

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR AMMONIUM CHLORIDE FUME

INTRODUCTION

This guideline summarizes pertinent information about ammonium chloride fume for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

• Formula



• Synonyms

Amchlor fume, ammoneric fume, ammonium muriate fume, darammon fume, sal ammonia fume, salammoniac fume, salammonite fume, salmiac fume

• Identifiers

1. CAS No.: 12125-02-9
2. RTECS No.: BP4550000
3. DOT UN: 9085 31
4. DOT label: None

• Appearance and odor

Ammonium chloride is a noncombustible, white, crystalline solid. It is odorless and somewhat hygroscopic. Ammonium chloride fume is the finely divided particulate form of this substance.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 53.5
2. Boiling point (760 mm Hg): 520°C (968°F)
3. Specific gravity (water = 1): 1.52 at 25°C (77°F)
4. Vapor density: Not applicable
5. Melting point: 350°C (662°F) sublimes
6. Vapor pressure at 160.4°C (320.7°F): 1 mm Hg
7. Solubility: Soluble in water, liquid ammonia, methanol, and ethanol; practically insoluble in acetone, ether, and ethyl acetate
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Heat
2. Incompatibilities: Violent reactions may result from contact of ammonium chloride fume with boron trifluoride, boron pentafluoride, iodine heptafluoride, or potassium chlorate. In the presence of alkalis, ammonia is evolved; in the presence of acids, hydrogen chloride is evolved. Ammonium chloride is also incompatible with the salts of lead or silver.
3. Hazardous decomposition products: Toxic gases and vapors (such as ammonia and hydrochloric acid) may be released in a fire involving ammonium chloride fume.
4. Special precautions: At fire temperatures, ammonium chloride fume corrodes metals.

• Flammability

The National Fire Protection Association has assigned a flammability rating of 0 (no fire hazard) to ammonium chloride fume. This substance is not combustible.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

1. Flash point: Not applicable
2. Autoignition temperature: Not applicable
3. Flammable limits in air: Not applicable
4. Extinguishant: Use water spray to reduce the fumes and irritant gases produced in a fire involving ammonium chloride. For small fires, use dry chemical, Halon[®], water spray, foam, or other noncombustible material suitable for the materials involved in the surrounding fire.

Firefighters should wear a full set of protective clothing (including a self-contained breathing apparatus) when fighting fires involving ammonium chloride fume.

EXPOSURE LIMITS

• OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) for ammonium chloride fume are 10 mg/m³ of air as an 8-hr time-weighted average (TWA) and 20 mg/m³ as a short-term exposure limit (STEL)—the 15-min TWA that should not be exceeded at any time during a workday [29 CFR 1910.1000, Table Z-1-A].

• NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) of 10 mg/m³ as an 8-hr TWA and 20 mg/m³ as a STEL (15-min TWA) [NIOSH 1992].

• ACGIH TLV[®]

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned ammonium chloride fume a threshold limit value (TLV) of 10 mg/m³ as a TWA for a normal 8-hr workday and a 40-hr workweek and 20 mg/m³ as a STEL (15-min TWA) [ACGIH 1991b].

• Rationale for limits

The limits are based on the risk of respiratory system irritation associated with exposure to ammonium chloride fume.

HEALTH HAZARD INFORMATION

• Routes of exposure

Exposure to ammonium chloride fume can occur through inhalation and eye or skin contact.

• Summary of toxicology

1. *Effects on Animals:* Ammonium chloride is a tissue irritant and metabolic acidifying agent. Topical administra-

tion of 100 or 500 mg onto the eyes of rabbits caused severe or mild irritation, respectively [NIOSH 1991]. No animal data are available on the toxic effects of inhalation exposure to the fume of ammonium chloride. The acute oral LD₅₀ in rats is 1,650 mg/kg [NIOSH 1991]. An acute lethal intravenous dose to mice induced hyperventilation, convulsions, coma, and death [NLM 1991]. During a 13-week subchronic study, 10 male rats ingested a purified diet containing 5% ammonium chloride. This metabolic acidifying agent depressed food consumption and weight. Necropsy of an animal that died during week 10 revealed hemorrhagic abdominal fluid, a blood clot in the enlarged urinary bladder, inflammation of the seminal vesicles and prostate, and haemothorax. Terminal relative kidney weights were also increased. Histopathology of selected organs demonstrated only a diffuse hyperplasia of the urinary bladders in 4 of 10 rats treated with ammonium chloride. Two males had a moderate hyperplasia, and two other males had severe hyperplasia with small papillary protrusions [NIOSH 1991; de Groot et al. 1988].

2. *Effects on Humans:* Ammonium chloride fume is a mild irritant of the eyes, nose, throat, lungs, and skin in humans. Repeated inhalation of ammonium chloride fumes (concentration unspecified) during welding also caused pulmonary sensitization in some workers [Genium 1991]. A 50-year-old woman ingested 6 g of ammonium chloride per day as a urine acidifying agent for the treatment of renal stone disease, air hunger, and profound metabolic acidosis [NLM 1991]. Ingestion of large doses of this chemical induced nausea, gastric irritation and distress, vomiting, thirst, headache, hyperventilation, progressive drowsiness, anorexia, bradycardia, mental confusion, phases of excitement, calcium-deficient tetany, tremors, hyperreflexia, and coma. Clinical chemistry analyses revealed the following adverse alterations: profound metabolic acidosis, hypokalemia, hyperchloremia, hyperglycemia, and glycosuria. EEG abnormalities have also been reported [NLM 1991].

• Signs and symptoms of exposure

1. *Acute exposure:* Acute exposure to ambient ammonium chloride can cause irritation of contacted tissues. Ingestion exposure can cause nausea, gastric irritation and distress, vomiting, thirst, headache, hyperventilation, progressive drowsiness, anorexia, bradycardia, mental confusion, phases of excitement, calcium-deficient tetany, tremors, hyperreflexia, and coma.

2. *Chronic exposure:* Chronic exposure to ammonium chloride fume can cause difficult breathing, wheezing, and coughing in sensitized individuals.

• Emergency procedures



Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result! **Immediately and thoroughly** flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Irritation may result. **Immediately and thoroughly** wash contaminated skin with soap and water.

3. *Inhalation exposure:* Move the victim to fresh air **immediately**.

If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following uses of ammonium chloride may result in worker exposures to ammonium chloride fume:

- Use as a flux for coating sheet iron with zinc, in tinning, and in soldering
- Use in dry and Leclanche batteries
- Use in electroplating and welding
- Use in cleaning soldering irons

The following methods are effective in controlling worker exposures to ammonium chloride fume, depending on the feasibility of implementation:

- Process enclosure
- Local exhaust ventilation
- General dilution ventilation
- Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. *Industrial ventilation—a manual of recommended practice*. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
2. Burton DJ [1986]. *Industrial ventilation—a self study companion*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
3. Alden JL, Kane JM [1982]. *Design of industrial ventilation systems*. New York, NY: Industrial Press, Inc.
4. Wadden RA, Scheff PA [1987]. *Engineering design for control of workplace hazards*. New York, NY: McGraw-Hill.
5. Plog BA [1988]. *Fundamentals of industrial hygiene*. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety or health, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

• Preplacement medical evaluation

Before a worker is placed in a job with a potential for exposure to ammonium chloride fume, a licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the respiratory tract and skin. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

A preplacement medical evaluation is recommended to assess an individual's suitability for employment at a specific

job and to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to ammonium chloride fume at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with allergies or with respiratory tract or skin diseases.

- **Periodic medical examinations and biological monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to ammonium chloride fume exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of ammonium chloride fume on the respiratory tract and skin. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for ammonium chloride fume.

- **Medical examinations recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of job placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne ammonium chloride fume is determined by using a tared, low-ash polyvinyl chloride filter (5-micron). Samples are collected at a maximum flow rate of 2 liters/min until a maximum air volume of 960 liters is collected. Analysis is conducted by gravimetric measurement (weighing). This method has a sampling and analytical

error of 0.10 and is described in the *OSHA Industrial Hygiene Technical Manual* [OSHA 1985].

PERSONAL HYGIENE

If ammonium chloride fume contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing and shoes contaminated with ammonium chloride fume should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of ammonium chloride fume, particularly its potential for causing irritation.

A worker who handles ammonium chloride fume should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, or using toilet facilities.

Workers should not eat, drink, or use tobacco products in areas where ammonium chloride fume is generated.

RELEASES

In the event of a large release of ammonium chloride fume, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a release:

1. Notify safety personnel.
2. Remove all sources of heat and ignition.
3. Ventilate potentially explosive atmospheres.
4. Use cleanup procedures such as vacuuming and wet mopping to minimize dust generation.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

Ammonium chloride is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

A hazardous substance release is defined by EPA as any spilling, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment (including the abandonment or discarding of contaminated containers). In the event of a release that is above the reportable quantity for that chemical, employers are required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the proper Federal authorities.

The reportable quantity for ammonium chloride fume is 5,000 lb. If an amount equal to or greater than this quantity is released within a 24-hr period in a manner that will expose persons outside the facility, employers are required to do the following:

- Notify the National Response Center *immediately* at (800) 424-8802 or at (202) 426-2675 in Washington, D.C. [40 CFR 302.6].
- Notify the emergency response commission of the State likely to be affected by the release [40 CFR 355.40].
- Notify the community emergency coordinator of the local emergency planning committee (or relevant local emergency response personnel) of any area likely to be affected by the release [40 CFR 355.40].

- **Community right-to-know requirements**

Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of ammonium chloride fume emitted or released from their facility annually.

- **Hazardous waste management requirements**

EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although ammonium chloride fume is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the

RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of ammonium chloride fume exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information on the selection and use of respirators and on the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing (gloves, boots, aprons, and gauntlets, as appropriate) should be worn to prevent skin contact with ammonium chloride fume. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. Chlorinated polyethylene is recommended for protection against ammonium chloride.

Safety glasses, goggles, or face shields should be worn during operations in which ammonium chloride fume might

contact the eyes. Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with ammonium chloride fume. Contact lenses should not be worn if the potential exists for exposure to ammonium chloride fume.

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