

**CHLORINE****ICSC: 0126**

**Date of  
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**CAS # 7782-50-5 Cl<sub>2</sub>**  
**RTECS # FO2100000 Molecular mass: 70.9**

**UN # 1017**  
**EC Annex 1 017-001-  
Index # 00-7**







**EC/EINECS 231-959-5**

<b>TYPES OF HAZARD / EXPOSURE</b>	<b>ACUTE HAZARDS / SYMPTOMS</b>	<b>PREVENTION</b>	<b>FIRST AID / FIRE FIGHTING</b>
<b>FIRE</b>	Not combustible but enhances combustion of other substances. Many reactions may cause fire or explosion.	NO contact with incompatible materials; see Chemical Dangers.	In case of fire in the surroundings: use appropriate extinguishing media.
<b>EXPLOSION</b>	Risk of fire and explosion (See Chemical Dangers).	NO contact with incompatible materials; see Chemical Dangers.	In case of fire: keep cylinder cool by spraying with water but NO direct contact with water.

<b>EXPOSURE</b>		<b>AVOID ALL CONTACT!</b>	<b>IN ALL CASES CONSULT A DOCTOR!</b>
<b>Inhalation</b>	Cough. Sore throat. Shortness of breath. Wheezing. Laboured breathing. Symptoms may be delayed (see Notes).	Breathing protection. Closed system and ventilation.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer immediately for medical attention.
<b>Skin</b>	ON CONTACT WITH LIQUID: FROSTBITE. Redness. Burning sensation. Pain. Skin burns.	Cold-insulating gloves. Protective clothing.	First rinse with plenty of water for at least 15 minutes, then remove contaminated clothes and rinse again. Refer immediately for medical attention.
<b>Eyes</b>	Causes watering of the eyes. Redness. Pain.	Safety goggles, face shield and eye protection	Rinse with plenty of water (remove contact lenses if

	Burns.	in combination with breathing protection.	easily possible). Refer immediately for medical attention.
<b>Ingestion</b>		Do not eat, drink, or smoke during work.	

<b>SPILLAGE DISPOSAL</b>	<b>PACKAGING &amp; LABELLING</b>
Evacuate danger area! Consult an expert! Personal protection: gas-tight chemical protection suit including self-contained breathing apparatus. Ventilation. Shut off cylinder if possible. Isolate the area until the gas has dispersed. NEVER direct water jet on liquid. Remove gas with fine water spray. Do NOT let this chemical enter the environment.	Special insulated cylinder. Marine pollutant. <b>EU Classification</b> Symbol: T, N R: 23-36/37/38-50 S: (1/2-)9-45-61 <b>UN Classification</b> UN Hazard Class: 2.3 UN Subsidiary Risks: 8 <b>GHS Classification</b> Danger Contains gas under pressure; may explode if heated Fatal if inhaled gas Causes severe skin burns and eye damage May cause respiratory irritation Very toxic to aquatic life
<b>EMERGENCY RESPONSE</b>	<b>STORAGE</b>
Transport Emergency Card: TEC (R)-20S1017 or 20G2TC NFPA Code: H 4; F 0; R 0; OX	Fireproof if in building. Provision to contain effluent from fire extinguishing. Separated from food and feedstuffs, see Chemical Dangers. Cool. Dry. Keep in a well-ventilated room. Store in an area without drain or sewer access.
<b>IPCS</b> International Programme on Chemical Safety    	Prepared in the context of cooperation between the International Programme on Chemical Safety and the Commission of the European Communities © IPCS, CEC 2005  <b>SEE IMPORTANT INFORMATION ON BACK</b>

**CHLORINE**

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<b>IMPORTANT DATA</b>	
<b>PHYSICAL STATE; APPEARANCE:</b> GREEN TO YELLOW COMPRESSED LIQUEFIED GAS , WITH PUNGENT ODOUR.  <b>PHYSICAL DANGERS:</b> The gas is heavier than air.  <b>CHEMICAL DANGERS:</b> The solution in water is a strong acid, it reacts violently with bases and is corrosive. The substance is a strong oxidant and reacts violently with combustible and reducing materials. The substance reacts with most organic and inorganic compounds , causing fire and explosion hazard. Attacks metal, some forms of plastic,	<b>ROUTES OF EXPOSURE:</b> Serious local effects by all routes of exposure.  <b>INHALATION RISK:</b> On loss of containment, a harmful concentration of this gas in the air will be reached very quickly.  <b>EFFECTS OF SHORT-TERM EXPOSURE:</b> Lachrymation. The substance is corrosive to the eyes, the skin and the respiratory tract. Rapid evaporation of the liquid may cause frostbite. Inhalation may cause asthma-like reactions. Inhalation may cause pneumonitis. Inhalation may cause lung oedema, but only after initial corrosive effects on eyes and/or

<p>rubber and coatings.</p> <p><b>OCCUPATIONAL EXPOSURE LIMITS:</b>  TLV: 0.5 ppm as TWA, 1 ppm as STEL; A4 (not classifiable as a human carcinogen); (ACGIH 2008).  EU OEL: 0.5 ppm, 1.5 mg/m<sup>3</sup> as STEL (EU 2006).</p>	<p>airways have become manifest. The effects may be delayed. Medical observation is indicated. Exposure may result in death.</p> <p><b>EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:</b>  The substance may have effects on the respiratory tract and lungs , resulting in chronic inflammation and impaired functions. The substance may have effects on the teeth , resulting in dental erosion.</p>
<p><b>PHYSICAL PROPERTIES</b></p>	
<p>Boiling point: -34°C  Melting point: -101°C  Solubility in water, g/100 ml at 20°C: 0.7  Vapour pressure, kPa at 20°C: 673  Relative vapour density (air = 1): 2.5</p>	
<p><b>ENVIRONMENTAL DATA</b></p>	
<p>The substance is very toxic to aquatic organisms. It is strongly advised that this substance does not enter the environment.</p>	
<p><b>NOTES</b></p>	
<p>The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Do NOT spray water on leaking cylinder (to prevent corrosion of cylinder). Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.</p>	
<p><b>ADDITIONAL INFORMATION</b></p>	
<p><b>LEGAL NOTICE</b></p>	<p>Neither the CEC nor the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information</p>
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Chlorine

International Programme on Chemical Safety  
Poisons Information Monograph 947  
Chemical

This Monograph contain the following sections completed: 1, 2, 3, 4.1, 4.2, 7.2, 9, 10 & 11.

## 1. NAME

### 1.1 Substance

Chlorine

### 1.2 Group

Chlorine and compounds  
Group VIIa (17) element

### 1.3 Synonyms

Chlore; Liquefied chlorine gas;  
Molecular chlorine

### 1.4 Identification numbers

#### 1.4.1 CAS number

7782-50-5

#### 1.4.2 Other numbers

UN/NA number: 1017  
RTECS number: FO2100000  
EU EINECS/ELINCS number: 231-959-5

### 1.5 Main brand names, main trade names

### 1.6 Main manufacturers, main importers

## 2. SUMMARY

### 2.1 Main risks and target organs

Chlorine reacts with tissue water to form hydrochloric and hypochlorous acids, thus a potent irritant of the eyes, skin and mucous membranes, and respiratory tract. Injury is proportional to the concentration of the gas, duration of contact and water content of exposed tissues. Evidence exists suggesting that patients with pre-existing respiratory disease may be at greater risk from chlorine exposure. The extent of the injury depends upon the concentration and duration of the exposure, as well as the water content of the tissue involved and the presence of underlying cardiopulmonary disease.

### 2.2 Summary of clinical effects

EXPOSURE    SYMPTOMS

1 to 3 ppm      Mild mucous membrane irritation after 1 hour

5 to 15 ppm	Moderate irritation of upper respiratory tract
30 ppm	Immediate chest pain, vomiting, and coughing
40 to 60 ppm	Toxic pneumonitis and pulmonary oedema
430 ppm	Lethal after 30 minutes
1,000 ppm	Fatal within a few minutes

Inhalation: Initially: irritation of the eyes, nose and throat, followed by coughing and wheezing, dyspnoea, sputum production and chest pain. Larger exposures may lead to hyperchloraemic acidosis; anoxia may lead to cardiac and/or respiratory arrest and pulmonary oedema. Following chemical pneumonitis respiratory distress and chest pain generally subsides within 72 hours; cough may persist for up to 14 days, however in one case reduced airway flow and mild hypoxemia persisted for 14 months.

Dermal: Irritation, pain, erythema, blister and burns. Liquid chlorine may cause burns on contact.

Eyes: Irritation and conjunctivitis. Liquid chlorine may cause burns on contact.

### 2.3 Diagnosis

The specific odour of chlorine, the respiratory, eye and skin symptoms following exposure make the diagnosis. Measurement of the air levels of chlorine is of significance in occupational circumstances and case of accidental release.

### 2.4 First aid measures and management principles

Care workers must ensure adequate protection to prevent self-contamination when carrying out decontamination and medical treatment. Remove contaminated clothing and put in a sealed bag.

#### Inhalation:

Patients without immediate symptoms may require no treatment, but a full physical examination and a record of respiratory peak flow may be of use in assessing any subsequent respiratory effects.

Patients with mild effects: require a full physical examination and peak flow and discharge accordingly, and advised to return if symptoms recur or develop over the following 24 to 36 hours.

Patients showing immediate moderate or severe effects: Check lung function and perform chest x-rays. Oxygen and bronchodilators (e.g. salbutamol; orally or inhaled) are used for bronchospasm. Pulmonary oedema should be treated with Positive End Expiratory Pressure (PEEP), or Constant Positive Airway Pressure (CPAP). Corticosteroids may inhibit the inflammatory response and should be considered in severe cases. Monitor arterial blood gases, treat hyperchloraemic acidosis.

Patients with pre-existing respiratory disease: assess and consider admission for at least 24 hours.

Dermal: Wash thoroughly with running water or saline. Treat as a thermal burn, if necessary.

Eyes: Irrigate thoroughly for 10 to 15 minutes. Refer to an ophthalmologist.

### 3. PHYSICO-CHEMICAL PROPERTIES

#### 3.1 Origin of the substance

#### 3.2 Chemical structure

Chemical formula: Cl<sub>2</sub>  
Structural Formula: Cl-Cl  
Molecular weight: 70.906

#### 3.3 Physical properties

##### 3.3.1 Colour

Greenish-yellow

##### 3.3.2 State/Form

Gas

##### 3.3.3 Description

Melting Point: -101°C (-149.8 deg F)  
Boiling Point: -34.1°C (-29.3 deg F)  
Relative Density (Specific Gravity):  
1.467 at 0°C and 368.9 kPa (saturated  
liquefied gas)  
0.0032 at 0°C (gas) (water = 1)  
Solubility In Water: Slightly soluble (0.73 g/100 g  
water at 20°C) (reacts)

Solubility In Other Liquids: Very soluble in dimethylformamide; soluble in benzene, chloroform, carbon tetrachloride, tetrachloroethane, chlorobenzene, glacial acetic acid (99.84%), sulfuryl chloride, phosphoryl chloride, silicon tetrachloride and metal chlorides, such as chromyl chloride, titanium tetrachloride and vanadium oxide chloride.

Vapour Density: 2.48 (air=1) (27,28)

Vapour Pressure: 673.1 kPa (6.64 atm) at 20 deg C;  
1427 kPa (14.1 atm.) (27)

pH Value: Not applicable (reacts with water to form an acidic solution)

Critical Temperature: 144 deg C (291.2 deg F)

Critical Pressure: 7711 kPa (76.1 atm) (27,28)

Conversion Factor:

1 ppm = 2.89 mg/m<sup>3</sup>; 1 mg/m<sup>3</sup> = 0.346 ppm at  
25 deg C (calculated)

Appearance and Odour:

Greenish-yellow gas or clear amber liquid (under pressure) with a pungent suffocating odour.

Lachrymator (gas irritates the eyes and causes tears).

(CCOHS, 1998)

### 3.4 Hazardous characteristics

Chlorine is shipped in steel cylinders as a compressed liquefied gas under its own vapour pressure of 598 kPa (86.8 psig or 5.9atm.) at 21.1°C. It is available in a number of grades having a purity of at least 99.5 wt%. Contaminants are mainly carbon dioxide, nitrogen, oxygen and water, but may include traces of chlorinated hydrocarbons, such as hexachloroethane and hexachlorobenzene, inorganic salts such as ferric chloride, bromine or iodine (CCOHS, 1998).

## 4. USES

### 4.1 Uses

#### 4.1.1 Uses

#### 4.1.2 Description

The major uses of chlorine are in the manufacture of chlorinated organic chemicals (such as vinyl chloride monomer, carbontetrachloride, perchlorethylene, 1,1,1-trichloroethane, chlorobenzenes, chloroprene and epichlorohydrin), organic chemicals (such as propylene oxide and glycols) and chlorinated inorganic chemicals (such as sodium hypochlorite, hydrochloric acid, hypochlorous

acid, sulfur chlorides, phosphorous chlorides, titanium chlorides and aluminum chloride) (CCOHS, 1998).

It is also widely used as a bleaching agent in the manufacture of pulp and paper; in bleaching textiles and fabrics; in the manufacture of pesticides, herbicides, refrigerants, propellants, household and commercial bleaches, detergents for automatic dishwashers, antifreeze, antiknock compounds, plastics, synthetic rubbers, adhesives and pharmaceuticals; for drinking and swimming water purification; sanitation of industrial and sewage wastes; and in the degassing of aluminum metal (CCOHS, 1998).

### 4.2 High risk circumstance of poisoning

Household exposures: The mixing of household cleaning agents (for example bleach and acids) may liberate chlorine gas.

Environmental exposures: spills and traffic accidents.

### 4.3 Occupationally exposed populations

## 5. ROUTES OF EXPOSURE

### 5.1 Oral

Chlorine exists as a liquid under pressure.

## 5.2 Inhalation

Main route of exposure to chlorine.

## 5.3 Dermal

Chlorine gas and liquid exposure can lead to dermal irritation and burns.

## 5.4 Eye

Chlorine gas and liquid exposure can lead to ocular irritation and burns.

## 5.5 Parenteral

Unknown.

## 5.6 Other

Unknown.

# 6. KINETICS

## 6.1 Absorption by route of exposure

## 6.2 Distribution by route of exposure

## 6.3 Biological half-life by route of exposure

## 6.4 Metabolism

## 6.5 Elimination and excretion

# 7. TOXICOLOGY

## 7.1 Mode of action

## 7.2 Toxicity

### 7.2.1 Human data

#### 7.2.1.1 Adults

#### 7.2.1.2 Children

### 7.2.2 Relevant animal data

### 7.2.3 Relevant in vitro data

### 7.2.4 Workplace standards

### 7.2.5 Acceptable daily intake (ADI)

## 7.3 Carcinogenicity

## 7.4 Teratogenicity



## 7.5 Mutagenicity

## 7.6 Interactions

# 8. TOXICOLOGICAL ANALYSES AND BIOMEDICAL INVESTIGATIONS

## 8.1 Material sampling plan

### 8.1.1 Sampling and specimen collection

#### 8.1.1.1 Toxicological analyses

#### 8.1.1.2 Biomedical analyses

#### 8.1.1.3 Arterial blood gas analysis

#### 8.1.1.4 Haematological analyses

#### 8.1.1.5 Other (unspecified) analyses

### 8.1.2 Storage of laboratory samples and specimens

#### 8.1.2.1 Toxicological analyses

#### 8.1.2.2 Biomedical analyses

#### 8.1.2.3 Arterial blood gas analysis

#### 8.1.2.4 Haematological analyses

#### 8.1.2.5 Other (unspecified) analyses

### 8.1.3 Transport of laboratory samples and specimens

#### 8.1.3.1 Toxicological analyses

#### 8.1.3.2 Biomedical analyses

#### 8.1.3.3 Arterial blood gas analysis

#### 8.1.3.4 Haematological analyses

#### 8.1.3.5 Other (unspecified) analyses

## 8.2 Toxicological Analyses and Their Interpretation

### 8.2.1 Tests on toxic ingredient(s) of material

#### 8.2.1.1 Simple Qualitative Test(s)

#### 8.2.1.2 Advanced Qualitative Confirmation Test(s)

#### 8.2.1.3 Simple Quantitative Method(s)

#### 8.2.1.4 Advanced Quantitative Method(s)

### 8.2.2 Tests for biological specimens

#### 8.2.2.1 Simple Qualitative Test(s)

#### 8.2.2.2 Advanced Qualitative Confirmation Test(s)

- 8.2.2.3 Simple Quantitative Method(s)
- 8.2.2.4 Advanced Quantitative Method(s)
- 8.2.2.5 Other Dedicated Method(s)

8.2.3 Interpretation of toxicological analyses

### 8.3 Biomedical investigations and their interpretation

8.3.1 Biochemical analysis

8.3.1.1 Blood, plasma or serum  
 "Basic analyses"  
 "Dedicated analyses"  
 "Optional analyses"

8.3.1.2 Urine  
 "Basic analyses"  
 "Dedicated analyses"  
 "Optional analyses"

8.3.1.3 Other fluids

8.3.2 Arterial blood gas analyses

8.3.3 Haematological analyses  
 "Basic analyses"  
 "Dedicated analyses"  
 "Optional analyses"

8.3.4 Interpretation of biomedical investigations

### 8.4 Other biomedical (diagnostic) investigations and their interpretation

### 8.5 Overall interpretation of all toxicological analyses and toxicological investigations

### 8.6 References

## 9. CLINICAL EFFECTS

### 9.1 Acute poisoning

9.1.1 Ingestion

9.1.2 Inhalation

#### EXPOSURE SYMPTOMS

1 to 3 ppm	Mild mucous membrane irritation after 1 hour
5 to 15 ppm	Moderate irritation of upper respiratory tract
30 ppm	Immediate chest pain, vomiting, and coughing
40 to 60 ppm	Toxic pneumonitis and pulmonary oedema
430 ppm	Lethal after 30 minutes
1,000 ppm	Fatal within a few minutes

Initially: irritation of the eyes, nose and throat, followed by coughing and wheezing, dyspnoea, sputum production and chest pain. Larger exposures may lead to hyperchloraemic acidosis; anoxia may lead to cardiac and/or respiratory arrest and pulmonary oedema. Following chemical pneumonitis respiratory distress and chest pain generally subsides within 72 hours; cough may persist for up to 14 days, however in one case reduced airway flow and mild hypoxemia persisted for 14 months.

#### 9.1.3 Skin exposure

Irritation, pain, erythema, blister and burns. Liquid chlorine may cause burns on contact.

#### 9.1.4 Eye contact

Irritation and conjunctivitis. Liquid chlorine may cause burns on contact.

#### 9.1.5 Parenteral exposure

#### 9.1.6 Other

### 9.2 Chronic poisoning

#### 9.2.1 Ingestion

#### 9.2.2 Inhalation

#### 9.2.3 Skin exposure

#### 9.2.4 Eye contact

#### 9.2.5 Parenteral exposure

#### 9.2.6 Other

### 9.3 Course, prognosis, cause of death

### 9.4 Systematic description of clinical effects

#### 9.4.1 Cardiovascular

#### 9.4.2 Respiratory

#### 9.4.3 Neurological

##### 9.4.3.1 Central nervous system (CNS)

##### 9.4.3.2 Peripheral nervous system

##### 9.4.3.3 Autonomic nervous system

##### 9.4.3.4 Skeletal and smooth muscle

#### 9.4.4 Gastrointestinal

- 9.4.5 Hepatic
- 9.4.6 Urinary
  - 9.4.6.1 Renal
  - 9.4.6.2 Other
- 9.4.7 Endocrine and reproductive systems
- 9.4.8 Dermatological
- 9.4.9 Eye, ear, nose, throat: local effects
- 9.4.10 Haematological
- 9.4.11 Immunological
- 9.4.12 Metabolic
  - 9.4.12.1 Acid-base disturbances
  - 9.4.12.2 Fluid and electrolyte disturbances
  - 9.4.12.3 Others
- 9.4.13 Allergic reactions
- 9.4.14 Other clinical effects
- 9.4.15 Special risks

## 9.5 Other

## 9.6 Summary

# 10. MANAGEMENT

## 10.1 General principles

Care workers must ensure adequate protection to prevent self-contamination when carrying out decontamination and medical treatment. Remove contaminated clothing and put in a sealed bag.

### Inhalation:

Patients without immediate symptoms may require no treatment, but a full physical examination and a record of respiratory peak flow may be of use in assessing any subsequent respiratory effects.

Patients with mild effects: require a full physical examination and peak flow and discharge accordingly, and advised to return if symptoms recur or develop over the following 24 to 36 hours.

Patients showing immediate moderate or severe effects: Check lung function and perform chest x-rays. Oxygen and bronchodilators (e.g. salbutamol; orally or inhaled) are used for bronchospasm. Pulmonary oedema should be treated with

Positive End Expiratory Pressure (PEEP), or Constant Positive Airway Pressure (CPAP). Corticosteroids may inhibit the inflammatory response and should be considered in severe cases. Monitor arterial blood gases, treat hyperchloraemic acidosis.

Patients with pre-existing respiratory disease: assess and consider admission for at least 24 hours.

Dermal: Wash thoroughly with running water or saline. Treat as a thermal burn, if necessary.

Eyes: Irrigate thoroughly for 10 to 15 minutes. Refer to an ophthalmologist.

## 10.2 Life supportive procedures and symptomatic/specific treatment

See section 10.1

## 10.3 Decontamination

See section 10.1

## 10.4 Enhanced elimination

See section 10.1

## 10.5 Antidote treatment

### 10.5.1 Adults

No antidote available.

### 10.5.2 Children

No antidote available.

## 10.6 Management discussion

## 11. ILLUSTRATIVE CASES

### 11.1 Case reports from literature

The effects of chronic exposure to chlorine amongst workers at a pulp mill have been reported by Bherer et al. (1994). Persistent respiratory symptoms, bronchial obstruction and bronchial hyper-responsiveness were observed in 82%, 23% and 41 % of the workers respectively at 18 to 24 months after exposure ended.

The clinical effects of acute exposure to chlorine gas inhalation has been reviewed by Williams (1997).

Acute exposure to chlorine in schoolchildren from swimming pools resulted from accidental maintenance procedures (Sexton and Pronchik, 1998). 13 children at two separate pools were treated with beta agonists and humidified oxygen, with 5 being admitted to hospital.

## 12. Additional information

### 12.1 Specific preventive measures

Care workers must ensure adequate protection to prevent self-contamination when carrying out decontamination and medical treatment.

### 12.2 Other

The following references may be useful:

Green TC (1997) Out of the blue and into the pink. A new litmus test for chlorine gas exposure. Med J Aust 167(11-12):651

Myers SJ (1997) Chlorine inhalation in a pediatric patient. J Emerg Nurs 23(6):583-585.

## 13. REFERENCES

Bherer L, Cushman R, Couteau JP, Quevillon M, Cote G, Bourbeau J, L'Archeveque J, Cartier A, & Malo JL (1994) Survey of construction workers repeatedly exposed to chlorine over a three to six month period in a pulp mill: II. Follow up of affected workers by questionnaire, spirometry, and assessment of bronchial responsiveness 18 to 24 months after exposure ended. Occup Environ Med 51(4):225-228.

CCOHS (1998) CHEMINFO Record Chlorine (No. 85). IPCS INTOX CD-ROM Issue 98-1. Canadian Centre for Occupational Health and Safety, Hamilton Canada.

Sexton JD & Pronchik DJ (1998) Chlorine inhalation: the big picture. J Toxicol Clin Toxicol 36(1-2):87-93

Williams JG (1997) Inhalation of chlorine gas. Postgrad Med J 73(865): 697-700.

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