

Occupational Health Guideline for Hydrogen Chloride

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: HCl
- Synonyms: Anhydrous hydrogen chloride; hydrochloric acid, anhydrous
- Appearance and odor: Colorless gas with an irritating, pungent odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hydrogen chloride is a ceiling of 5 parts of hydrogen chloride per million parts of air (ppm). This may also be expressed as 7 milligrams of hydrogen chloride per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Hydrogen chloride can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

• Effects of overexposure

1. Short-term Exposure: When hydrogen chloride gas is inhaled, it may cause irritation of the respiratory tract with burning, choking, and coughing. Severe breathing difficulties may occur which may be delayed in onset. At times ulceration of the nose and throat may occur. Hydrogen chloride gas and solutions of hydrogen chloride (hydrochloric acid) may cause eye irritation, severe burns, and permanent damage with loss of sight. Solutions of hydrogen chloride may cause severe burns of the skin unless the acid is washed off immediately. Exposure of the skin to hydrogen chloride gas may

cause skin inflammation or burns. Swallowing hydrogen chloride solution may cause burns of the mouth, throat, and stomach.

2. Long-term Exposure: Repeated or prolonged exposure to hydrogen chloride may cause erosion of the teeth. Repeated exposure of the skin to dilute solutions of hydrogen chloride may cause skin rash.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to hydrogen chloride.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to hydrogen chloride at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system, skin, and eyes should be stressed.

—14" x 17" chest roentgenogram: Hydrogen chloride causes lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Hydrogen chloride is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• Summary of toxicology

Hydrogen chloride gas irritates the eyes, mucous membranes, and skin. Exposure of rabbits and guinea pigs to $6400 \text{ mg}/\text{m}^3$ (approximately 4290 ppm) for 30 minutes caused death, in many instances from laryngeal spasm, laryngeal edema, or pulmonary edema. Exposure of three species of animals to 300 ppm for 6 hours caused

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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corneal and upper respiratory irritation. In humans, exposure to the gas immediately causes severe irritation of the upper respiratory tract resulting in cough, burning of the throat, and a choking sensation; effects are usually limited to inflammation and occasionally ulceration of the nose, throat, and larynx; if inhaled deeply, pulmonary edema may occur. In workers, exposure to 50 to 100 ppm for 1 hour was barely tolerable; short exposure to 35 ppm caused irritation of the throat, and 10 ppm was considered the maximal concentration allowable for prolonged exposure. High concentrations of the gas caused eye irritation and may cause prolonged or permanent visual impairment, including total loss of vision. Exposure of the skin to a high concentration of the gas or to a concentrated solution of the gas (hydrochloric acid) will cause burns; repeated or prolonged exposure to dilute solutions may cause dermatitis. Erosion of the teeth may occur from repeated or prolonged exposure. Although unlikely to occur, ingestion of hydrochloric acid causes severe burns of the mucous membranes of the mouth, esophagus, and stomach; pain; nausea and vomiting.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 36.5
2. Boiling point (760 mm Hg): -85 C (-121 F)
3. Specific gravity (water = 1): 1.194 (liquid)
4. Vapor density (air = 1 at boiling point of hydrogen chloride): 1.27
5. Melting point: -114 C (-173 F) (triple point)
6. Vapor pressure at 20 C (68 F): Greater than 1 atmosphere
7. Solubility in water, g/100 g water at 20 C (68 F): 62
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: High temperatures may cause cylinders to burst.
2. Incompatibilities: Contact with most metals corrodes them severely and forms flammable hydrogen gas. Contact of hydrogen chloride gas or liquid with any alkali or active metal may develop enough heat to cause fire in adjacent combustible material.
3. Hazardous decomposition products: None
4. Special precautions: Hydrogen chloride will attack most metals and some forms of plastics, rubber, and coatings.

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• Flammability

1. Not combustible

• Warning properties

1. Odor Threshold: Patty notes that according to Hirt, a concentration of 35 ppm "cannot be detected by taste or odor. (Editor's note: Most people can detect 1 to 5 ppm; 5 to 10 ppm is disagreeable)." The editor does not specify how most people can detect 1 to 5 ppm, however.

2. Eye Irritation Level: Grant states that an exposure of animals to "100 ppm for 6 hours daily for 50 days caused only slight unrest and irritation of the eyes, but no injury."

3. Other Information: The *Documentation of TLV's* states that hydrogen chloride is a strong irritant. Thirty-five ppm "caused irritation of the throat on short exposure Elkins states, however, that hydrogen chloride was immediately irritating when inhaled at concentrations of 5 ppm or more."

4. Evaluation of Warning Properties: Through its irritant effects, hydrogen chloride can be detected at or slightly above the permissible exposure limit. For the purposes of this guideline, therefore, hydrogen chloride is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of hydrogen chloride. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of hydrogen chloride in a bubbler containing sodium acetate solution, followed by dilution with water, and analysis with an ion-specific electrode. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure hydrogen chloride may be used. An analytical method for hydrogen chloride is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted

are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with mists or solutions of hydrogen chloride which have a pH less than 3.0.
- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with mists or solutions of hydrogen chloride which have a pH equal to or greater than 3.0.
- Where there is any possibility of exposure of an employee's body to solutions of hydrogen chloride which have a pH less than 3.0, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0 should be removed immediately and not reworn until the hydrogen chloride is removed from the clothing.
- Non-impervious clothing which becomes wet with solutions of hydrogen chloride with a pH equal to or greater than 3.0 should be removed promptly and not reworn until the hydrogen chloride is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of mists of solutions of hydrogen chloride contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to solutions of hydrogen chloride which have a pH less than 3.0, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0 should be immediately washed or showered to remove any hydrogen chloride.
- Skin that becomes wet with solutions of hydrogen chloride which have a pH equal to or greater than 3.0 should be promptly washed or showered to remove any hydrogen chloride.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to hydrogen chloride may occur and control methods which may be effective in each case:

Operation	Controls
Use during pickling of metals including stainless steel, iron, nickel, and monel	Local exhaust ventilation; general mechanical ventilation; personal protective equipment
Use as a catalyst or chlorinating agent in chemical synthesis; use during metal treatment and fabricating operations in electroplating, acid dipping, stripping, electropolishing, etching, welding, and flame-cutting of metal primed with paint or cleaned with chlorinated hydrocarbons, and used as a gaseous flux in babbiting	Local exhaust ventilation; general mechanical ventilation; personal protective equipment
Use in oxyhydrochlorination processing in production of chlorinated hydrocarbons	Local exhaust ventilation; general mechanical ventilation; personal protective equipment
Use in food processing and manufacture including sugar cane refining, glucose, and corn sugar, and brewing operations	Local exhaust ventilation; general mechanical ventilation; personal protective equipment
Use in industrial chemical cleaning operations; use in production of plastics and resins	Local exhaust ventilation; general mechanical ventilation; personal protective equipment
Use in rubber manufacture including synthesis of chloroprene; use as a chlorinating agent and in coagulation of latex	Local exhaust ventilation; general mechanical ventilation; personal protective equipment

Operation

Liberation during synthesis of other organic chemicals; use in extraction and reduction processing of metal ores

Use as a deliner of hides in leather manufacture

Use in activation of petroleum wells; use in waste treatment operations for neutralization of alkaline waste streams; use in production of chlorine

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know the locations of rescue equipment before the need arises.

SPILL AND LEAK PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of leaks until cleanup has been completed.

- If hydrogen chloride gas is leaked, the following steps should be taken:

1. Ventilate area of leak to disperse gas.
2. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty.

- If solutions of hydrogen chloride are spilled, the following steps should be taken:

1. Collect or confine spilled material in the most convenient and safe manner.
2. If possible, reclaim the spilled material. If this is not possible;
3. dilute and/or neutralize and dispose in a secured sanitary landfill.

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas get on the skin, immediately flush the contaminated skin with water. If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas penetrate through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention immediately.

• Breathing

If a person breathes in large amounts of hydrogen chloride, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

If solutions of hydrogen chloride have been swallowed and the person is conscious, give him large amounts of water to dilute the hydrogen chloride. Do not attempt to make the exposed person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and

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RESPIRATORY PROTECTION FOR HYDROGEN CHLORIDE

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Gas Concentration 50 ppm or less	Any chemical cartridge respirator with an acid gas cartridge(s). Any supplied-air respirator. Any self-contained breathing apparatus.
100 ppm or less	Any chemical cartridge respirator with a full facepiece and an acid gas cartridge(s). A gas mask with a chin-style or a front- or back-mounted acid gas canister. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 100 ppm** or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against acid gases. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of hydrogen chloride; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 100 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.