Personnel Safety

Health Effects

Agent Characteristics

Updated January 2015 (replaced previous version dated 2011)

PPE

Medical

Scenario

General Population Limit (GPL)

Exposure Guidelines: IDLH

Cited/Used in NRT Quick Reference Guides for Chemical Warfare Agents:

Air: Acute Exposure Guideline Levels (AEGLs) for general population one-time exposure emergency scenarios for HD (complete definitions are available in Key References Cited/Used in NRT Quick Reference Guides for Chemical Warfare Agents):

Air Release Scenarios are assumed most probable; however, other release scenarios and exposure routes should be considered.

Open Areas: HD is difficult to disperse in air due to low volatility; however, it may be possible to disperse HD as a vapor/aerosol plume if an appropriate heat/explosive device is employed. The low volatility of HD would limit the size and extent of plume dissipation, posing localized hazards. HD has a freezing point at 15°C (59°F), so the re-aerosolization of liquids and solids, as ambient temperatures rise, may present a real hazard. HD vapors are heavier than air, so vapors can accumulate in lower terrains.

Water/Water Systems:

Indoor Facility:

Releases of HD from indoor facilities will result in localized areas of surface contamination. HVAC system intakes near to liquid HD should be investigated for contamination from HD vapors and aerosols. HD vapors are heavier than air so HD vapors can accumulate in lower levels or utility corridors inside the buildings.

Water/Water Systems:

Open Areas:

Persistence:

Sulfur mustard is sometimes called "mustard gas" but is actually a yellow to brown oily liquid with a garlic, onion, horseradish or mustard-like odor. It is a blister (vesicant) agent that can cause severe pain on contact with skin, eyes, mucous membranes and respiratory system.

Safety and Health Effects:

Onset:

Exposure:

Routes:

Skin: Direct contact with HD liquid can cause redness or blisters in 2-24 hours. Warm and sweaty skin areas (underarms, groin) are most susceptible to exposure. Eyes: Eyes are the most sensitive to HD injury; effects noted after 1-12 hours include irritation, burning, gritty feeling, itching, weeping, reddening, lid swelling, light sensitivity, pain and conal injury. High concentration effects are extremely painful and generally require extended medical treatment.

Ingestion:

Consumption of contaminated food or drink could cause burning, nausea and vomiting.

Inhalation:

Emergency workers should wear respirators with high efficiency particulate air filters and water resistant or impermeable or water-impermeable materials such as carpets and vinyl tile as the "nicks" for absorbing HD vapors and liquids, prolonging persistence.

Release Scenarios

AERIAL RELEASE SCENARIOS ARE ASSUMED MOST PROBABLE; HOWEVER, OTHER RELEASE SCENARIOS AND EXPOSURE ROUTES SHOULD BE CONSIDERED.

Onset:

Exposure:

Routes:

Onset and severity of effects depend on dose, duration and route of exposure (not all signs/symptoms may develop). The effects caused by HD are not typically fatal immediately. In general, the severity of effects depends upon the dosage. Mild: Effects delayed 1-48 hours (severely depends on dose): Eye irritation (tearing, grittiness), runny nose, sneezing, nosebleed, hoarseness, hacking cough. Moderate: Effects delayed 1-24 hours: Mild effects plus reddening and swelling of eyelids, severe cough, shortness of breath, reddening of skin. Severe: Effects delayed 1-24 hours: Upper respiratory/lung damage may occur at high concentrations and longer exposure durations.

Air: Acute Exposure Guideline Levels (AEGLs) for general population one-time exposure emergency scenarios for HD (complete definitions are available in Key References Cited/Used in NRT Quick Reference Guides for Chemical Warfare Agents):

AEG Level in mg/m³ at various exposure durations

10 min. 30 min. 1 hr. 4 hr. 8 hr.

AEGL 1: Mild threshold effects
0.40 0.13 0.067 0.017 0.0083

AEGL 2: Potentially irreversible effects or impaired ability to escape
0.60 0.20 0.10 0.025 0.013

AEGL 3: Threshold for severe effects/medical needs/increasing potential for lethality
3.9 2.7 2.1 0.53 0.27

Exposure Guidelines: IDLH = 0.7 mg/m³; STEL = 3.0 x 10⁻³ mg/m³; Worker Population Limit (WPL) [an 8-hr time-weighted average occupational value] = 4.0 x 10⁻⁴ mg/m³; General Population Limit (GPL) [a 24-hr time-weighted average] = 2.0 x 10⁻³ mg/m³. Soil: Industrial Exposure Scenario = 0.3 mg/kg (10⁻⁷ cancer risk); Residential Exposure Scenario = 0.01 mg/kg (10⁻⁹ cancer risk); Drinking Water: Provisional Advisory Levels (PAL-1) for HD are not available due to the rapid hydrolysis of dissolved HD to TDG. In the absence of PAL, the Army's Military Emergency Exposure Guidelines (MEGs) may be used; the MEG at 8 mg/L, for 7 days = 140 µg/L.

Note: Personal Protective Equipment (PPE) selection (levels A-D), medical surveillance requirements, First Aid options and personnel decontamination may vary depending upon the amount of poison, site conditions and the release scenario. Additional information on personnel safety and PPE selection criteria can be found at: www.cdc.gov/niosh/phehdb. We also recommend that responders check their own internal procedures (e.g., SOPs) if they have them.

Medical

Pre-incident: Annual physical and respiratory function exams. During incident: Conduct periodic on-site medical monitoring, observe for any signs and symptoms as per Health Effects section above and treat accordingly as per First Aid section below.

First Aid

PPE

PERSONAL SAFETY

HD is rarely employed as a "area-persisting" chemical warfare agent with liquid deposition on surfaces lasting for hours to days. Persistence will depend upon amount and purity of the agent, method of release, environmental conditions, and the types of surfaces and materials impacted. Under certain environmental conditions, HD liquid may go through a partial hydrolysis that results in an outer protective coating around "globules" that are resistant to further hydrolysis and can persist for decades if not physically disturbed. Porous, permeable, organic or polymeric materials such as carpets and vinyl tile can act as "sinks" for absorbing HD vapors and liquids, prolonging persistence.

Field Detection

Real-time field screening tools (results not confirmatory or quantitative): Caution should be given to equipment that has not been properly evaluated. False positive and false negatives may occur in the presence of interferents common in the environment. The following is a summary of minimum screening concentration ranges for equipment procured by many EPA and HAZMAT response teams. Other screening tools may be used by these teams and other agencies & responders since there are many with similar capabilities & limitations.
Decontamination/Cleanup Planning: Once site controls are in place, develop a site-specific decontamination/cleanup plan. Decontamination may require a "tiered approach" using a variety of techniques and products. Call the EPA/HQ-EOC at 202-564-3850 for more information.

General Considerations: A cost vs. benefit evaluation should be undertaken for each decontamination strategy and approach that considers: public safety, total cost, impact on the facility, wastes generated, as well as time the facility or item will be out of service and any socio-economic, psychological, and/or security impacts that may result. Large volumes of decontamination wastes may be generated that will need to be collected, treated and disposed of properly. Waste handling and disposal must be addressed as early in the decontamination and cleanup process as possible (see Waste Management section below).

Disposal Option: The urgency to restore a facility as quickly as possible may result in the outright and timely removal and disposal of contaminated materials. Certain materials may be resistant to decontamination formulations, or may be cheaper to discard and replace than to decontaminate and restore. 

Monitored Natural Attenuation: HD degrades via natural processes. Environmental monitoring must be maintained during decontamination and recovery phases. Monitored natural attenuation may require institutional controls (e.g., access restriction and contaminant containment measures). The time to achieve clearance must be considered in the overall cost/benefit evaluation. This option is more passive than other options but is non-destructive to materials.

Fix-in-Place Option: Partially immobilized HD contaminated surfaces may be impossible to clean and may require a "fix-in-place" strategy. Physical barriers can be used to separate and immobilize the agent contamination from coming into contact with the environment or the public. This can be a temporary or permanent solution.

Decontamination Strategy: A decontamination strategy can be developed by designating contaminated areas into three broad categories: 1) surfaces or hot spots, 2) large volumetric spaces, and 3) sensitive equipment or items. In each category may be treated using one or more unique decontamination processes in a tiered approach to the overall site-specific decontamination strategy.

Surfaces/Hot Spots: This category is for areas smaller in size but with higher levels of agent contamination. They may require more rigorous decontamination products and methods. In contrast to the rapid hydrolysis when HD is dissolved in water, the hydrolysis of HD on surfaces is slow. 1) Hypochlorite solutions are effective but can be very corrosive to certain surfaces, such as aluminum. Household bleach solutions (5% sodium hypochlorite) are very effective for HD with efficacy achieved with contact time of 15-60 minutes depending on surface material. Calcium hypochlorite, present in commercial products, such as HTH (10% hypochlorite solution), is better for surfaces with high concentrations of liquids in localized areas. 2) Proprietary decontamination foams and gels such as DF-200®, CASCAD®, Decon Green®, or L-Gel® have been reported to be effective against HD. HVAC systems in large indoor spaces may require a separate decontamination strategy that could include the use of HD Air ventilation or fumigation.

Sensitive Equipment and Items: 1) Forced or Hot Air ventilation methods may be used for HD and can be used either in-situ or ex-situ to decontaminate these items. 2) Modified VHP® fumigation can be used on these items with less corrosion to electronics than dilute hypochlorite solutions.

CAUTION: Decontamination products may have unique safety/IPPE requirements due to their own toxicity or that of breakdown products during use (e.g., bleach results in chlorine vapors). Strong oxidizers, such as hypochlorite, may react violently with organics. Under oxidizing conditions (i.e., bleach), HD can break down into several toxic breakdown products. Formulations should be chosen that do not allow the formation of these toxic breakdown products. Dirt, grime and other coatings can reduce the efficacy of decontamination; pre-cleaning surfaces with soap and water may be needed before the application of decontamination formulations but resulting pre-cleaning rinsates may need to be discarded and spread agent.

Decontamination of Soil: Site specification and specific. Please contact EPA/HQ-EOC at 202-564-3850 for further assistance.


Waste Management: Under the Resource Conservation and Recovery Act (RCRA), waste is generally classified as hazardous waste (Subtitle C) or solid waste (Subtitle D). Under RCRA, waste is generically classified as hazardous if: (A) causes or significantly contributes to an increase in mortality or an increase in serious, irreversible or incapacitating reversible illness or (B) poses a substantial, present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of otherwise managed. The RCRA regulations generally define the term hazardous waste as if it: (1) is listed waste (40 CFR§261.21, §261.32), (2) exhibits specific characteristics (§261.21-261.24) or (3) is a spilled or discarded commercial chemical product (§261.33). The States (except for Alaska and Iowa) have the primary responsibility to implement the hazardous waste regulations and can impose more stringent requirements than the Federal program, so it is critical to open a dialogue with regulators as early as possible. Several states (CO, IN, KY, MD, OR, UT) have their own waste designations for CWA, which may be applicable for the cleanup of contaminated residues. HD is not a hazardous waste under the Federal regulations, but state codes may apply for HD-contaminated residues, soils and debris. Management of toxic decomposition compounds, associated residual decontamination solutions, local waste acceptance criteria, and transportation and handling requirements may be considered. The EPA has developed I WASTE, a web-based tool that contains links to waste transportation guidance, treatment and disposal facilities, state regulatory offices, packaging guidance, and guidance to minimize the potential for contaminating the treatment or disposal facility. Access to this decision support tool requires pre-registration (www2.epa.gov/idot/tool/login.aspx).