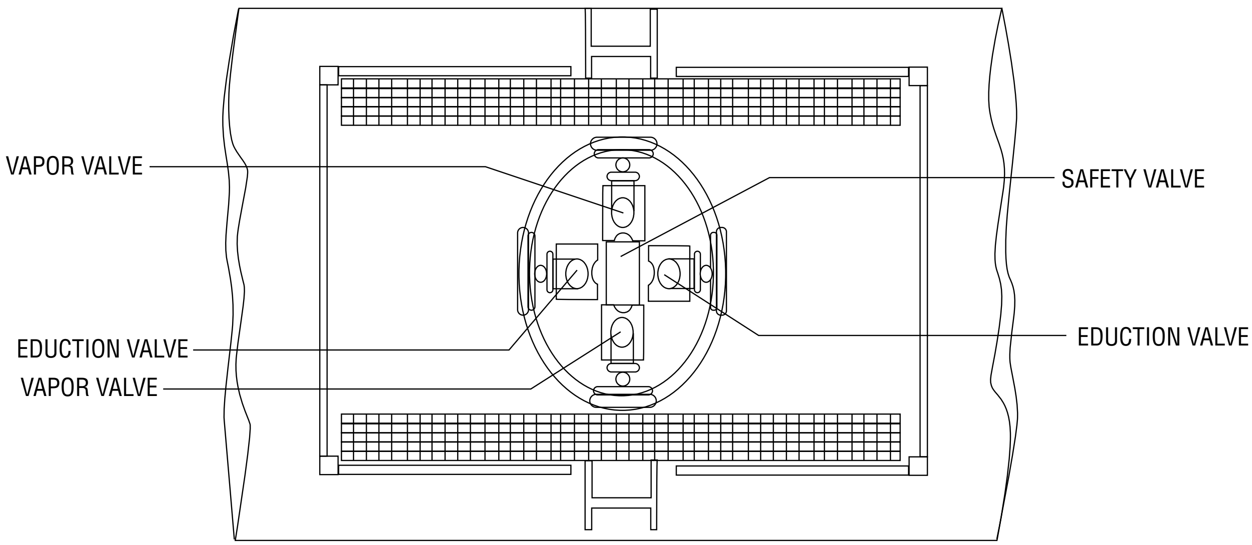
As conditions permit safe access, and with the use of appropriate personal protective equipment, consider collecting and recording the following additional data:

- Railcar/trailer placard information – year built, identification number For tank truck, determine material of construction
- Ambient temperature and pressure tank temperature
- Quantity of AHF in tank
- Full or half head shields on railcars

Some examples of the type of information that may be inspected, measured, and recorded in the secondary assessment are as follows:

- AHF leakage — look carefully for leaks at relief devices, valves, flanged/gasket joints, welds, scores, gouges, wheel burns, rail burns, dents, and stub sill and other tank attachments.
- Crack length and direction — look for cracking associated with welds, scores, gouges, dents, wheel burns, stub sill and other tank attachment welds, and fasteners in flanged joints. PARTICULARLY NOTE any cracking at welds in conjunction with scores, gouges, wheel burns, rail burns, and dents. Large open cracks may be found visually; however, small tight cracks may require dye penetrant examination. Cracks in

Typical Railcar (and some Trailers) Valve Arrangement in Dome



the pressure tank or welds directly on the tank are critical. Cracks in pads or attachments are often non-critical and may not require a response (acceptable) unless they have the potential to extend into the pressure tank;

- Length, maximum depth and direction of scoring, gouging, wheel burns, rail burns, cold worked areas, and dents — PARTICULARLY NOTE the condition at welds and weld heat affected zones the metal depth removed by crossing scores, gouges or wheel burns;

The following considerations may be useful in assisting the evaluation:

  - A crack, gouge, wheel burn, or dent at near a weld tend to suggest more significant structural damage than similar damage to the base metal
  - The larger or deeper the crack, gouge, wheel burn, or dent, the more suggestive of significant damage
  - The closer the crack, gouge, wheel burn, or dent to a weld, the more suggestive of significant damage
  - In winter temperatures where the railcar or tank truck shell temperature has dropped, the lower temperature may affect equipment and materials.

- Minimum radius-of-curvature — and depth of dents, rail burns and cold worked areas;
- Accessibility — to internal dip pipe, dip pipe position and condition versus transloading requirements; condition of railcar/trailer regarding pressurization to 50 psig for transloading.

Collecting information from the first and secondary assessments, as well as any other relevant information, helps responders evaluate whether the damaged railcar or tank truck can be moved from the incident site. Railcars or tank trucks with significant damage that threaten the integrity of the equipment are generally not moved, but transloaded in place.

The following table provides general considerations for transportation equipment based on the primary and secondary assessment:

Condition	Action to Consider	Notes
Leaking AHF from fittings, valves, relief devices	Tighten fasteners, install capping kit	Avoid water on AHF leaks (corrosive)
Leaking AHF (that cannot be stopped by tightening, or capping)	Transload in place; Do Not Move	Avoid water on AHF leaks (corrosive)
Pressure within 15% of relief device setting	Transload in place; Do Not Move	If exposed to fire or heat, spray water to cool tank

8.0 Leaks

This section focuses on mitigation of leaking AHF containers. Depending on the fact-specific circumstances of an incident, emergency response personnel may address other concerns in advance of dealing with leaks.

8.1 Type of HF Leak (Vapor or Liquid)

AHF liquid can vaporize, with a total vapor volume 285 times greater than the liquid (this means that one cubic foot of liquid AHF will make more than 285 cubic feet of HF vapor). Positioning a container so that the leak is in the vapor space, if possible, will help minimize the leak.

Liquid HF trapped in a vessel liquid full can fail catastrophically as it is warmed up due to thermal expansion. This also applies to plug and ball valves.

CAUTION: Because AHF liquid can vaporize, avoid trapping liquid AHF in lines between closed valves or in the cavity of plug and ball valves.

8.2 Leak Locations

8.2.1 Equipment Leaks

Most leaks occur in fittings. Fitting leaks tend to be small and can occur for a variety of reasons. Often, tightening the valve or fitting stops the release. Some locations for these leaks are:

- Flanges
- Pressure Plates
- Relief Valves
- Process Valves
- Plugs
- Stems of Packed Valves

8.2.2 Equipment Breaches

These leaks are typically caused by impact or improper repairs. The leaks can be any size. They usually are:

- Punctures found at the impact site
- Cracks found along body plates and welding seams

8.3 Compatible Equipment and Materials

There are a number of materials that have been successfully used in HF service to address HF leaks. The materials here are some of those that have been successfully used for gaskets and patching leaks.

8.3.1 Materials Demonstrated to Be Suitable for Use (Compatible) to Address HF leaks

- Polypropylene – good for all HF concentrations
- Polytetrafluoroethylene (PTFE); Teflon®
- EPDM
- Viton®
- Steel
- A516-70 Carbon Steel for HF concentrations of 70% or greater
- Butyl Rubber (n-Butyl Rubber or Chlorobutyl Rubber)

8.4 Techniques/Equipment Used to Address Leaks

The chart on the next page illustrates some methods and practices to address leaks that have been effective in industry experiences. Other techniques and equipment may be appropriate given particular circumstances.

8.4a Techniques/Equipment Used to Address Leaks

Methods/Tools to Address Leaks	Type of Leaks	Special Conditions of Use
Metal Crimping	Works on stainless steel tubing	
Capping Kits	• Relief valves on railcars and some tank trucks • Process valves on railcars and some tank trucks	Capping Kit must be specifically made for HFservice (check with kit manufacturer and/or instructions). Some relief devices for cargo tanks may require a 3” threaded plug or cap. Contact railcar or tank truck owner, or HF producers, for experience regarding selection of appropriate capping kit. Distinguish between the standard kit and the next generation rail car. Emergency Kit “C”(“C-Kit”) application to the Midland Manufacturing dual valve Models A-718-HC and Model A-718-A.
Plugs	• Small leaks in pipe • Small leaks in vessels	Plug material should be HF compatible, or use a compatible gasket material for the contact surface between the HF and the plug
Pneumatic Bags and Strap	• Irregular sized leaks • Leaks with uneven surfaces	Surface contacting HF must be HF-compatible. Metal strapping or steel chains should be used; many plastic strapping materials can degrade when in HF contact
Stainless Steel Self Tapping Screws	Very small puncture holes	A hole may be required to install a tap screw (especially in rail cars) CAUTION: use care if the leak was not caused by impact. A condition called hydrogen blistering could have occurred in the vessel, which could result in a bigger hole when a tap screw is used.
Pipe Clamps and Flange Clamps/Covers *(intended for high pressure service leaks)*	• Piping leaks • Fitting leaks	Clamps that cover lines or flanges must be intended for high pressure leak service. The clamp gasketing material must be compatible with HF and, when sealed, provides for pressure service.
Blind Flanges	Can be installed temporarily for leaky valves	Can be installed for short-term transport or as an unloading seal CAUTION: AHF liquid should not be blocked in a non-vented, non-pressure vessel because of the expansion potential
Pressure Plate Attached by Welded Bolt or Stud	• Small vessel leaks • Vessel leaks with close to flat surfaces	After bolt or stud welding is completed, use an HF-compatible gasketing material to seal pressure plate onto damaged vessel.
Hot or Cold Tapping	Small flowing leaks that need to be diverted before sealing	A stub is installed which diverts flow from leak tapping before it is sealed. *See Section 9.3, Hot/Cold Taps, for more detail.*

9.0 Emergency Transloading

9.1 Introduction

Emergency on-site transloading is an option on those occasions when the damaged container cannot be safely moved to a manufacturing or user facility experienced with handling bulk AHF, or when the damaged container has not been immediately managed at the incident site. When possible, all containers being used to receive the material from a damaged transport container should be placed on portable scales to indicate material transfer. In any case, a suitable method of level determination (e.g. back scatter radiation device, infrared temperature reading device) must be employed to prevent an overfill of the transfer container.

In most cases, the liquid transfer hose will be connected to the damaged tank at the lowest point connection. If the damaged vessel is on its side, the vent line may best facilitate gravity transfer.

This section presents a series of illustrations of typical transloading practices. Company practices may vary, and responses to any particular incident may vary based on specific facts and circumstances.

> **NOTE: Unless people trained and equipped for HF specific first aid procedures are present, no transfer should be attempted.**

9.2 Using Existing Valves and Fittings on Non-leaking Containers

9.2.1 Differential Pressure Transfer

To conduct a differential pressure transfer, connect the liquid hose from the damaged vessel liquid valve discharge to the receiving container liquid inlet. The liquid transfer line will have a block and bleed valve assembly for pressuring the line. Install the block and bleed valve assembly as close as is practical to the damaged container. Leak check the connections with nitrogen or air and an appropriate leak detection fluid prior to HF introduction.

Run a vent line from the receiving container vapor vent to a neutralization container. (See discussion of neutralization facilities below at Section 9.4, Venting/Field Scrubbing).

The receiving vessel is maintained at a slight positive pressure to minimize HF vaporization by controlling the vapor line bleed valve. Appropriately pressure the damaged container with nitrogen or dry air (10-15 pounds maximum is generally used).

Open the vapor line from the receiving container to a neutralization system. Open the damaged container liquid transfer line isolation valve to the receiving container's isolation valve. The transfer operation will take considerable time due to the damaged vessel's low pressure and the neutralization system capacity. The liquid transfer hose will sag, immediately indicating the transfer is flowing.

When the transfer operation is concluded, the liquid hose will jump, and the nitrogen or dry air can be heard blowing through the hose. Close the damaged container's liquid line transfer valve, purge the line to the receiving vessel, and close the receiving vessel's liquid transfer valve. Vent the receiving container to atmospheric pressure through the neutralization system.

9.2.2 Gravity Transfer

Gravity transfer requires the receiving container to be located below the damaged container. Either the damaged container can be elevated or the receiving container can be placed below it, terrain permitting. The receiving container is vented to the damaged container or to a scrubbing system to prevent pressure buildup.

Gravity transfer will be slower than differential pressure transfer due to HF flashing. Inducing a small amount of pressure in the damaged container may be necessary to initiate liquid transfer.

9.2.3 Pump Transfer

Pump transfer of AHF liquid is a practice used in stationary plant environments, and it is technically feasible to use field transfers using this technique.

> **CAUTION: This technique should only be attempted by personnel with appropriate expertise and in consultation with HF experts.**

If this option is under consideration, consult with appropriate technical experts, such as the pump manufacturer, with HF transfers.

9.2.4 Non-sealable Breached Container

This type of leaking container presents a technically challenging transfer. The HF will generally flash off (volatilize) and interrupt transfer. However, the

HF flashing will then cause the remaining material to liquefy and pool in the damaged container. This breached container is emptied and decontaminated prior to removal. Generally, a breached container that cannot be sealed is not moved.

Gravity transfer can be used where the terrain is conducive to gravity flow. If the terrain is not suitable for gravity transfer, excavation may allow a receiving container to be placed below the breached container. The breached container requires a dip tube submerged into the liquid. Initiating flow is particularly challenging, as the material will prefer to flash when it enters the pipe and transfer hose.

9.3 Hot/Cold Taps

CAUTION: Although technically feasible, there is little to no industry experience with this technique. This technique should only be attempted by personnel with appropriate expertise and in consultation with HF experts.

A sealed container with unusable unloading connections may be given a "Hot Tap." A hot tap is created by welding a nipple onto the damaged container at the vessel low point. Additionally, any pressure that may build due to the welding heat must be controlled. With this technique, after installation of the welded nipple, a special apparatus would be mounted on the nipple that would seal the connection, provide a drain/transfer hose connection with an isolation valve, and allow drilling through the container wall. Once the container is punctured with the drill, the drill is extracted into a containment cavity. The drill bit has a packing gland to prevent/minimize any leakage during drilling and extraction. A flex hose is connected on the apparatus that would connect to the receiving container for gravity transfer.

A "Cold Tap" apparatus is similar to the "Hot Tap" equipment noted above. The primary difference is the method of attaching to the damaged container. Some bases of the cold tap apparatus are magnetic, with chain/belt reinforcement to assist in holding the apparatus onto a carbon steel (C/S) container. The drilling function and hose connection/isolation valves are the same as the hot tap apparatus.

9.4 Venting/Field Scrubbing

Receiving containers or vessels are vented to prevent pressure build up. Acidic HF vapors are contained by a neutralizing scrubber. The simplest system to accomplish this consists of a flex hose or piping attached through a check valve to the vent of the receiving vessel and discharging sub-surface into a container filled with a suitable alkaline material. See chart "Typical Alkaline Materials (Bases) for Neutralization of HF" in Section 6.1.6a, Neutralization, for scrubbing media options.

The transfer/vent hose or pipe may be of stainless, carbon steel or any other HF compatible material. See Section 8.3, Compatible Equipment and Materials, for further discussion.

To minimize the likelihood of plugging and precipitation in the scrubber vessel, an alkaline material that will yield a soluble salt product (e.g., Caustic Soda or Caustic Potash) should be considered. Note: The spent scrubber salt solution may need further treatment to remove dissolved fluoride prior to ultimate disposal.

The efficiency of the scrubber can be increased by use of a diffusion sparger on the sub surface line discharge. The line and sparger are carefully secured in the scrubber container.

The scrubber container capacity and the strength of the alkaline scrubbing medium will influence the rate at which the transfer can proceed. The transfer rate is adjusted to accommodate the scrubber capability. If plastic or plastic lined vessels are used (e.g., polyethylene or polypropylene), the transfer rate is controlled so as to not overheat the scrubber, which may cause the container walls to distend. A cold water curtain on the external surface of the scrubber may control the heat evolution.

The scrubber media is generally monitored for pH. A pH of 7 or less, stable for a reasonable period (generally at least 15 minutes), indicates the alkaline scrubbing medium has been expended. If the medium is expended, cease the transfer, remove the scrubber salt solution for ultimate proper disposal, and replenish the scrubber with fresh alkaline solution before continuing.

A successful field transfer of a full truck load of AHF was accomplished using a portable 4000 gal. high-density polyethylene tank filled with water and the pH maintained at 10 with soda ash. A stainless steel hose with a stainless steel check valve installed was connected to the vapor space of the receiving trailer and used as a sparger in the scrubber tank. The volume of water was sufficient to serve as a heat sink for the heat of neutralization for the entire transfer. No foaming or off gassing was experienced.

10.0 Decontamination of Transfer Equipment

10.1 Purging/Evacuating to Non-Fuming Condition

After a damaged container is emptied, water flooding is often used to complete damaged container purging, and continues until the container is completely clean. Ice and slaked lime may be used with water to reduce the extreme heat of reaction and possible HF and water vaporization. Refer to chart "Typical Alkaline Materials (Bases) for Neutralization of HF" in Section 6.1.6, Neutralization, for heat of reaction/dilution information. The effluent pH is checked until neutral and stable for an appropriate period, generally at least 15 minutes, because the pH may drift downward.

10.2 Flushing with Neutralizing Solutions

Large amounts of water are generally used to flush an empty container. Alternatively, use ice followed by slaked lime or ground limestone. Formation of insoluble CaF, while non-hazardous, may render the container unusable.

Water is likely to cause increased vapors and extreme heat. Hydrogen gas, which may be explosive, could also be generated.

10.3 Sealing Equipment for Transportation

Tools are decontaminated before leaving the incident site. Due to HF reactivity, it may be necessary to dispose of the tools following decontamination. Checking equipment for a neutral pH by swiping with a water dampened broad range pH paper is a valuable step in verifying that the equipment has been properly decontaminated.

After decontamination, the container can be sealed and water filled (with proper venting). Remaining trace AHF will be readily absorbed into the water, which supports the safe transport of the container. Empty metal containers holding residual HF and water traces may result in hydrogen gas formation, which could be explosive, so it is important that they are properly vented.

10.4 Transporting Cleaning Effluents

Dispose of cleaning effluents in accordance with applicable local, state, and federal requirements. Dilute acid solutions may be transported in lined containers; neutralized solutions may be shipped in plastic containers. It may be appropriate for dilute acid solutions to be discharged into aqueous waste systems through slaked lime or ground limestone. The resultant calcium fluoride CaF2 is non-hazardous.

10.5 Decontamination of PPE

Protection of emergency response personnel from inadvertent exposure to HF requires thorough decontamination of PPE prior to removal of contaminated or even potentially contaminated PPE. Decontamination of PPE following a response is an important part of any Emergency Response Plan (ERP). A typical decontamination procedure prior to removal of PPE used in an HF response might include:

1. rinse with water
2. rinse with dilute neutralizing agent, such as Baking Soda (sodium bicarbonate, (NaHCO3))
3. rinse with water

PPE should be cleaned and inspected in accordance with the manufacturer's guidelines. If PPE cannot be thoroughly decontaminated (due, for example, to an unknown amount of permeation), dispose of the PPE properly.

APPENDIX A

Physical Properties and Characteristics of AHF, 70% HF, and 49% HF

Concentration	ANHYDROUS HF (AHF)	70% HF	49% HF
General Description	• A clear, colorless, corrosive fuming liquid with an extremely acrid odor. • Forms dense white vapor clouds if released. • Both liquid and vapor can cause severe burns. • Exposure requires specialized medical treatment.	• A fuming, corrosive liquid acid. • Both liquid and vapor can cause severe burns • Exposure requires specialized medical treatment.	• A corrosive, liquid acid. • Both liquid and vapor can cause severe burns. • Exposure requires specialized medical treatment.
Appearance	Colorless liquid, fumes in air	Colorless liquid, fumes in air	Colorless liquid
Physical State (at 70ºF)	Liquid	Liquid	Liquid
Molecular Weight	20.01	20.01 (HF)	20.01 (HF)
Chemical Formula	HF	70% HF in H_2O by weight	49% HF in H_2O by weight
Odor	Sharp Pungent Odor	Sharp Pungent Odor	Sharp Pungent Odor
Specific Gravity	Water=1.0) 0.97 @ 70°F (21.1°C)	Water=1.0) 1.225 @ @ 70°F (21.1°C)	Water=1.0) 1.175 @ 60°F (15.5°C)
Solubility in Water	100% by weight	100% by weight	100% by weight
pH	Not Applicable	Not Applicable	3.4pH
Boiling Point	67.2°F (19.54°C)	151°F (66°C)	224°F (106°C)
Melting Point	-118°F (-84°C)	-95.8°F (-71°C)	-34°F (-37°C)
Vapor Pressure	776 mmHg at 70°F (21°C)	110 mmHg at 70°F (21°C)	27 mmHg at 70°F (21°C)
Vapor Density (Air=1.0)	2.21 at 70°F, 1.76 at 80°F	2.21 at 70°F, 1.76 at 80°F	2.21 at 70°F, 1.76 at 80°F
Evaporation Rate	Not Applicable	Not Applicable	Not Applicable
% Volatiles	100%	100%	100%
Ionization Potential	15.98 eV	15.98 eV	15.98 eV
Flash Point	Not Flammable	Not Flammable	Not Flammable

NOTE: This Appendix presents data for anhydrous, 70% and 49% hydrofluoric acid because these are the most commonly available concentrations. Note, however, that HF solutions may be available in lower percentages. The user should be aware that even lower concentrations may be extremely hazardous, and should consult the manufacturer's SDS for specific safety information

APPENDIX B

Examples of Specific HF Product Applications

Catalyst

- Petroleum alkylation units to produce high octane gasoline blending stock

Fluorochemicals

- Refrigeration – process cooling, food preservation, industrial-home-auto air conditioning and refrigeration
- Electronics – cleaning and etching for silicon based semi-conductor devices
- Pharmaceutical intermediates and anesthetics Agrochemical intermediates
- Metered dose inhalers Fire extinguishing agents
- Foam blowing agents – polyurethane and polystyrene insulation for domestic appliances,
- construction, food processing and packaging

Metal Processing Aluminum manufacture

- Metal extraction – tantalum, beryllium, titanium, niobium
- Metal processing – surface treatment of stainless steel, titanium and high-strength aerospace alloys chemical milling
- Nuclear reactor fuel production for electric power generation and military applications

Fluoropolymers and fluoroelastomers *(these are chemically resistant across a broad temperature range)*

- Aerospace and military – wire cable insulation, seals, hoses, space apparel
- Automotive – seals, fuel/brake hoses, control cables
- Chemicals – lined pipes/valves/pumps, gaskets/seals, tank linings, wire insulation
- Semiconductors – high-purity handling equipment, silicon wafer carriers, garments
- Power Generation – acid resistant filter bags, radiation resistant wire insulation
- Telecommunications – LAN Cable, wiring, fiber optic cladding and cable
- Consumer – non-stick cookware, waterproof/breathable clothing, appliance wiring
- Protective clothing - firefighting and hazardous response

APPENDIX C

Description of AHF Tank Car

Image courtesy of Honeywell International

AHF is typically shipped 80-90 net tons, 23,000 U.S. gallon shell full, non-insulated tank cars designed according to the Association of American Railroads (AAR) "Manual of Standards and Recommended Practices, Specifications for Tank Cars." AHF tank cars are painted white and have a "safety orange" center band.

US DOT requires that each tank car manufactured after March 16, 2009 for AHF be Class 105J500I or 112J500I.(49CFR 173.244(a)(2). Tank cars manufactured prior to March 16, 2009 authorized for AHF can continue to be in use for the car's service life. These may include DOT 112S200W, 112S400W, 112S340W or 112S500W,.

Special conditions noted here are contained in the DOT exemptions for AHF rail cars, DOT-SP 11759 for pre-2009 cars, and DOT-SP 15284 for the post 2009 tank cars in that alternative pressure devices are authorized. Additionally, the requirement for insulating metal jackets are waived. This is due to the special need for external inspection access because of the highly corrosive nature of AHF. Transport Canada has granted Equivalency Certificates for the same requirements.

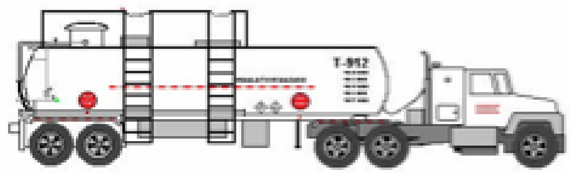
Bottom outlets are prohibited [49 CFR 179.100-14(a)]. All access valves are located within a cylindrical protective housing mounted on a top center cover plate [49 CFR 179.100-12]. A hinged cover is provided with provision for a cable seal at the front and a back secure latch [HFIPI Tank Car Unloading Guideline for AHF, latest edition].

Two (2) primary liquid valves connected to dip piping are mounted on the longitudinal axis. Two (2) primary vapor valves in contact with the vapor space are mounted on the horizontal axis. A pressure relief valve is mounted in the protective housing center.

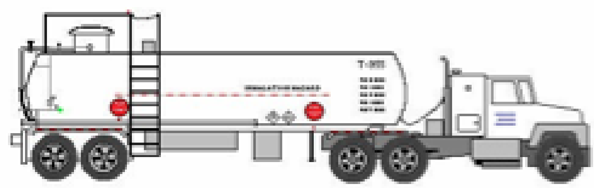
For further information on the valve types used for AHF Tank Cars, refer to the latest edition of the HFIPI's "New Tank Car Guideline for Anhydrous Hydrogen Fluoride" (www.hfipi.org).

APPENDIX D

Description of AHF Tank Trailer



DOT 412 (current design criteria)



MC 312 design (construction pre-1996)

Images courtesy of Honeywell International

Trailers in AHF (UN 1052) service are typically 5,300 gallon capacity, single compartment, non- insulated, non-coiled, non-baffled and designed according to DOT-412 specifications or, for units constructed prior to September 1995, MC-312 specifications. Payload is usually 36,000 to 40,000 lbs. Tank and piping construction material is A516 Grade 70 carbon steel or 316L stainless steel. Alloy 20 is also used for piping, but not for the tank. Bottom outlets are not authorized for HF service. Acid is unloaded by applying regulated nitrogen pressure to the vapor space and discharging product through a standpipe terminating at an external valve. All root valves are contained in a single protective dome at the top, trailer rear. Tanks typically contain product and vapor at ambient temperatures.

Differences between MC-312 and DOT-412 are significant and are addressed separately. MC-312 Root valves for liquid loading, liquid discharge or nitrogen pressurization may be either manual ¼turn valves or rising stem internal or external valves that may be remotely operable. They are contained in a protective housing at the trailer rear. If the nitrogen pressurizing and liquid discharge valves are manual, remotely actuated, air operated emergency shutdown valves are also provided. Manual root valves require climbing on the cargo tanks' top. Remotely operable valves are typically air-to-operate open, spring-to-close and operable from several locations at grade around the trailer. Pressure relief valves are also mounted within the rear dome. All product and pressure relief valves may be capped using either a Chlorine Institute "C" Kit or devices designed for AHF service and provided by the shipper.

DOT-412

All root valves (internal or external) in product contact must be remotely operable and are typically contained in a protective housing at the trailer top rear. Enhanced relieving capacity must be designed into DOT-412 pressure relief devices and the devices must be mounted in the longitudinal and lateral center of the vapor space. All valves and pressure relief devices are capable of being capped using either a Chlorine Institute "C" Kit or devices designed for AHF service and provided by the shipper.

APPENDIX E

Description of Hydrofluoric Acid Solution (Aqueous HF) Cargo Tank

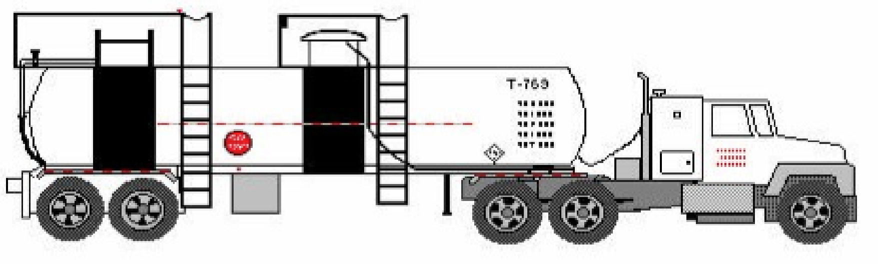


Image courtesy of Honeywell International

Cargo tanks in Aqueous HF (UN 1790) service are typically 4,500 gallon capacity, single compartment, non-insulated, non-coiled, non-baffled and designed according to DOT-412 specifications or, for units constructed prior to September 1995, MC-312 specifications. Payload is usually 36,000 to 40,000 lbs. Acid strength encountered in commerce can be 25%, 38%, 49% or 70%. Construction material of the tank is carbon steel. Tanks are lined with chlorobutyl rubber or, for acid strength at or below 49%, may be lined with fluoropolymer (e.g. PTFE). All external piping is fluoropolymer or plastic lined. Bottom outlets are not authorized for HF service. Acid is unloaded by applying regulated air pressure to the vapor space and discharging product through a standpipe terminating at a valve at the trailer top rear. Pressurizing and loading valves and pressure relief devices are typically installed at the tank top center. All valves and tank openings are protected by a protective dome or tombstone type rollover protection. Tanks typically contain product and vapor at ambient temperatures.

Other differences between MC-312 and DOT-412 are significant and are addressed separately. MC-312 root valves for liquid loading, liquid discharge or air pressurization may be either manual ¼ turn valves or rising stem internal or external valves that may be remotely operable. If the liquid discharge valve is manual, a remotely actuated, air operated emergency shutdown valve is also provided. Remotely operable valves are typically air-to-operate open, spring-to-close and operable from several locations at grade around the trailer. Pressure relief valves may be mounted at the rear but are usually found in the tank center.

DOT-412

All root valves (internal or external) in contact with the product must be remotely operable. Enhanced relieving capacity must be designed into DOT-412 pressure relief devices and the devices must be mounted in the longitudinal and lateral center of the vapor space.

APPENDIX F

Description of ISO Containers

AHF ISO containers are carbon steel framed tanks. They normally come in two sizes. One is about 20 feet long (6,000-6,700 gal) and the other is about 30 feet long (8,900-10,000 gal). Both containers are 8 feet in width and can range in height from 8 to 8.5 feet. They are baffled and all fittings, access point are welded on the container. All valves and fittings are in a locked or sealed housing to protect them against damage caused by overturning or impact and from unauthorized access. Typically the vapor valves are painted yellow and the liquid valves are painted red. The liquid valves are attached to a dip pipe that terminates in a sump. All outlet valves have an internal stop valve.

For aqueous hydrogen fluoride "IM101" DOT 51 intermodal containers are used. Their nominal size is 4,500 to 5,000 gallons. Carbon steel or stainless steel construction material is lined with either chloro-butyl or an appropriate fluoropolymer material.

APPENDIX G

References to Regulations and Other Guidance

American Conference of Governmental Industrial Hygienists:

- TLVs ® and BEIs ® Based on the Documentation of the Threshold Limit Value for Chemical Substances and Physical Agents & Biological Exposure Indices

Agency for Toxic Substances and Disease Registry (ATSDR):

- "Managing Hazardous Materials Incidents" series (https://www.atsdr.cdc.gov/MHMI/index.asp) contains recommendations for on-scene (pre-hospital), and hospital medical management of patients exposed during a hazardous materials incident.
- Toxicological Profile for Fluorides (https://www.atsdr.cdc.gov/mhmi/mmg11.pdf)

American Industrial Hygiene Association (AIHA):

- AIHA 2016: Environmental Response Planning Guidelines (https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Pages/default.aspx)

CHEMTREC:

- "Users Guide for Emergency Responders," published by ACC (www.chemtrec.org)

Environmental Protection Agency (EPA):

- "Chemical Profile for Hydrogen Fluoride," published by Office of Solid Waste and Emergency Response (https://www.epa.gov/sites/production/files/2016-10/documents/hydrogen-fluoride.pdf)

European Union:

- Substance Information- Hydrogen Fluoride (https://echa.europa.eu/substance-information/-/substanceinfo/100.028.759)

National Fire Protection Association (NFPA):

- 472 "Professional Competence of Responders to Hazardous Materials Incidents" (http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=472)

National Institute of Occupational Safety and Health

- NIOSH Pocket Guide to Chemical Hazards (https://www.cdc.gov/niosh/npg/npgd0334.html)

North American Emergency Response Guide (ERG)

- https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg

Occupational Safety and Health Administration:

- Permissible Exposure Limit (https://www.osha.gov/dts/chemicalsampling/data/CH_246500.html)

U.S. Department of Transportation:

- North American Emergency Response Guide (ERG), latest edition (http://phmsa.dot.gov/hazmat/outreach-training/erg)

United Nations:

- "Environmental Health Criteria #227, Fluorides," World Health Organization, 2002.

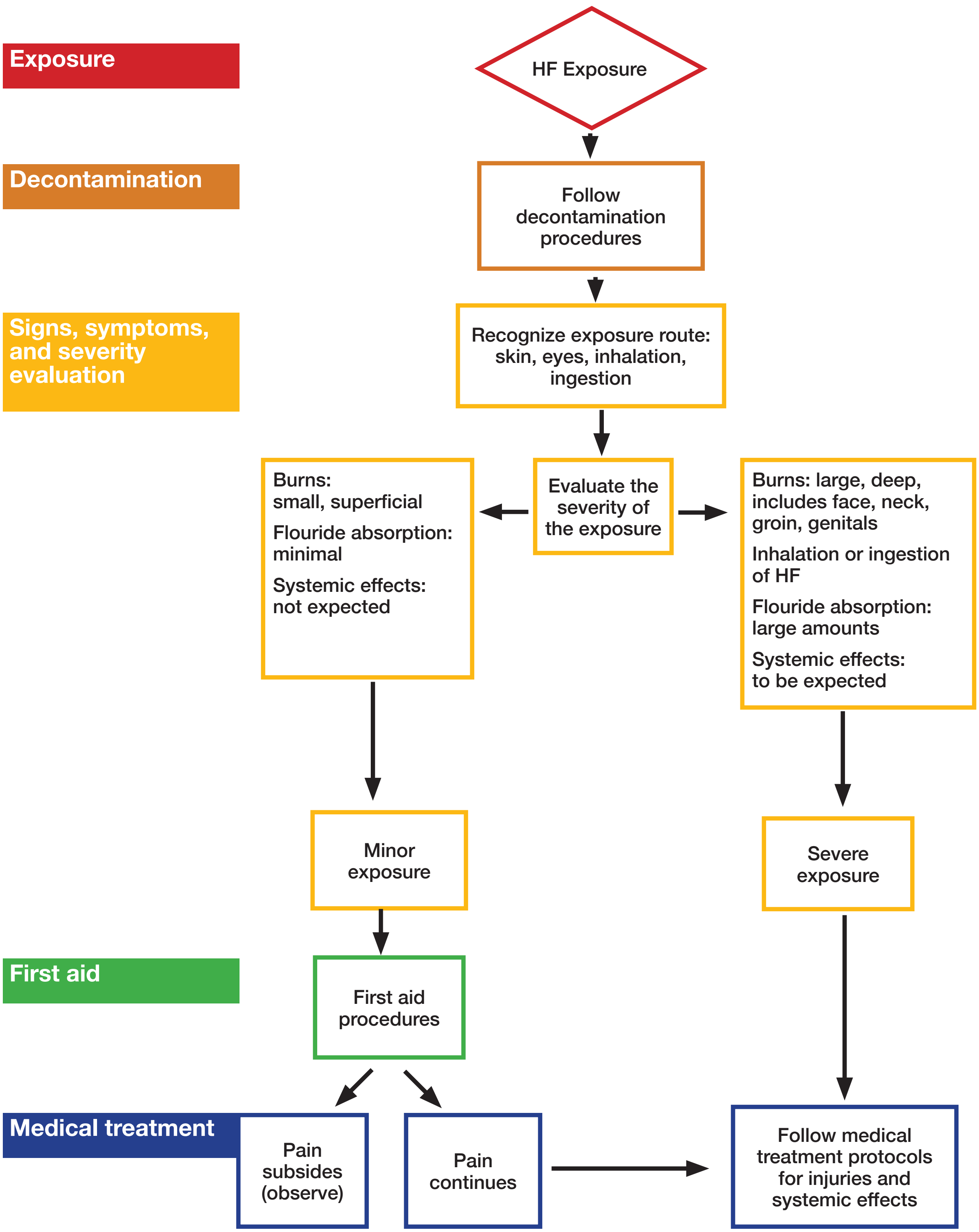
(http://www.inchem.org/documents/ehc/ehc/ehc227.htm)

- UN1052 and UN1790 regulations for trailers in AHF and aqueous HF service

APPENDIX H

Typical Exposure Management Flowcharts
(Decontamination, Evaluation, First Aid and Medical Treatment)

General Procedure to be followed:



Exposure

Skin Exposure

Decontamination

Decontamination procedure for AHF and HF aqueous solutions:
- Go to the nearest source of water or safety shower
- Turn water on
- While washing, remove ALL clothing, shoes, and jewelry
- Finally, while closing your eyes and facing the water flow, remove your goggles or respirator face mask
- Wash for 5 minutes maximum if first aid treatments are immediately available. Otherwise continue to wash until first aid treatments are available.

Decontamination procedure for HF-containing tars and oils:
After protecting your hands with PVC, nitrile or neoprene gloves, proceed to
- Mechanically remove the tar or oil usubg gauze, tongue depressor, paper towels, etc.
- Consider all discarded materials hazardous waste and handle them appropriately
- Use baby oil to remove leftover tar or oil
- Remove baby oil residue thoroughly by washing with soap and water
- Wash with copious amounts of water for 5 minutes maximum or until first aid treatments are available.

Signs, symptoms, and severity evaluation

- Exposure to solution concentrations of HF <30%
- Exposed body surface to AHF less than 16 square inches
- Injury or pain appears several hours after exposure
- Superficial injuries
- Redness, blanching, swelling, pain
- Patient is conscious, stable, cooperative
- No apparent systemic toxic effects

Minor exposure

- Exposure to high concentrations of HF >30% or AHF
- Exposed body surface is greater than 16 square inches
- Injury or pain appears immediately after exposure, with severe pain, redness, blanching, blistering, and tissue necrosis
- Exposure of the face, groin, genitals or neck
- Patient is unconscious and unstable
- Cardiac arrythmia (irregular hearbeats)
- Systemic toxic effects present

Severe exposure

First aid

First aid procedures:
Using acid resistant gloves
- Immersion or compress with iced zephiran solution (0.13% benzalkonium chloride)

OR
- Continuously rub calcium gluconate 2.5% gel on the exposed area
- Note the time of initiation
- If pain significantly decreases or disappears with 20 to 30 minutes, stop and observe

First aid procedures:
Using acid resistant gloves
- Immersion or compress with iced zephiran solution (0.13% benzalkonium chloride)

OR
- Continuously rub calcium gluconate 2.5% gel on the exposed area until you reach medical assistance
- Follow medical procedures

Medical treatment

During transportation to a medical facility or while waiting for a physician to see the victim, it is extremely important to continue the zephiran soaks or compresses or continue massaging calcium gluconate gel

Medical treatment procedures:
Medical management of the chemical injuries after decontamination and first aid:
- If burn is responding to standard first aid treatments (i.e., zephiran soaks or calcium gluconate gel), continue until pain subsides
- If pain does not subside, inject into, around, and under all injuries a solution of 2.5-5% calcium gluconate solution in normal saline
- Never use local anesthetics which may hide pain perception, which is important to determine the amount of calcium gluconate to be injected
- Treat the injury after the injections as you would any open wound
- Do not over-inject digits, nose flaps or ear lobes so as to avoid ischemic necrosis

Medical treatment of the toxic systemic effects:
- Start IV drop of 1000cc normal saline + 20cc of 10% calcium gluconate solution
- The amount of solution and rate of administration will depend on the patient's serum calcium (electrolyte titration technique)
- Monitor EKG (prolonged QT interval), electrolytes (with special interest in calcium, magnesium, sodium, and potassium), chest X-rays, pH, blood chemistry, fluorides in urine and blood, liver and kidney functions
- Consider hemodialysis for the removal of serum fluorides and excess potassium

* There are other available and proven techniques—refer to Appendix 1

Exposure

Eye Exposure

Decontamination

Decontamination procedure:
- Go to the nearest eye wash or source of clean water
- Turn water on
- Put your eyes in the water flow
- Open your eyes for 5 minutes maximum. If you cannot open them, use your finger to maintain your eyelids open or ask for

Signs, symptoms, and severity evaluation

Severity: All exposures are considered severe because of the danger of vision loss. Consider the following in formation:

Exposure effects on	Mild exposure	Severe exposure
Skin	Minor irritation, reddening or swelling	Severe irritation, evidence of chemical burns of the eyelids and peri-ocular skin
Conjunctiva	Minimal irritation and injection (reddening)	Severe irritation, injection (reddening) and swelling, possible ulcerations
Cornea	No evidence of injury or minor irritaion	Corneal opacification, pitting or ulceration with vision loss and intense pain
Vision	No evidence of vision loss	Vision loss that can be temporary if it is only diue to corneal opacification, or permanent vision loss is retinal death occurs die to increased intraocular pressure

First aid

First aid procedures:
- Irrigate each eye with 1000cc of a 1% calcium gluconate solution (no higher than 1%) for a minimum period of 15 minutes or if necessary until medical aid is available.
- Use standard IV tubing fixed to the forehead if one eye is exposed. For both eyes use a nasal cannula (designed for oxygen delivery) mounted on the nose or a "morgan lens"® system for eye irrigation.
- The use of a local anesthetic such as two drops of Pontocaine® (tetracaine) will facilitate the irrigation of the eyes and also alow the insertion of the "morgan lens." This should always be inserted and removed while a continual flow of the irrigation solution is present.
- Always obtain specialized medical evaluation & treatment.

During transportation to a medical facility or while waiting for a physician to see the victim, it is extremely important to continue the calcium gluconate irrigation.

Medical treatment

Medical treatment procedures:
Evaluation: you should always obtain a specialized medical evaluation which includes a detailed study of the exposed eyes using a slit lamp, determination of ocular pressure and fundoscopy.
Treatment:
- If necessary, continue treatment with 1% calcium gluconate eye drops.
- Antibiotics and steroids can be used as indicated by an eye specialist.
- Monitor ocular pressure.
- Evaluate corneal opacification and conjunctival injury frequently.
- If skin, inhalation or ingestion exposure occurred do not forget to follow decontamination, first aid and medical treatment for those entry routes, including systemic toxicity Treatment protocols.
- Psychological support may be necessary.

* Other accepted treatment are listed in appendix 2.

Exposure

Inhalation Exposure

Decontamination

Decontamination procedures:
- It is not possible to decontaminate the respiratory tract.
- If exposed to HF vapors, expect to see skin and eye exposure. Follow decontamination procedures for these entry routes as described.

Signs, symptoms, and severity evaluation

Signs & symptoms:
- No signs & symptoms.
- Minor coughing.
- Erythema (reddening) and minor mucosal edema.

Mild exposure with minimal or no systemic effects expected

Signs & symptoms:
- Coughing
- Labored breathing
- Shortness of breath
- Erythema (reddening), swelling of the mouth, nose and throat
- Bronchial spasm
- Mucosal bleeding
- Upper airway edema
- Pulmonary edema
- Cardiac arrhythmia (irregular heart beat)

Severe exposure with respiratory, skin, eyes and systemic effects

First aid

First aid procedures:
- Administer oxygen by mask 12L per minute
- Nebulize calcium gluconate 2.5% In normal saline for 15 to 20 minutes minimum
- Obtain medical evaluation and observe

First aid procedures:
- Administer oxygen by mask 12L per minute
- Nebulize calcium gluconate 2.5% In normal saline continuously until medically evaluated
- If respiratory assistance is needed use indirect methods such as “Microshilds”® or “ambu” bag

Medical treatment

Medical treatment procedures:
For the respiratory tract and toxic systemic effects.
- Remember your abc’s secure air way and breathing, follow BCLS and ACLS procedures.
- Intermittent positive pressure breathing (ippb), and positive end expiratory pressure (peep) may be necessary.
- Respiratory assistance may be necessary until pulmonary edema has resolved and blood gaes are stabilized.
- The use of bronchodilators, steroids and antibiotics may be necessary.
- Start an IV drip of 1000cc of normal saline + 20cc of 10% calcium gluconate, the amount & flow of this solution will depend on the electrolyte results (ca).
- Monitor: chest x rays, ekg, blood gases, electrolytes, with special interest in CA, MG, K, NA, blood chemistry, fluorides in urine & blood and kidney & liver functions.
- In addition to CA, other electrolytes such as MG, K, and NA may need to be supplemented by IV.
- Consider hemodialysis for the removal of serum fluorides and excess potassium.

Exposure

Ingestion

Decontamination

Decontamination procedures:

- It is not possible to decontaminate the G.I. Tract.
- If skin or eyes have been exposed, decontamination & treatment procedures should de followed.

Signs, symptoms, and severity evaluation

Severity:

All exposures are considered severe because of the high probability of systemic toxic effects and G.I. Complications.

Signs & symptoms:

- Erythema (reddening) of the oral mucosa (mouth).
- Oral injury - ulcerations.
- Dysphagia (difficulty in swallowing).
- Bleeding of the oral cavity (mouth).
- Systemic toxicity should be expected.
- Possible bronchial or pulmonary injury due to aspiration if vomiting occurs.
- Cardiac arrhythmia (irregular heart beat).
- Death may occur.

First aid

First aid procedures:

- DO NOT INDUCE VOMITING!
- If patient is able to swallow, give oral calcium solutions or calcium based antacids, milk or water.
- If patient is unconscious obtain medical attention immediately.

Medical treatment

Medical treatment procedures:

Injury management:

- HF destroys fiber optics—consider before attempting endoscopic techniques.
- If possible install naso-gastric tube.
- Gastric lavage with calcium solutions or antacids.

Systemic toxic effects management:

- Establish IV drip 1000cc normal saline + 20cc of 10% calcium gluconate.
- The amount & flow rate of the calcium IV solution will depend on the serum calcium levels.
- Monitor ekg, electrolytes with special interest in CA, MG, K, and NA, chest x rays, blood gases, blood chemistry fluorides in urine & blood, kidney & liver functions.
- In addition to CA, other electrolytes such as MG, K, and NA may need to be supplemented by IV.
- Follow BCLS & ACLS procedures if necessary.
- Consider hemodyalisis for the removal of fluorides or excess potassium in blood.

APPENDIX I

Personnel Decontamination Procedures

CAUTION: Personnel responding to an HF exposure must wear appropriate Personal Protective Equipment to prevent secondary exposure. Wear surgical gloves, as a minimum, to protect against a secondary HF burn. Nitrile, PVC or neoprene gloves provide a higher degree of protection than latex gloves and should be used if available.

Eliminating HF contact quickly will minimize fluoride absorption.

Skin:

- Proceed to the nearest water source and begin flushing affected area with copious quantities of water.
- Under the water flow remove all clothing, jewelry and shoes.
- When using chemical goggles or a full face respirator, face the water flow, close eyes, remove the equipment and let the water flow away from the eyes.
- Flush with water for one to five minutes under the safety shower depending on shower flow rate, and the speed with which contaminated clothing, personal protective equipment, and other items can be removed.
- Immediately administer first aid and promptly seek medical attention.

Eyes:

- Proceed to the nearest water source.
- Under low pressure, clean water flow, open and close eyes continuously.
- Flush with water from one to five minutes under the eyewash, but it must be assured that there is adequate irrigation under the lids and in the corners of the eyes.
- Immediately administer first aid and promptly seek medical attention.

Respiratory Tract or Gastrointestinal Tract cannot be decontaminated. Immediately administer first aid and promptly seek medical attention.

First Aid Procedures

CAUTION: Significant Exposures to the skin, via inhalation or ingestion will lead to systemic toxic effects such as hypocalcemia and/or Acute Fluoride intoxication due to fluoride ion absorption. Please refer to the next section's Medical Treatment decision tree procedures for various exposure routes.

NOTE: Personnel who respond to an HF exposure incident must wear appropriate Personal Protective Equipment to prevent secondary exposure.

After thorough water decontamination and for inhalation or ingestion, where skin and possibly eyes need to be decontaminated, follow the First Aid procedures listed below. Ensure that the person to be treated is in a clean and safe environment.

Skin Decontamination

After an HF liquid or vapor exposure to the skin, begin decontamination with water under a safety shower as soon as possible. Clothing, personal protective equipment, and jewelry/watches should be assumed to be contaminated and removed while under the safety shower. HF is very water soluble, so water decontamination is highly effective. If more definitive treatment for HF exposures is available, decontamination time should be kept to a minimum. This may be as short as 1 to 5 minutes under the safety shower depending on shower flow rate, and the speed with which contaminated clothing, personal protective equipment, and other items can be removed.

If more definitive treatment for HF exposure is not available, water decontamination should be continued until either:

- More definitive treatment is available
- Transport services are available to take the individual to a medical care facility
- The need to treat other injuries or exposures (such as HF inhalation) takes precedence over further skin decontamination

The advice above applies to exposures of HF alone or in combination with another agent that is very water soluble. HF exposures combined with hydrocarbons or other agents that are not water soluble may require longer water decontamination or use of other decontamination methods.

HF Exposures to the Eye

Initial decontamination is with water from an eyewash or similar high flow device. Because of the discomfort associated with irrigating under the eyelids and in the corners of the eyes, use of a topical anesthetic is recommended after an initial brief decontamination. HF is very water soluble, so water decontamination is highly effective. If more definitive treatment for HF exposures is available, decontamination time should be kept to a minimum. This may be as short as 1 to 5 minutes under the eyewash, but it must be assured that there is adequate irrigation under the lids and in the corners of the eyes.

Once decontamination has been completed, continued irrigation with a low flow solution of 1% calcium gluconate is recommended. If 1% calcium gluconate for eye irrigation is not available, low flow irrigation with 0.9% saline should be continued while the individual is transported for medical evaluation by an eye specialist.

HF Ingestion

All individuals who have ingested HF or compounds that may generate HF on exposure to water should be transported to a medical facility for evaluation and treatment of both the local effects on the mouth and esophagus, and for systemic effects of HF. Given the limited efficacy of first aid treatments for HF ingestion, do not delay transport in order to give first aid treatment.

If trained personnel and supplies are available to initiate intravenous medications, strongly consider the infusion of calcium gluconate intravenously as presumptive treatment for impending systemic effects of HF (hypocalcemia being the most immediate).

Individuals who are conscious and have a burning sensation in the mouth may have some pain relief from rinsing with water or a calcium gluconate solution (the 1% solution for eyes or 2.5% solution used for nebulization would be suitable). They should be instructed not to swallow the solution, as this may trigger emesis (vomiting).While the use of calcium or magnesium antacids has been suggested as treatment for HF ingestion, there is little evidence of the efficacy of these treatments. Giving anything by mouth should be done only under the direction of a physician or poison control center.

APPENDIX J

Definitions and Acronyms

AAR: Association of American Railroads

ACGIH: American Conference of Governmental Industrial Hygienists

AEGL: Acute Exposure Guideline Level

AIHA: American Industrial Hygiene Association

AHF: Anhydrous Hydrogen Fluoride

ACC: American Chemistry Council

APF: Assigned Protection Factor

ATSDR: Agency for Toxic Substances and Disease Registry

Chemical Company: Legal entity that manufactures, transports, or uses HF products, including AHF and HF acid by rail, water or truck in the United States, Canada, or Mexico.

CFR: Code of Federal Regulations

CHEMTREC® (Chemical Transportation Emergency Center): 24-hour, 365-days per year chemical transportation emergency center operated by the American Chemistry Council.

DOT: U.S. Department of Transportation

EPA: U.S. Environmental Protection Agency

ERP: Emergency Response Plan

ERPG: Emergency Response Planning Guideline

FID: Flame ionization detector

GPM: Gallons per minute

HAZWOPER: Hazardous Waste Operations and Emergency Response HF: Hydrogen Fluoride (used for both anhydrous and aqueous HF)

HFIPI: Hydrogen Fluoride Industry Practices Institute

HF Mutual Aid Network: Network of Member Responders, coordinated by the American Chemistry Council through its Chemical Transportation Emergency Center (CHEMTREC®), providing emergency response to Hydrogen Fluoride Distribution Incidents (HFDI).

HF Mutual Aid Network Agreement: The Hydrogen Fluoride Mutual Aid Network Policy Statement and Agreement establishing the HF Mutual Aid Network, and the HF Mutual Aid Network Operations Framework, both of which are mutually incorporated by reference.

HF Mutual Aid Network Contact: Telephone number designated by each Member for emergency calls from the HF Mutual Aid Network 24 hours per day, every day of the year.

HF Mutual Aid Network Management: Task group composed of a single representative from each HF Mutual Aid Network Chemical Company Member.

Hydrogen Fluoride Distribution Incident (HFDI): A term used in the HF Mutual Aid Agreement to describe a distribution incident involving HF, AHF or HF Acid solutions that in the Shipper's, Transporter's or local authority's judgment may require a Member Responder's presence to provide Technical Advice and Assistance.
In such case, the incident: (i) presents a significant injury possibility for persons at or in the vicinity thereof; or (ii) presents a significant serious environmental damage possibility; or (iii) is capable of causing such injury or damage if response is mishandled. An HFDI response conditions will exist if the person(s) notifying CHEMTREC of the incident reports any of the following: (i) the incident involves a derailment, over-the-road accident, or marine accident which resulted in visible structural HF container damage; (ii) the incident involves a derailment, over-the-road accident, or marine accident in which the HF container has overturned regardless of whether structural damage is visibly apparent; (iii) any incident resulting in a fire in close proximity to the HF container; or (iv) any incident involving an HF release or a potential release, determined according to this

Framework as established by the HF Mutual Aid Network Management. CHEMTREC (with Responder's advice when necessary and/or available) may determine whether a HFDI exists based upon initial reports. The Responder at the scene will determine when the HFDI has ended, subject to the Shipper's discretion.

ISO: International Standards Organization

LEPC: Local Emergency Planning Committee

Member: Chemical Company who executes the HF Mutual Aid Network Agreement and agrees to make their Responders available to the HF Mutual Aid Network.

Member's Responder: Any duly designated response personnel employed by, or any for-hire company, contractor, or independent contractor retained by a Member, who functions as an HFDI Responder.

NFPA: National Fire Protection Association

OSHA: Occupational Safety and Health Administration

PEL: Permissible Exposure Limit

PID: Photo-Ionization Detector

PIH: Poison Inhalation Hazard

PPE: Personal Protection Equipment

Promptly: In response context, means responding to or being at the scene of a HFDI as soon as reasonably possible, considering the incident seriousness, the potential public exposure, potential environmental harm, the Responder proximity and the geographic, weather, travel, and other relevant conditions.

PSIG: Pounds per square inch (gauge)

PTFE: Polytetrafluoroethylene

RCRA: Resource Conservation and Recovery Act

RQ: Reportable Quantity

Responder: An individual, qualified as set forth in this Framework, and designated by a Member.

Response Levels: Degree of technical advice and assistance that Members agree to provide during an HFDI.

SDS: Safety Data Sheet

Shipper: Name appearing on the product shipping papers involved in a HFDI including Shipper's associations, brokers, forwarders, consolidators, and other intermediaries, or notwithstanding the above.

Technical Advice and Assistance: Information and assistance (including hands-on assistance, if appropriate) which may be given by a Responder, and which may include identifying the HF hazards,, and determining measures, if any, to be taken, including communications, precautions, evacuation if necessary, and chemical handling and containment.

Transporter: Entity responsible for the physical conveyance of the HF, AHF, or HFA from one location to another. The Transporter may, or may not, be a Member.

TSD: Treatment Storage and Disposal

Hydrogen Fluoride Panel
American Chemistry Council 700 Second Street, NE, 20002
Washington, DC