

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** HYDROGEN CHLORIDE ***

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for HYDROGEN CHLORIDE

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance HYDROGEN CHLORIDE.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

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(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of hydrogen chloride not in excess of 5 parts per million (ppm) (7 milligrams per cubic meter (mg/M3)) averaged over any 15-minute period during an eight-hour work shift, as stated in 1910.1000, Table Z-1.

(2) "Action level" means one-half of the permissible exposure for hydrogen chloride averaged over an eight-hour work shift.

(b) Initial determination and exposure measurement. (1) Each employer who has a place of employment in which hydrogen chloride is released into the workplace air shall determine if there is any possibility that any employee may be exposed to airborne concentrations of hydrogen chloride above the permissible level. The initial determination shall be made each time there is a change in production, process, or control measures which may result in an increase in airborne concentrations of hydrogen chloride.

(2) A written record of the initial determination shall be made and shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to hydrogen chloride;

(ii) Any measurements of hydrogen chloride taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to hydrogen chloride; and

(iv) Date of initial determination, work being performed at the time, location within work site, and employees considered.

(3) If the employer determines that any employee may be exposed to hydrogen chloride above the permissible exposure, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b) (3) of this section reveals employee exposure to hydrogen chloride above the action level, the employer shall:

(i) Identify all employees who may be exposed above the permissible level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to hydrogen chloride above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every three months.

(6) If an employee exposure measurement reveals that an employee is exposed to hydrogen chloride above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section; and

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to hydrogen chloride above the permissible exposure. The employee shall also be notified of the results of the exposure measurements and of the corrective action being taken to reduce the exposure to below the permissible exposure.

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(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to hydrogen chloride below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over an eight-hour work shift (See Appendix B (IV) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy
Above permissible exposure	$\pm 25\%$
At or below permissible exposure and above the action level	$\pm 35\%$
At or below the action level	$\pm 50\%$

(d) Compliance. (1) No employee shall be exposed to hydrogen chloride above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of hydrogen chloride shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (1) When local exhaust is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity or static pressure shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of hydrogen chloride.

(ii) Open surface tank operations shall be performed in accordance with § 1910.94 (d).

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

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(ii) In work situations in which engineering and work practice controls are not feasible; or

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of hydrogen chloride to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided. When an employee informs his employer that he is experiencing eye irritation from hydrogen chloride while wearing a respirator allowed in Table 2, the employer shall provide and ensure that the employee use an equivalent respirator with a full facepiece, helmet or hood.

TABLE 2 RESPIRATORY PROTECTION FOR HYDROGEN CHLORIDE GAS

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION*
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	A chemical cartridge respirator with full facepiece and 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

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operated in pressure-demand or other positive pressure mode.

Escape Any gas mask providing protection against acid gases.

Any escape self-contained breathing apparatus.

*Use of supplied-air suits may be necessary to prevent skin contact and respiratory exposure from airborne concentrations of hydrogen chloride. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitation and potential life endangering characteristics of supplied-air suits. Where supplied-air suits are used above a concentration which may be immediately dangerous to life and health (100 ppm), an auxiliary positive-pressure self-contained breathing apparatus must also be worn.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for hydrogen chloride.

(2) Hydrogen chloride shall be stored so as not to come in contact with metals and alkalies.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees 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. Face shields shall comply with § 1910.133 (a)(2), (a)(4), (a)(5), and (a)(6).

(2) Employers shall provide and ensure that employees use appropriate protective clothing and equipment 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.

(3) 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, employers shall provide facilities for quick drenching of the body within the immediate work area for emergency use.

(4) Employers shall ensure that non-impervious clothing which becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0 be removed immediately and not reworn until the hydrogen chloride is removed from the clothing.

(5) Employers shall ensure that non-impervious clothing which becomes wet with solutions of hydrogen chloride with a pH equal to or greater than 3.0 be removed promptly and not reworn until the hydrogen chloride is removed from the clothing.

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(6) Employers shall provide and ensure that employees use splash-proof safety goggles which comply with (a)(2)-(a)(6) where there is any possibility of mists or solutions of hydrogen chloride contacting the eyes.

(7) Where there is any possibility that an employee's eyes may be exposed to solutions of hydrogen chloride which have a pH less than 3.0, employers shall provide an eye-wash fountain within the immediate work area for emergency use.

(g) Spills and disposal. In the event that hydrogen chloride is inadvertently released the employer shall immediately provide available ventilation to disperse the gas.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0 immediately wash or shower to remove any hydrogen chloride from the skin.

(2) Employers shall ensure that employees whose skin becomes wet with solutions of hydrogen chloride which have a pH equal to or greater than 3.0 promptly wash or shower to remove any hydrogen chloride from the skin.

(i) Training and information. (1) Each employer who has a workplace in which hydrogen chloride is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to hydrogen chloride above the action level without regard to the use of respirators, or employees who may have skin or eye contact with hydrogen chloride or solutions of hydrogen chloride, or employees who work where a release of hydrogen chloride gas or spill of solutions of hydrogen chloride may occur, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for hydrogen chloride (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to hydrogen chloride.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of overexposure to hydrogen chloride which are listed in Appendix A of the section;

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to hydrogen chloride.

(j) Medical surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) Preplacement medical examination. The employer shall make available to each employee who is exposed, or will be exposed, to airborne concentrations of hydrogen chloride above the action level, without regard to the use of respirators, or employees who may have skin or eye contact with hydrogen chloride or solutions containing hydrogen chloride a preplacement medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the lungs, skin and eyes;

(ii) Forced vital capacity (FVC) and forced expiratory volume-one second (FEV (1 second)) tests;

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(iii) 14" x 17" chest roentgenogram.

(3) Periodic medical examination. The employer shall make available to each employee exposed to airborne concentrations of hydrogen chloride above the action level, without regard to the use of respirators, or employees who may have skin or eye contact with hydrogen chloride or solutions containing hydrogen chloride twelve months from the date of the employee's first exposure, and every twelve months thereafter, a periodic medical examination which must include the following:

(i) A medical history and physical examination with emphasis on the lungs, skin and eyes;

(ii) Forced vital capacity (FVC) and forced expiratory volume-one second (FEV (1 second)) tests;

(iii) A 14" x 17" chest roentgenogram, if pulmonary function tests show significant abnormalities.

(4) Alternative medical procedures. If the examining physician chooses to use alternative medical procedures to those specified in paragraphs (j)(2) and (j)(3) of this section, the employer may accept such alternative medical procedures as meeting the requirements of this section provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical procedures, the rationale for substitution, and evidence that they will be equally effective;

(ii) Informs each exposed worker of the fact that alternative medical procedures to those required in paragraphs (j)(2) and (j)(3) of this section are to be made available.

(5) Interim medical examination. The employer shall provide an interim medical examination employee if the employee informs the employer of any of the signs or symptoms of exposure to hydrogen chloride which are listed in Appendix A which the employee suspects are caused by exposure to hydrogen chloride.

(6) Informing the physician. The employer shall provide to the physician performing any medical examination required by this section the following information:

(i) A copy of this regulation with Appendixes A, B, and C for hydrogen chloride;

(ii) A description of the affected employee's duties as they relate to his exposure to hydrogen chloride;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurements which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure level; and

(vi) Upon request of the physician, any available information from previous medical examinations of the affected employee.

(7) Where a medical examination is required by paragraphs (j)(2), (j)(3), or (j)(5) of this section, following such examination the employer shall obtain from the examining physician a written opinion which conforms with paragraph (j)(8) of this section.

(8) Physician's written opinion. (i) The physician's written opinion by the examining physician shall specifically state:

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(A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to hydrogen chloride;

(B) Any recommended limitations upon the employee's exposure to hydrogen chloride, including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to the employee's employment.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(9) Results of tests. Where a preplacement or periodic medical examination is required by paragraphs (j)(2) or (j)(3) of this section, following such examination the employer shall obtain from the examining physician for inclusion in the employee's medical record:

(i) A recording of the results of the pulmonary function tests;

(ii) The 14" x 17" chest roentgenogram when required, or a medically acceptable copy;

(iii) Where alternative medical procedures have been performed in accordance with paragraph (j)(4) of this section, a recording of such alternative procedures.

(10) No employee shall be exposed to hydrogen chloride in such a way as would put the employee at increased risk of material impairment of his health from such exposure. The employer shall base this decision on any information available including the physician's written opinion.

(11) No medical procedure which would be performed pursuant to paragraphs (j)(2) or (j)(3) of this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(12) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risk involved by refusal to be examined.

(13) The employer shall provide emergency medical treatment for any employee injured through exposure to hydrogen chloride.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) This record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to hydrogen chloride.

— (ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to hydrogen chloride which are being monitored;

(C) Sampling and analytical method used and evidence of their accuracy;

(D) Number, duration, and results of samples taken; and

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(E) Name, social security number and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name and social security number of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name and social security number of the employee;

(B) Results of tests required by paragraph (j)(2) and (j)(3) of this section and results of any tests conducted pursuant to paragraphs (j)(4) of this section;

(C) Any employee medical complaints relative to exposure to hydrogen chloride;

(D) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(E) Physician's written opinion; and

(F) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of and for five years after termination of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Each employee or former employee shall have access to the exposure determination and exposure measurement records required to be maintained by this section which indicate his own exposure to hydrogen chloride.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(1) Employee observation of measurement. (1) The employer shall give each employee or his representative an opportunity to observe any measurement of his exposure to hydrogen chloride which is conducted pursuant to this section.

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(2) When observation of measurement of employee exposure to hydrogen chloride requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of hydrogen chloride that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendix for hydrogen chloride is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent that the information supplements this regulation for hydrogen chloride, it is advisory in nature.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR HYDROGEN CHLORIDE

I. SUBSTANCE IDENTIFICATION

- A. Substance: Hydrogen chloride
- B. Permissible Exposure: 5 parts of hydrogen chloride per million parts of air (ppm) (7 milligrams of hydrogen chloride per cubic meter of air (mg/M3)) shall not be exceeded during any fifteen minute period during an eight-hour work shift.
- C. Appearance and Odor: Colorless gas with an irritating pungent odor

II. HEALTH HAZARD DATA

- A. Ways in which the chemical affects your body: Hydrogen chloride can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.
- B. 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.

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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: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to hydrogen chloride.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye Exposure: If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas get into your eyes, wash your 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.
- B. Skin Exposure: If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas get on your skin, immediately flush the contaminated skin with water. If solutions of hydrogen chloride or strong concentrations of hydrogen chloride gas penetrate through your clothing, remove the clothing immediately and flush the skin. Get medical attention immediately.
- C. Breathing: If you or any other 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.
- D. Swallowing: When solutions of hydrogen chloride have been swallowed, if the person is conscious, give him large quantities of water immediately to dilute the hydrogen chloride. Do not attempt to make the exposed person vomit. Get medical attention immediately.
- E. Rescue: Move 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 yourself. Understand your emergency rescue procedures and know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators: Respirators are not the best way to control exposure to hydrogen chloride. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration

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(MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required. If you can smell hydrogen chloride while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

- B. Protective Suits: In some work situations the wearing of supplied-air suits or other impervious coverings such as acid suits may be necessary. Your employer should instruct you in their proper use and operation.
- C. Protective Clothing: You must wear appropriate protective clothing and equipment to prevent any possibility of skin contact with mists or solutions of hydrogen chloride which have a pH less than 3.0. You must wear appropriate protective clothing and equipment 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. Replace or repair impervious clothing that has developed leaks.
- D. Eye Protection: You must wear splash-proof safety goggles where there is any possibility of mists or solutions of hydrogen chloride contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. Hydrogen chloride must be stored in a cool, well ventilated area away from metals and alkalis.
- B. You must immediately remove any non-impervious clothing that becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0, and this clothing must not be reworn until the hydrogen chloride is removed from the clothing.
- C. You must promptly remove any non-impervious clothing that becomes wet with solutions of hydrogen chloride which have a pH equal to or greater than 3.0 and this clothing must not be reworn until the hydrogen chloride is removed from the clothing.
- D. If your skin becomes contaminated with solutions of hydrogen chloride which have a pH less than 3.0, you must immediately wash or shower to remove the hydrogen chloride from your skin.
- E. If your skin becomes wet with solutions of hydrogen chloride which have a pH equal to or greater than 3.0, you must promptly wash or shower to remove the hydrogen chloride from the skin.
- F. Eye flushing facilities and quick drenching facilities, where provided, must be readily available and you should know where they are and how to operate them.
- G. Ask your supervisor where hydrogen chloride is used in your work area and for any additional safety and health rules.

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VI. ACCESS TO INFORMATION

- A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for hydrogen chloride. In addition, your employer must instruct you in the safe use of hydrogen chloride, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to hydrogen chloride. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure data for at least one year and to keep medical data during your employment, and for a period of five years following your termination of employment. Your employer is required to make the exposure data available to you upon your request. Your employer is also required to release your medical records to your physician upon your written request.
- D. Your employer must give you a copy of the physicians written opinion for any physical examination required by this standard.

NOTE: The information contained in the following appendix for hydrogen chloride is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent that the information supplements this regulation for hydrogen chloride, it is advisory in nature.

APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR HYDROGEN CHLORIDE

I. PHYSICAL AND CHEMICAL DATA

- A. Substance Identification
 - 1. Synonyms: Anhydrous hydrogen chloride; hydrochloric acid, anhydrous
 - 2. Formula: HCl
 - 3. Molecular weight: 36.5
- B. Physical Data
 - 1. Boiling point (760 mm Hg): -85 C (-121 F)
 - 2. Specific gravity (water = 1): 0.42 (liquid)
 - 3. Vapor density (air = 1 at boiling point of

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hydrogen chloride): 1.27

4. Melting point: -114 C (-173 F) (triple point)
5. Vapor pressure at 20 C (68 F): Greater than 1 atmosphere
6. Solubility in water, % by weight at 20 C (68 F): 62
7. Evaporation rate (butyl acetate = 1): Not applicable
8. Appearance and odor: Colorless gas with an irritating pungent odor

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Not combustible

B. Reactivity

1. Conditions contributing to instability: High temperatures may cause cylinders to explode.
2. Incompatibilities: Contact with most metals corrode 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.

III. SPILL AND LEAK PROCEDURES

A. 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 leak or allow cylinder to empty.

B. 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.

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

IV. MONITORING AND MEASUREMENT PROCEDURES

A. EXPOSURE ABOVE THE ACTION LEVEL: Measurements taken for the purpose of determining employee exposure under this section are best taken during periods of maximum expected airborne concentrations of hydrogen chloride. Each measurement should consist of a 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 measurements taken is a good estimate of the employee's highest exposure for that shift. The sampling and analysis under this section may be performed by instruments such as detector tubes certified by NIOSH under 42 CFR part 84, portable direct-

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reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of hydrogen chloride to plus or minus 35%.

- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: The monitoring and measurements under this section should be essentially the same as described under paragraph IV. A. When sampling for peak or ceiling exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the employee has or has not, in fact, been exposed in excess of the permissible limit. Laboratories performing chemical analyses should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of hydrogen chloride to plus or minus 25%.

- C. METHODS: Methods meeting these accuracy requirements are available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161 under the title "NIOSH Analytical Methods for Set R" (Order number XXXXXXXXXX).

- D. QUALIFIED PERSONS: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

- A. Store hydrogen chloride gas in a cool, well ventilated area.
- B. Use of supplied-air suits or other impervious coverings (such as acid suits) may be necessary to prevent skin irritation from hydrogen chloride. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life endangering characteristics of supplied-air suits.
- C. Employers should advise employees of all areas and operations where their exposure to hydrogen chloride could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to hydrogen chloride is likely to occur are: During its formation as a by-product in chlorination reactions, pyrolysis of organic chlorine compounds, Dow process for making metallic magnesium; wherever strong hydrochloric acid is used as in metal cleaning, oil-well activation, or many chemical reactions; during the pickling of metals, and in metal treating and fabricating operations; and during food processing.

—NOTE: The information contained in the following appendix is neither intended, by itself, to create any additional obligations not otherwise imposed, nor detract from any existing obligation. To the extent that the information supplements this regulation for hydrogen chloride, it is advisory in nature.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Hydrogen chloride gas is an irritant of the eyes, mucous membranes, and skin. Exposure of rabbits and guinea pigs to 6400 mg/M3 (approximately 4290 ppm) for 30 minutes caused death, in many instances from laryngeal spasm, laryngeal edema, or pulmonary edema. Exposure of 3 species of animals to 300 ppm for 6 hours caused 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.

III. SIGNS AND SYMPTOMS

Inflammation and ulceration of the nose, throat, larynx; cough, burning of the throat, choking sensation; burns of the eyes and skin; dermatitis; by analogy to effects caused in animals, high concentrations may cause laryngeal spasm and pulmonary edema.

IV. SPECIAL TESTS

None in common usage.

V. TREATMENT

Persons who have been exposed to a high concentration of hydrogen chloride gas or who have had contact with hydrochloric acid should be subjected immediately to a drenching shower of water. Contaminated clothing should be removed as rapidly as possible, even while the person is under the shower. If hydrochloric acid is splashed in the eyes, the eyes must be immediately flushed with water. If hydrochloric acid is swallowed and the person is conscious, immediately administer water.

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orally. The person may be expected to vomit spontaneously, but no attempt should be made to induce vomiting. Give artificial resuscitation and administer oxygen if indicated. Consideration should be given to hospitalization and observation for the possible delayed onset of pulmonary edema.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of hydrogen chloride are caused by its irritant properties. Serious intoxication from inhalation is rare, because the irritant nature of the gas prevents work in air containing dangerous concentrations. Dental erosion may occur at high levels. It is important that the physician become familiar with plant operating conditions in which exposure to hydrogen chloride occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to hydrogen chloride:

1. A complete history and physical examination -- The purpose is to detect preexisting 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.
2. 14" x 17" chest roentgenogram -- Hydrogen chloride causes lung damage. Surveillance of the lungs is indicated.
3. 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.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis except that an x-ray is required only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

VII. REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Hydrogen Chloride," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 129.

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2. Hygienic Guide Series: "Hydrogen Chloride," American Industrial Hygiene Association Journal, 19:350-351, 1958.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 849-851.

4. Manufacturing Chemists Association, Inc.: Chemical Safety Data Sheet SD-39, Hydrochloric Acid, 1970, pp. 5-6, 24-26.

5. Poteshman, N.L.: "Corrosive Gastritis Due to Hydrochloric Acid Ingestion," American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, 99:182-185, 1967.

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REFERENCES AND SOURCES
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- (f) Personal Protective Equipment, and, (h) Sanitation
- Eye: Manufacturing Chemists' Association, "Chemical Safety Data Sheets;" Stauden, "Kirk-Othmer Encyclopedia of Chemical Technology," 2nd edition; International Labour Office, "Encyclopedia of Occupational Health and Safety;" Grant, "Toxicology of the Eye"
- Skin: Manufacturing Chemists' Association, "Chemical Safety Data Sheets;" Stauden, "Kirk-Othmer Encyclopedia of Chemical Technology;" 2nd edition; International Labour Office, "Encyclopedia of Occupational Health and Safety;" Patty, "Industrial Hygiene and Toxicology;" von Oettingen, "Poisoning"
- Ingestion: Manufacturing Chemists' Association, "Chemical Safety Data Sheets;" Patty, "Industrial Hygiene and Toxicology;" Deichmann and Gerarde, "Toxicology of Drugs and Chemicals;" Baskin, "Handling Guide for Potentially Hazardous Commodities"

COMMENTS

- Eye - Classification: 1 and 2
Output statement numbers: 9, 13
Exceptions: 13 modified, see below; Statement 10 is deleted and statement 9 is used to require eye protection for all situations involving potential eye exposure to mists or solutions containing hydrogen chloride.

"Contact of the eyes with hydrogen chloride . . . in solution, rapidly causes severe irritation of the eyes and eyelids," according to the MCA. They further state that the acid can cause "prolonged or permanent visual impairment or total loss of sight" if it is not quickly removed by thorough irrigation.

Stauden notes that exposure to acid "may result in chemical burns," and that "particular care should be taken to avoid contact with the eyes because of possible corneal damage."

The ILO says that "contact with the eyes may produce reduced vision or blindness, the severity being determined by the concentration of the solution."

In a detailed study, Grant says, "Hydrochloric is one of the most common acids, and for more than a century reports have been appearing of injuries of the eye from splashes of this substance. The severity has varied according to the quantity, concentration, and time of contact, and has ranged from inconsequential redness and irritation of the conjunctiva to total corneal opacification and loss of the eye. In rare instances opacities of the lens have been produced in human and rabbit eyes."

Most commonly a drop splashed in the eye and immediately washed out with water causes white coagulation of corneal and conjunctival epithelium, but does no significant damage to the corneal stroma or deeper parts of the eye. Usually the injured epithelium comes loose in a day or two and is replaced in a few days by new epithelium, and the eye returns to normal.

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The reactions of rabbit eyes to hydrochloric acid have been studied in great detail. Hydrochloric acid is injurious only below pH3. Contact with 0.25N to 1N acid for twenty seconds results in some scarring of rabbit corneas.

Strong acids obviously have the potential to cause permanent and serious injury. Since Grant reports that the acid is injurious only below pH3, solutions containing hydrogen chloride which have a pH less than 3.0 are assigned a classification of 1 while solutions containing hydrogen chloride which have a pH of 3.0 or greater are assigned a classification of 2. Eye wash facilities are required only for the stronger solutions.

Skin - Classification: 1 and 2

Output statement numbers: 1, 2, 8a, 14g, 14i, 16g, 16i

Exceptions: 20a deleted

The MCA says the liquid will cause burns "if in contact with any part of the body." Furthermore, "concentrated solutions are destructive to clothing . . . Repeated contact of the skin with dilute solutions may lead to the development of dermatitis. In cases of severe or extensive burns, shock symptoms, such as rapid pulse, sweating, and collapse, may occur at any time." Patty further adds that "contact with concentrated solutions of hydrogen chloride (muriatic acid) in cleaning metal gives rise to small burns and ulcerations of the hands."

According to Stauden, the substance "exerts a destructive action on the mucous membrane and skin. Exposure to . . . acid may result in chemical burns or dermatitis." The ILO says that the severity of the burn depends on the concentration of the solution, and that burns on the face may produce serious and disfiguring scars. Frequent contact with aqueous solutions may lead to dermatitis.

According to von Oettingen, "hydrochloric acid is a solution of hydrogen chloride gas in water, usually in a concentration of 38 per cent. The direct contact of hydrochloric acid with the skin causes inflammation, corrosion and necrosis. In one instance, injury of the skin by hydrochloric acid was followed after several months by lesions comparable to lupus erythematosus and showing the same histologic changes."

Hydrogen chloride has a boiling point of -121 degrees F, a vapor pressure at 20 degrees C of greater than 1 atmosphere and a 62% solubility in water.

Based on Grant's discussion (See "Eye"), strong solutions (pH less than 3.0) are assigned a classification of 1 while weaker solutions (pH equal to or greater than 3.0) are assigned a classification of 2. Because of the rapidity with which the substance reacts with skin and other substances, it is concluded that specification of statement 20a is superfluous. Since skin contact with the mist can be a common source of exposure in industry, it is specifically mentioned in several of the requirements, as appropriate.

Ingestion - Classification: 0

Output statement numbers: None

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Exceptions: None

The MCA says when "concentrated hydrochloric acid is swallowed, it causes severe burns of the mucous membranes of the mouth, esophagus, and stomach. The lips and mouth usually turn white, and later brown. There is pain in the throat and stomach, difficulty in swallowing, intense thirst, nausea, and vomiting, followed by diarrhea and, in severe cases, by collapse and death."

Patty reports "repeated oral administration of dilute hydrochloric acid to dogs induces acute and chronic gastritis and duodenitis, and leads to the appearance of ulcers of the pylorus, while toxic doses lower the alkaline reserve of the blood."

Deichmann and Gerarde says that "ingestion of a corrosive dose will cause pain in the mouth, destruction of tissues, salivation, and severe gastroenteric distress. Normal stomach acid is 0.5% hydrochloric acid."

According to Baskin, the estimated fatal dose by ingestion is 1 gm or approximately 15 mg/kg body weight.

Because of the corrosivity of the substance and the rapidity with which it reacts, it is concluded that ingestion, in the context of this standard, would not present a significant hazard in the industrial environment.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

National Fire Protection Association, "Fire Protection Guide on Hazardous Materials," 5th ed., 1975 (NFPA)

Manufacturing Chemists' Association, Chemical Safety Data Sheet SD-39 (MCA)

Dow Chemical USA, Material Safety Data Sheet (Dow)

Kirk-Othmer, "Encyclopedia of Chemical Technology," 2nd edition, Vol. 11, p. 307 (K-O)

Sources of data items used:

- I. A. 1. Synonyms: MCA
2. Formula: NFPA-49
3. Molecular weight: ADL
- B. 1. Boiling point: MCA, Dow
2. Specific gravity: K-O
3. Vapor density: Dow
4. Melting point: K-O
5. Vapor pressure: Dow, MCA
6. Solubility in water: Dow
7. Evaporation rate: Not applicable
8. Appearance and odor: NFPA-49, MCA
- II. A. 1. Not combustible
- B. 1. Conditions contributing to instability: Dow
2. Incompatibilities: NFPA-49M, MCA, Dow
3. Hazardous decomposition products: None
4. Special precautions: K-O
- III. A. Steps if released or spilled: NFPA-49, MCA, Dow
- V. Miscellaneous precautions: MCA

USE/EXPOSURE AND CONTROL DOCUMENT

The references used in the preparation of this document include:

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- "Anhydrous Hydrogen Chloride," Material Safety Data Sheet, Dow Chemical Company, Midland, Michigan (Dow)
- Harris, W. B., Breslin, A. J., Glauberman, H. and Weinstein, M. S., "Environment of Hazards Associated in the Milling of Uranium Ore," Archives of Environmental Health, 20:365 - 382, 1959 (Harris)
- "Hydrochloric Acid and Hydrogen Chloride," Hygienic Information Guide No. 19, Commonwealth of Pennsylvania, Department of Environmental Resources, Occupational Health, 8/71 (Penn)
- "Hydrochloric Acid Manufacture Report No. 3," Journal of the Air Pollution Control Administration, 13:496 - 505, 1963 (JAPCA)
- International Labour Organization, "Encyclopedia of Occupational Health and Safety," Geneva, 1972 (ILO)
- Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, Division of John Wiley, 2nd edition, 1972 (K-O)
- Kramkowski, R. S., "Health Hazard Evaluation Report 72-99-55," Peerless Wiregoods Company, Lafayette, Indiana, Hazard Evaluation Service Branch, National Institute of Occupational Safety and Health, Cincinnati, 1973 (Kramkowski)
- Louks, Charles, M., "Boosting Capacities with Chemicals," Chemical Engineering, February 26, 1973 (Louks)
- "Merck Index of Chemicals and Drugs," Merck and Co., Inc., Rahway, N. J., 8th edition, 1968 (Merck)
- Patty, F. A., "Industrial Hygiene and Toxicology," Vol. II, Interscience Publishers, 1962 (Patty)
- Rinzema, L. C. and Silverstein, L. G., "Hazards from Chlorinated Hydrocarbon Decomposition during Welding," American Industrial Hygiene Association Journal, 33:35 - 40, 1972 (Rinzema)
- Stanford Research Institute, "Chemical Economics Handbook," Menlo Park, California (SRI)
- Stanford Research Institute, "Chemical Origins and Markets," SRI, Menlo Park, California, 1967 (Chem Origins)
- Steel, J., "Health Hazards in the Welding and Cutting of Paint-Primed Steel," Annals of Occupational Hygiene, 7:247-252, 1964 (Steel)

References for Specific Use/Exposure

1. K-O, SRI, Patty
2. ADL estimate, JAPCA
3. Chem Origins, K-O
4. Kramkowski, Rinzema, Steel
5. K-O, Chem Origins
6. K-O, Chem Origins, SRI
7. Louks, K-O
8. K-O, Chem Origins, ILO
9. K-O, Merck, Chem Origins
10. JAPCA
11. Harris, SRI, K-O
12. Chem Origins, K-O
- 13. K-O, Chem Origins
14. SRI
15. Merck, K-O

References for Specific Control Methods

Penn, ILO and Dow were the references used in all the Specific Control Methods.

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RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: Hydrogen chloride gas

D. O. L. STANDARD: 5 ppm (7 mg/M3) shall not be exceeded

WARNING PROPERTIES:

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 - 5 ppm; 5 - 10 ppm is disagreeable)." The editor does not specify how most people can detect 1 - 5 ppm, however.

Eye Irritation Level: Grant states that an exposure of animals to "100 ppm for six hours daily for fifty days caused only slight unrest and irritation of the eyes, but no injury." For the purpose of this standard, half-facepiece respirators are permitted up to a concentration of 50 ppm (PF = 10X). If eye irritation occurs, full facepiece respirators must be worn.

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."

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 standard, therefore, hydrogen chloride is treated as a material with good warning properties. Gas sorbent respiratory equipment is permitted.

IDLH: 100 ppm

Basis for IDLH Value: This IDLH is based upon the report in Patty Concerning the effects on humans, which reports that "according to Matt, work is impossible when one inhales air containing hydrogen chloride in concentrations of 75 to 150 mg/cu meter (50 to 100 ppm); work is difficult but possible when the air contains concentrations of 15 to 75 mg/cu meter (10 to 50 ppm); and work is undisturbed at the concentration of 15 mg/cu meter (10 ppm)."

The Documentation of TLV's reports that the "TLV of 5 ppm is interpreted to be sufficiently low to prevent toxic injury, but on the borderline of severe irritation."

Other Toxicological Information: According to Patty, "when inhaled in sufficiently high concentration, hydrogen chloride acts as an irritant to the respiratory tract. The inhalation of air containing 6400 mg/cu meter for 30 minutes by rabbits and guinea pigs resulted in death, in many instances from laryngeal spasm, laryngeal edema, or rapidly developing pulmonary edema. Lehmann found that exposure of cats, rabbit and guinea pigs for 1 1/2 hours to the concentration of 5000 mg/cu meter (34000 ppm) (sic) caused death after 2 to 6 days, while a slightly shorter exposure to the concentration of 2000 mg/cu meter (1350 ppm) caused severe irritation, dyspnea, and clouding of the cornea. When the duration of exposure was 2 to 6 hours, the concentration of 1000 mg/cu meter (675 ppm) caused some fatalities. A 6 hour exposure to the concentration of 450 mg/cu meter (300 ppm) caused slight corrosion of the cornea and upper respiratory irritation. This response was but slight after a similar exposure to the concentration of 150 to 210 mg/cu (100 to 140 ppm) . . . When inhaled in high concentrations, the gas causes necrosis of the tracheal and bronchial epithelium as well as

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pulmonary edema, atelectasis, and emphysema, and damage to the pulmonary blood vessels."

LFL: Hydrogen chloride is not combustible.

VAPOR PRESSURE AT 20 C: Hydrogen chloride is a gas at room temperature.

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USE/EXPOSURE AND CONTROL DOCUMENT
HYDROGEN CHLORIDE

Principal Route
of Entry

Currently Used
Control Methods

- | | Use/Exposure | Principal Route of Entry | Currently Used Control Methods |
|----|--|--------------------------|---|
| 1. | Inhalation of gas or mist and skin contact with liquid during pickling of metals (including stainless steel, iron, nickel, and monel) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 2. | Inhalation of gas or mist and skin contact with liquid during production and handling of gas, liquefied gas, and acid | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 3. | Inhalation of gas or mist and skin contact with liquid during use as a catalyst or chlorinating agent in chemical synthesis (including alkyl chlorides, aniline, pharmaceutical hydrochlorides, metallic and other inorganic chlorides) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 4. | Inhalation of gas or mist and skin contact with liquid during metal treating and fabricating operations (including electroplating, acid dipping, stripping, electropolishing, etching, welding and flamecutting of metal primed with paint or cleaned with chlorinated hydrocarbons, and used as a gaseous flux in babbitting) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 5. | Inhalation of gas and mist and skin contact with liquid during oxyhydrochlorination processing in production | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber |

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of chlorinated hydrocarbons (including dichlorobenzene, phenol, and 1,2-dichloroethane)

boots, aprons, gloves)

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|-----|--|-----|---|
| 6. | Inhalation of gas and skin contact with liquid during food processing and manufacture (including sugar cane refining, glucose and corn sugar, gelatin and pectin, MSG, vanillin, and brewing operations) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 7. | Inhalation of gas and mist and skin contact with liquid during industrial chemical cleaning operations (including boilers, pipelines, heat-exchangers, etc.) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 8. | Inhalation of gas or mist and skin contact with liquid during production of plastics (including vinyl chloride monomer, melamine resin acid colloids, and dimethyl silicone polymer) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 9. | Inhalation of gas or mist and skin contact with liquid during rubber manufacture (including synthesis of chloroprene, used as a chlorinating agent, and for coagulation of latex) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 10. | Inhalation of gas or mist and skin contact with liquid during production as a by-product in synthesis of other organic chemicals (including methyl and methylene chloride, chloroform, carbon tetrachloride, and fluorinated | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |

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organics)

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|-----|---|-----|---|
| 11. | Inhalation of gas and mist and skin contact with liquid during extraction and reduction processing of metal ores | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 12. | Inhalation of gas or mist and skin contact with liquid during use in delining of hides in leather manufacture | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 13. | Inhalation of gas and skin contact with liquid during use in activation of petroleum wells | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 14. | Inhalation of gas or mist and skin contact with liquid during waste treatment operations (including for neutralization of alkaline waste streams) | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |
| 15. | Inhalation of gas and mist and skin contact with liquid during production of chlorine | A,B | Local exhaust ventilation; general mechanical ventilation; personal protective equipment (respiratory protective devices, rubber boots, aprons, gloves) |

- A -- Inhalation
B -- Skin and eye contact resulting in localized irritation
C -- Ingestion
D -- Skin contact resulting in absorption and subsequent systemic poisoning