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| Agent Characteristics | <p>Agent Classification: Toxic Industrial Chemical, proposed Chemical Warfare Agent; CAS: 7784-42-1; Formula: AsH₃; Molecular Weight: 77.95 g/mol. Description: Colorless gas which produces no immediate symptoms. It has a garlic odor, but its high odor threshold diminishes this safeguard. SA is typically transported as a compressed gas, but can be formed by the reaction of arsenic-containing substances with hydrogen in water or acids. Environmental breakdown products of SA include highly toxic arsenic compounds. Decon by-products include arsenic (V) compounds, which are generally less toxic than arsenic (III) compounds, but may be considered hazardous. Persistence: SA is considered "non-persistent." Vapor: minutes-hours; liquid: rapidly evaporates at ambient temperatures and pressures. Persistence will depend upon the amount & purity of the agent, method of release, environmental conditions & the types of surfaces & materials impacted. Physical properties are listed at/near STP unless otherwise indicated. Conversion Factors: ppm = mg/m³ x 0.3143; mg/m³ = ppm x 3.182</p> | | | | | | | | |
| | Vapor Pressure | Volatility | Freezing Point | Vapor Density | Boiling Point | Flash Point | Aqueous Solubility | Soluble | Gas Density |
| | 11,000 mm Hg (68°F/20°C) | 30,900,000 mg/m ³ (32°F/0°C) | -177°F/-116°C | 2.7 (air = 1) | -80°F/-63°C | decomposes when heated, but is highly flammable | 0.280 g/L | alcohols, alkalis, chloroform, benzene | 3.18 g/mL |
| Release Scenarios | <p>AIR RELEASE SCENARIOS ARE ASSUMED MOST PROBABLE; HOWEVER, OTHER RELEASE SCENARIOS & EXPOSURE ROUTES SHOULD BE CONSIDERED. Open Areas: SA is a gas and the primary release/attack scenario is an airborne release. SA is expected to degrade by reaction with moisture and surfaces, with toxic arsenic compounds likely formed. SA is reactive, extremely flammable, and may ignite forming toxic arsenic fumes. Unreacted SA clouds can migrate several miles from the release site by the wind while maintaining very dangerous concentrations. SA is heavier than air and may accumulate in lower terrains. Water/Water Systems: SA is soluble in water but is not considered a likely release scenario. Arsenic may be introduced into water systems as solid salts. When SA is released into water it forms arsenic compounds, which may exert toxic effects if present in high concentrations. If a large cloud of SA is released, not all SA may dissolve or react before the cloud leaves the vicinity of the water. For water systems, plumbing, surfaces, and equipment that have contacted contaminated water must be evaluated for toxic arsenic compounds along with the bulk water. Indoor Facility: Due to its volatility as a gas, SA could potentially be dispersed inside a building or facility; HVAC systems could be impacted. Explosive vapors can be formed with oxidants. Toxic vapors can be formed as SA decomposes in the presence of heat, moisture, and light. SA is heavier than air and will accumulate in lower levels and utility corridors inside the building.</p> | | | | | | | | |
| Health Effects | Onset | Symptoms may occur within 1-24 hr of exposure. Late effects from acute exposure have been reported to occur days to months post exposure. | | | | | | | |
| | Signs/Symptoms | <p>Regardless of route the following range of effects may occur depending on dose Mild to Moderate: <i>Inhalation:</i> Weakness, headache, drowsiness, disorientation, confusion, chills, rapid breathing, rapid heart rate, nausea, vomiting, abdominal pain, and/or muscle cramps. Some effects may occur days to months post exposure and include hemolytic anemia (fatigue, shortness of breath), red or dark urine, yellow skin and eyes (jaundice), irritation, memory losses, and agitation. <i>Skin:</i> Contact with liquefied gas may cause burns and/or frostbite. Severe: <i>Inhalation:</i> Loss of consciousness, convulsions, paralysis, respiratory failure, acute circulatory failure, possibly leading to death.</p> | | | | | | | |
| | Exposure Routes | <p>Inhalation: This is the most likely route of exposure after SA is released into the air. Absorption into the body through the eyes and the skin has not been known to occur. Other: SA targets red blood cells that lead to increased levels of hemoglobin and subsequent kidney damage. SA is broken down to different forms of arsenic compounds known to present a cancer hazard.</p> | | | | | | | |
| Effect Levels | <p>Air: Acute Exposure Guideline Levels (AEGLS) for general population one-time exposure emergency scenarios for SA (complete definitions are available in Key References Cited/Used* in NRT Quick Reference Guides for Chemical Warfare Agents). NR = not recommended.</p> | | | | | | | | |
| | AEGL Level in mg/m³; at exposure duration → | | 10 min | 30 min | 1 hr | 4 hr | 8 hr | | |
| | AEGL 1: threshold mild effects | | NR | NR | NR | NR | NR | | |
| | AEGL 2: potentially irreversible effects or impaired ability to escape | | 0.30 | 0.21 | 0.17 | 0.040 | 0.020 | | |
| AEGL 3: threshold for severe effects/medical needs/increasing potential for lethality | | 0.91 | 0.63 | 0.50 | 0.13 | 0.060 | | | |
| <p>Exposure Guidelines: IDLH (mg/m³) = 3; NIOSH REL (mg/m³) ceiling = 0.002; OSHA PEL (mg/m³) = 0.2; RfC (reference concentration for chronic inhalation exposure) (mg/m³) = 0.00005; Inhalation Provisional Advisory Levels (PAL-1) (mg/m³) for general public for 1 day = 0.013; for 30 days = 0.0028; and for 90 days = 0.00048; Soil: Industrial Exposure Scenario (mg/kg) = 3.97; Residential Exposure Scenario (mg/kg) = 2.74; Drinking Water Standards and Health Advisory's: None available for SA; see values for arsenic.</p> | | | | | | | | | |
| Personnel Safety | Note | Personal Protective Equipment (PPE) selection (levels A-D), medical surveillance requirements, First Aid options and personnel decon may vary depending upon the agent, site, & the release scenario. Additional information on personnel safety and PPE selection criteria can be found at: www.cdc.gov/niosh/ershdb | | | | | | | |
| | Medical | Pre-incident: Annual physical and respiratory function exams. During Incident: Conduct periodic on-site medical monitoring, observe for any signs & symptoms as per Health Effects section above and treat accordingly as per First Aid section below. | | | | | | | |
| | First Aid | Immediately remove person from affected area, remove contaminated articles. Wash bare skin with warm soapy water, and rinse eyes with plain water for 10-15 minutes. For compressed liquid observe and treat for frost bites Antidote: No antidote is available for SA. Send person for follow up medical attention and evaluation. If cleared to resume work, continue to monitor for signs/symptoms & treat accordingly. | | | | | | | |
| | PPE | <p>GENERAL INFORMATION: NIOSH-certified Chemical, Biological, Radiological, Nuclear (CBRN) Self Contained Breathing Apparatus (SCBA), Air Purifying Respirators (APR) or Powered Air Purifying Respirators (PAPR), full-face masks, & protective clothing should be used. Pre-incident training & exercises on the proper use of PPE is recommended. Per NIOSH guidance - LEVEL A: Recommended for the initial response to a SA incident where SA levels and exposure risks are unknown. Level A provides the greatest level of skin (fully encapsulating suit), respiratory (SCBA), & eye protection when the contaminant identity or concentration is unknown. Select Level A when the SA concentration is unknown or above the IDLH or AEGL-2, & when there is a potential of ocular or dermal exposure. LEVEL B: Provides the highest level of respiratory protection (SCBA) when a lesser level of skin protection is required. Select Level B when the SA concentration is unknown or above the IDLH or AEGL-2 & dermal exposure is less of a risk. Level B differs from Level A in that it incorporates a non-encapsulating, splash-protective, chemical-resistant outer suit that provides protection against most liquids but is not airtight. LEVEL C: Select Level C when the contaminant identity & concentration are known & the respiratory protection criteria factors for the use of APR or PAPR (i.e.: < IDLH, warning properties) are met. Level C may be appropriate when decontaminating personnel or equipment. Note: SA does not have any AEGL-1 values and limited inhalational warning; use APR/PAPR with caution. LEVEL D: Select Level D when the contaminant is known & the concentration is below the selected appropriate occupational exposure limit (e.g., OSHA PEL) for the stated duration times. Note: Downgrading PPE levels can be considered only when the identity & concentration of the contaminant & the risks of dermal exposure are known, & must be accompanied by on-site monitoring.</p> | | | | | | | |
| Field Detection | <p>Real-time field screening tools (results not confirmatory or quantitative): Caution should be given to equipment that has not been properly evaluated. False positive & false negatives may occur in the presence of interferents common in the environment. The following is a summary of minimum screening levels for equipment procured by most EPA response teams. Other screening tools may be used by other agencies & responders; some with similar capabilities & limitations.</p> | | | | | | | | |
| | Minimum Screening Levels | AP4C (as Arsenic) | Honeywell - SPM | Dräger Arsine tube | Dräger CDS tube | HACH (as Arsenic) | | | |
| | ppm | 0.15 | 0.015-0.150 | 0.05 | 0.10 | 0.005-0.010 ug/L (in water) | | | |
| | mg/m ³ | 0.47 | 0.047-0.47 | 0.16 | 0.32 | | | | |

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| Sampling | <p>Note: This section on sampling contains general guidelines & does not replace the need for a site-specific sampling plan. See reference list for specifics.</p> <p>Sampling Concerns: Detection, sampling equipment & procedures, & analytical techniques will be highly site-specific & depend on: 1) physical state of the agent; 2) type of surfaces contaminated (e.g., porous vs. nonporous); 3) the purpose of sampling (e.g. characterization, decon efficacy & clearance); & 4) specific laboratory requirements. Because SA is reactive and volatile, field detection instead of laboratory analysis for SA and/or arsenic may suffice and sometimes be necessary to achieve many goals of sampling. For sampling questions, call the EPA/HQ-EOC at 202-564-3850</p> |
| | <p>Sample Locations & Planning: Initially consider air sampling to ensure worker safety & to determine if there is a vapor plume which could impact other areas. Characterization sampling is initiated by targeted or judgmental sampling to identify "hot spots," potential agent flow paths, media or objects potentially acting as sinks. Additional biased or random sampling can be used to determine the extent of potential contamination or to verify the efficacy of decon. More thorough probabilistic sampling (e.g., grid, statistical approach) will be required for the clearance phase or if there are large areas of uncertainties. Because SA is reactive and generally not persistent, sampling/monitoring for a variety of arsenic containing compounds along with SA should be included in the sampling plan to "clear areas."</p> |
| | <p>Note: SA is highly volatile and reactive, forming a variety of arsenic breakdown and reaction products. Laboratory analysis may need to include these additional products. See ANALYSIS section below to ensure sampling procedures are compatible with all analytes. Concurrent air monitoring for SA is recommended for all matrices.</p> <p>Types of Samples: Air: On-site SA monitors may provide sufficiently accurate real-time results. For lab analysis, samples are collected using appropriate solid phase absorbent media at breathing zone level (~5 ft.) to assess inhalation exposure and at ground levels (~6 in.) to assess off gassing at surfaces.</p> <p>Water: SA is soluble in aqueous solutions but is expected to diffuse out of the bulk water phase or decompose to arsenical compounds. Arsenic is easy to analyze in the field by colorimetric/titrimetric methods and can be used as a marker for SA contamination.</p> <p>Soil: For localized hot spot areas where soil deposition may occur, surface soil samples may be analyzed for SA and arsenic containing reaction products and should be taken from a non-vegetated area to a depth of less than one inch.</p> <p>Surface Wipes: Although SA is very volatile, wipe samples are often desired to indicate the presence of SA and arsenic containing breakdown products, on non-porous surfaces.</p> <p>Bulk: Although SA is very volatile, bulk samples of actual pieces or cores of contaminated surfaces may be collected at hot spot areas where high levels of SA deposition occurred on porous surfaces (e.g., concrete, asphalt), using appropriate tools (scabbling, coring or drills) and submitted for subsequent laboratory extraction analysis for SA and any arsenic containing reaction products.</p> <p>Other Sample Matrices: Contact EPA/HQ-EOC at 202-564-3850 for sampling instructions.</p> |
| | <p>Sample Packaging & Shipping: The packaging & shipping of samples are subject to strict regulations established by DOT, CDC, USPS, OSHA, & IATA. Contact the sample-receiving laboratory to determine if they have additional packaging, shipping or labeling requirements.</p> |
| Analysis | <p>CAUTION: The Environmental Response Laboratory Network (ERLN) will use uniform, compatible sample prep & analytical methods (See http://www.epa.gov/oemerln1/). SA and arsenic-compounds such as total arsenic may be accurately determined in the field using available meters and field kits. Many laboratories are available for analysis of SA, arsenic and arsenic containing breakdown/reaction products; contact the EPA/HQ-EOC at 202-564-3850.</p> |
| Decontamination/Cleanup | <p>DO NOT USE WATER DIRECTLY ON LIQUID SA. USE WATER SPRAY TO KNOCK DOWN VAPORS OR TO DIVERT VAPOR CLOUD DRIFT. VAPOR CAN REACT EXPLOSIVELY WITH AIR AND OXIDIZING MATERIALS. Prevent wastewater from further contaminating the environment. Avoid use of acids, oxidizers, or heating as they release toxic arsenic fumes.</p> <p>SA is so volatile that it will dissipate quickly. As a gas, SA does not persist in the environment. SA is stable for days in air and will only slowly degrade in air by UV light into nonvolatile, oxidized compounds. Hence, most decontamination will not necessarily be for SA itself, but for decomposition products such as the toxic arsenic (III) compounds or somewhat less toxic arsenic (V) compounds. Separate, long-term decon strategies will need to be developed if those decomposition by-products are of concern in a particular situation. This decon section refers to SA itself.</p> <p>Decon/Cleanup Planning: Once site controls are in place, develop a site specific decon/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.</p> <p>General Considerations: A cost vs. benefit evaluation should be undertaken for each decon strategy and approach which considers: public safety, total cost, impact on the facility, wastes generated, as well as the 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 decon wastes may be generated which will need to be collected, treated, and disposed of properly. Waste handling and disposal must be addressed early in the decon and cleanup process as possible, see WASTE MANAGEMENT section below.</p> <p>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 decon formulations, or may be cheaper to discard and replace than to decon and restore.</p> <p>Monitored Natural Attenuation: SA dissipates via natural processes. Environmental monitoring must be maintained during decon 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 nondestructive to materials.</p> <p>Decon Strategy: A decon strategy can be developed by designating contaminated areas based on presence of: 1) liquid SA, 2) gaseous SA, or 3) aqueous solution of SA.</p> <p>Strategy for Liquid SA: Do not allow direct contact with water. Actions that promote safe volatilization of liquid SA may be useful since SA in gaseous form can be allowed to dissipate; volatilization may be a slow process depending on site conditions.</p> <p>Strategy for Gaseous SA: Aerate spaces where gaseous SA may be present. Forced air ventilation methods are recommended for vapor plume contamination or low concentration of arsine gas in large volumetric spaces or open areas.</p> <p>Strategy for Aqueous Solutions of SA: Hydrolysis will occur to produce arsenic compounds for which decon may be necessary.</p> <p>Sensitive Equipment & Items: For difficult-to-clean equipment thought to be contaminated with small amounts of SA, options for consideration include aeration followed by flushing with water.</p> <p>Verification of Decon: Site & situation specific. Please contact ERT (732-321-6660) and/or CBRN CMAT (513-487-2420) for further assistance.</p> |
| Waste Management | <p>CAUTION: Hazardous waste transportation & disposal are regulated federally; however more stringent regulations may exist under state authority. These regulations differ from state-to-state. Detailed state regulations can be found at http://www.envcap.org.</p> <p>Waste Management Planning: The U.S. EPA considers a waste to be hazardous: (1) if it exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24; (2) if it is specifically listed as a hazardous process waste (§261.21 and §261.32); or (3) if it is listed as a commercial chemical product that is discarded or spilled (§261.33). Under the Resource Conservation and Recovery Act (RCRA), U.S. EPA has specifically listed many chemical wastes as hazardous. SA is not a RCRA regulated waste but arsenic is a RCRA listed metal (D004) with an allowable limit of 5 ppm (§261.32). Other arsenic compound wastes may be generated and considered as RCRA regulated wastes (P010, P011, P012). Requirements for transporting hazardous materials & procedure for exemption are specified in http://www.fmcsa.dot.gov/safety-security/hazmat/complyhregs.htm#hmp. The U.S. EPA has developed a web-based Incident Waste Management Planning & Response Tool which contains links to guidance related to waste transportation, contact information for potential treatment, disposal facilities, state regulatory offices, packaging guidance to minimize risk to workers, & guidance to minimize the potential for contaminating the treatment or disposal facility. Access to the EPA's web based disposal tool requires pre-registration (http://www2.ergweb.com/bdrtool/login.asp). Current resources on packaging, labeling, and shipping are available at http://www.phmsa.dot.gov/hazmat</p> |