

PHOSGENE

HEALTH AND SAFETY GUIDE



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**PHOSGENE
HEALTH AND SAFETY
GUIDE**

This is a companion volume to
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INTRODUCTION

The Environmental Health Criteria (EHC) monographs produced by the International Programme on Chemical Safety include an assessment of the effects on the environment and on human health of exposure to a chemical or combination of chemicals, or physical or biological agents. They also provide guidelines for setting exposure limits.

The purpose of a Health and Safety Guide is to facilitate the application of these guidelines in national chemical safety programmes. The first three sections of a Health and Safety Guide highlight the relevant technical information in the corresponding EHC. Section 4 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. Within the Guide is a Summary of Chemical Safety Information which should be readily available, and should be clearly explained, to all who could come into contact with the chemical. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms. A bibliography has been included for readers who require further background information.

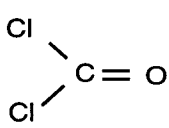
Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

The Director
International Programme on Chemical Safety
World Health Organization
1211 Geneva 27
Switzerland

**THE INFORMATION IN THIS GUIDE
SHOULD BE CONSIDERED AS A
STARTING POINT TO A COMPREHENSIVE
HEALTH AND SAFETY PROGRAMME**

1. PRODUCT IDENTITY AND USES

1.1 Identity

Common name:	Phosgene
Common synonyms:	carbonyl chloride, carbonic acid dichloride, carbon oxychloride, chloroformyl chloride
Molecular formula:	COCl_2
Chemical structure:	 <chem>ClC(=O)Cl</chem>
IUPAC name:	carbonic dichloride
CAS name:	carbonic dichloride
CAS registry number:	75-44-5
RTECS registry number:	SY 5600000
UN transport number:	UN 1076

Technical grade phosgene has a purity between 95 and 99% depending upon the intended local use. Impurities include nitrogen, carbon monoxide, hydrochloric acid, free chlorine and sulfur compounds.

1.2 Physical and chemical properties

Phosgene is a colourless gas at room temperature and standard pressure. It has a suffocating odour similar to mouldy hay. Although the odour of phosgene can be perceived at 1.6 mg/m^3 (0.4 ppm), after adaption recognition will be at levels $>6 \text{ mg/m}^3$ (1.5 ppm). It is slightly soluble in water and freely soluble in most liquid hydrocarbons, benzene, toluene and glacial acetic acid.

PRODUCT IDENTITY AND USES

In water, phosgene is sparingly soluble and decomposes to hydrochloric acid and carbon dioxide. It also reacts with ethanol but is soluble unaltered in benzene, toluene, most liquid hydrocarbons, and in glacial acetic acid.

Phosgene decomposes on heating above 300 °C producing chlorine and carbon monoxide. It is formed by thermal decomposition of chlorinated solvents, e.g., chloroform, carbon tetrachloride, tri- and tetra-chloroethylene and methylene chloride, as well as by the thermal degradation of chlorinated polymers. Some of its physical properties are as follows:

Melting point (°C)	-127.8
Boiling point (°C)	7.56
Relative density (water = 1)	1.4
Relative vapour density (air = 1)	3.42
Vapour pressure (20 °C)	161.6 kPa

1.3 Conversion factors

1 ppm = 4.05 mg phosgene/m³ air
1 mg phosgene/m³ = 0.25 ppm
at 25 °C and 101.3 kPa

1.4 Analytical methods

Phosgene in air may be detected by ultraviolet spectrophotometry, gas chromatography, infrared spectrophotometry, automated colorimetry and paper tape monitors containing 4-(4-nitrobenzyl)-pyridine and *n*-benzylaniline, both for personal badges and in continuous monitoring. Monitoring methods should provide data on accumulated exposure levels over time, preferably on a continuous basis.

1.5 Production, uses and occurrence

Phosgene is produced by reacting equimolar amounts of carbon monoxide and anhydrous chlorine in the presence of a carbon catalyst under appropriate conditions of temperature and pressure. The great majority is used directly in closed systems on-site.

PRODUCT IDENTITY AND USES

Phosgene is used as an intermediate in the manufacture of many organic chemicals. The largest amount (approximately 80% of world production) is used to produce toluene diisocyanate and other isocyanates used in polyurethane foam production, preparation of plastics, and pesticides. Accurate production figures are hard to determine since over 99% of phosgene production is "used on site". Approximately 3×10^6 tonnes of phosgene are used annually worldwide.

Phosgene levels in ambient air can arise from the thermal and photo-degradation of chlorinated solvents and chlorinated polymers. The major source of phosgene is the photochemical oxidation of chloroethylenes such as tri- and tetra-chloroethylene. Accidental releases from industries will affect only areas around the plant and not usually the general environment.

2. SUMMARY AND EVALUATION

2.1 Exposure

Human exposure to phosgene is by inhalation. Potential sources of exposure include the production and use of phosgene, ambient air and from the photo and thermal degradation of chlorinated solvents and polymers.

Although few data are available, average ambient air values vary between 80 and 130 ng/m³. The total daily intake would thus be between 1.6 and 2.6 µg. Much higher levels of phosgene exposure are possible during the home use of chlorinated solvents, e.g., methylene chloride, under conditions where temperatures are sufficiently high to lead to thermal degradation.

Data are inadequate to determine quantitatively the exposure to phosgene in the workplace. However, those working simultaneously with flames and/or thermal energy sources and organochlorine solvents or chlorinated polymers can be exposed to phosgene levels well above the present threshold limit value (time-weighted average) of 0.4 mg/m³ (0.1 ppm).

Fire-fighters and workers engaged in welding and the building trade are at risk from levels of phosgene formed by the thermal degradation of chlorinated solvents and polymers. Accidental release of phosgene during its manufacture, use or transport can lead to high levels of exposure in workers and in the general population in the vicinity of the accident.

2.2 Environmental fate

At normal ambient temperatures, the major pathway for phosgene degradation in air is gas-phase hydrolysis. However, even at high levels of humidity, phosgene in air is only slowly degraded and is likely to be persistent in the atmosphere and subject to long-range transport.

In water, phosgene is rapidly degraded to hydrochloric acid and carbon dioxide.

Detectable levels of phosgene in soil and vegetation are unlikely due to heterogeneous abiotic degradation.

SUMMARY AND EVALUATION

2.3 Kinetics and metabolism

There are very few data on the absorption, metabolism, distribution and fate of phosgene. Exposure is by inhalation. In view of the extremely short half-life (0.026 seconds) in aqueous solutions, and the penetration into the tissues of the respiratory tract by phosgene gas, only minimal amounts of phosgene are distributed in the body and no significant retention of phosgene in the body is possible. The hydrolytic products of phosgene, hydrochloric acid and carbon dioxide, are disposed by the body through normal physiological processes.

Phosgene exerts its toxicity through the acylation of proteins as well as through the release of hydrochloric acid. The amino, hydroxyl and sulfhydryl groups in proteins appear to be the target for acylation, leading to marked inhibition of several enzymes related to energy metabolism and a breakdown of the blood:air barrier.

2.4 Effects on organisms in the environment

No information has been reported on the effects of phosgene on the environment. However, the levels of phosgene now found in the general environment would not be expected to result in significant effects to aquatic or terrestrial biota.

Damage to plants and aquatic organisms could occur in areas where accidental release of phosgene has occurred, owing to the rapid release of hydrochloric acid.

2.5 Effects on animals and *in vitro* test systems

In all species that have been studied, the lung is the major target organ. After acute exposures of between 4 and 800 mg/m³ (1-200 ppm) the toxicological effect is due to the exposure (C) x time (T) (Habers Law), based on studies of lung disease and death. This relationship does not hold for chronic exposures.

SUMMARY AND EVALUATION

The $L(CT)_{50}$ for single exposure was reported to vary widely among animal species, ranging from $900 \text{ mg/m}^3\text{-min}$ (225 ppm-min) in the mouse to $1920 \text{ mg/m}^3\text{-min}$ (250 ppm-min) in the monkey. In all species the characteristic pathological feature was the dose-dependent clinical manifestation of pulmonary oedema. The extent of the long-term chronic effects of acute exposure appears to depend on the severity of the initial pathology. At low concentrations, pathological changes in the terminal bronchioles and alveoli were reported to be typical of a pulmonary irritant, whereas at higher levels pulmonary oedema occurred, leading to interference with gas exchange and death.

Preliminary data from single 4-h exposures to 2 or 4 mg/m^3 in rats and mice ($480 \text{ mg/m}^3\text{-min}$ or $960 \text{ mg/m}^3\text{-min}$) indicated a decrease in pulmonary immunocompetence. No effects were seen at 0.4 mg/m^3 ($96 \text{ mg/m}^3\text{-min}$). Although limited, other data confirmed these findings. In rats exposed to 4 mg/m^3 for 4 h ($960 \text{ mg/m}^3\text{-min}$), a 10-fold increase in influenza virus titre was noted per day post-infection. Pulmonary bacterial clearance was reduced in rats exposed for 6 h to $0.4 \text{ mg phosgene/m}^3$ ($144 \text{ mg/m}^3\text{-min}$) or to 0.4 mg/m^3 for 6 h/day, 5 days/week for 4 to 12 weeks. This effect was reversible following termination of exposure. In a host resistance assay in mice, exposure to concentrations of phosgene of 0.1 mg/m^3 or more for 4 h ($>24 \text{ mg/m}^3\text{-min}$) led to an increase in mortality from *Streptococcus zooepidemicus* infection.

No long-term exposure studies of phosgene have been reported and studies in dogs exposed 1-3 times/week for 12 weeks are of limited value for risk assessment in view of study design and a lack of dose response. Furthermore, available data in experimental animals are inadequate for the assessment of the potential reproductive, developmental, neurotoxic and carcinogenic effects from phosgene exposures.

Phosgene exposure can result in eye and skin irritation.

2.6 Effects on humans

As in experimental animals, the target organ in humans is the lung. After acute exposure to between 4 and 800 mg/m^3 , Habers Law (CxT) is applicable. The cascade of events after acute inhalation exposure in humans is similar to that in experimental animals. Their occurrence is dose-related

SUMMARY AND EVALUATION

and results in pulmonary oedema and death in humans at levels exceeding 120 mg/m³-min. Three distinct clinico-pathological phases can be recognized, namely: pain in the eyes and throat and tightness of the chest, often with shortness of breath, wheezing and coughing; a latent phase which is often asymptomatic and lasts normally up to 24 h depending upon the concentration and duration of exposure; and the final phase of pulmonary oedema. In one study pulmonary oedema occurred after a latent phase of 48 h.

Populations exposed to phosgene after industrial accidents have reported a wide variety of symptoms, including headache, nausea, cough, dyspnoea, fatigue, pharyngeal pain, chest tightness and pain, intense pain in the eye, and severe lacrimation. After short-term exposures throat irritation occurs at levels of 12 mg/m³ and eye irritation is noted at 16 mg/m³. It has been calculated that doses below 100 mg/m³ will result in no permanent adverse effects, whereas pulmonary oedema results from doses above 600 mg/m³-min. Death has been recorded at doses above 400 mg/m³-min, and exposure for several hours at concentrations at or below the odour threshold of 6 mg/m³ may result in severe tissue damage and death. Thus, the odour threshold for phosgene is an unacceptable parameter for early warning.

A review of the health status of workers recovering from acute phosgene exposures has shown no adverse effects, but full recovery may take several months.

Available data on human health effects associated with chronic exposure to phosgene are extremely limited. Epidemiological studies of phosgene production workers and uranium workers reported no adverse effects on human health. However these investigations were limited by small numbers of exposed workers, lack of reliable quantitative information on exposure to phosgene, concomitant exposure to other substances, limited number of end-points examined and limited reporting of relevant information.

3. CONCLUSIONS

3.1 Human health

Phosgene is an extremely reactive chemical. It has the potential to cause adverse effects in humans, the primary target organ being the respiratory system.

Acute severe phosgene exposure primarily causes respiratory disease (pulmonary oedema) and may result in death. Survivors may recover completely provided they receive proper medical support.

Accidental industrial releases can cause health problems to workers and the nearby community.

Occupational exposures in closed-system industrial facilities manufacturing and/or using phosgene and having good industrial hygiene practices have not shown demonstrable risk to the workers.

Present levels of exposure to phosgene in the general population are extremely low (1.6 to 2.6 $\mu\text{g}/24\text{ h}$) and do not pose a health risk. However, individuals working with chlorinated solvents such as tri- and tetrachloro-ethylene and methylene chloride or who are exposed to chlorinated hydrocarbon polymers (e.g., polyvinyl chloride) in contact with flames and/or other thermal energy sources, e.g., firemen, welders, painters and people working at home with these materials, can be exposed to levels of phosgene known to cause adverse effects in humans.

CONCLUSIONS

No human or animal data are available on the effects of chronic low-level exposure to phosgene.

Available data are inadequate to derive a meaningful health-based guidance value for exposure of the general population to phosgene. However, recent toxicological studies in rats sub-chronically exposed by inhalation to low levels of phosgene (0.4 mg/m³) indicate that early pulmonary effects may occur at present threshold limit values. Therefore, consideration by appropriate authorities might be given to re-evaluating current occupational exposure guidelines for this chemical.

3.2 Environment

No data are available concerning adverse effects of phosgene on the ecosystem. However, levels of phosgene in the environment would not be expected to result in significant effects on aquatic or terrestrial biota. Owing to the very rapid release of hydrochloric acid, damage to plants and aquatic organisms could occur in areas where accidental release of phosgene occurs.

4. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY RESPONSE

4.1 Human health hazards, prevention and protection, first aid

The only organs affected are skin, lung and eyes, with the lung being the primary target. Only a small portion of inhaled phosgene is hydrolysed in the fluid films of the eyes and the upper respiratory passages, giving rise to immediate but transient irritative signs and symptoms, if the inhaled phosgene concentration is greater than 16 mg/m^3 (4 ppm). Exposure to concentrations greater than $600 \text{ mg/m}^3\text{-min}$ (150 ppm-min) will cause pulmonary oedema, the clinical signs and symptoms of which may need several hours to appear and will do so in a dose-dependent fashion ("clinically latent period").

The human health hazards associated with certain types of exposures to phosgene, together with preventive and protective measures and first aid advice, are listed in the Summary of Chemical Safety Information in section 6.

4.1.1 *Advice to physicians*

4.1.1.1 *Symptoms of poisoning*

Phosgene is an extremely strong respiratory tract irritant. Alveolar toxic oedema may become evident 1 to 24 h after exposure depending upon the level and duration of exposure. Signs and symptoms of this type of pulmonary oedema are rapid shallow breathing, shortness of breath, cough with production of frothy fluid, pulmonary shadows on the X-ray, and reduction in vital capacity and respiratory volume.

Eye and skin irritation occurs after severe exposure ($> 12 \text{ mg/m}^3$). Serious skin injury from such exposures is unlikely.

Dermal burns can develop after exposure to the liquidified material.

4.1.1.2 *Medical treatment*

Immediate termination of exposure is essential and the patient should be removed to fresh air.

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

After exposure to liquid phosgene, contaminated clothing should be removed and disposed of. Exposed skin should be washed with large amounts of soap and water. If there was eye contact, the eyes should be flushed with copious amounts of water for at least 15 min.

After exposure by inhalation, physical exertion should be avoided and strict bed rest enforced for between 24 and 72 h, particularly if the exposure dose was unknown or above 100 mg/m³-min (25 ppm-min). Chest radiographs, arterial blood gases and other diagnostic procedures are indicated to evaluate the presence of pulmonary oedema, the primary danger after inhalation exposure to phosgene. When pulmonary oedema is present the patient should be managed as though respiratory failure was impending. Deep breathing is recommended to remove additional phosgene from the lung.

No specific antidote is known. Hexamethylenetetramine is effective only if administered prior to phosgene inhalation. Pulmonary oedema should be managed with positive pressure oxygen ventilation and the early intravenous administration of steroids (e.g., 1 g of methyl-prednisolone) may be beneficial. Additionally, the administration of such β -adrenergic agonists as terbutaline, albuteral, isoetharine and metaproterenol (as aerosols or nebulizers) seems to be effective to correct bronchospasms. In severe cases aminophylline should be considered to control bronchoconstriction and relieve vasoconstriction. Most other drugs are ineffective and may even be harmful, e.g., atropine, epinephrine, cardiac glycosides, sedatives and expectorants. Antibiotic treatment might become necessary if secondary infectious pneumonitis occurs.

Symptomatic therapy may become necessary, and patients should be followed and surveyed until pulmonary function has normalized and the patient fully recovered. Depending upon the exposure concentration and time, full recovery can take several months.

4.1.2 *Health surveillance advice*

Workers having the potential for exposure to phosgene should be supplied with personal monitors. Workplace controls should be initiated to lower the levels of phosgene to levels not detectable by paper strip monitors

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

(about 0.4 to 0.5 mg/m³). Preferably, monitoring devices must sound an alarm or otherwise warn workers when a concentration of 0.8 mg/m³ is reached.

Preplacement and periodic medical examinations should be given to all workers with the potential to be exposed to phosgene. These should include chest radiographs and pulmonary function tests.

4.2 Explosion and fire hazards

Phosgene is non-flammable. However, the presence of water or high temperature can cause containers of phosgene to rupture. This can release both liquid and gaseous phosgene, as well as toxic thermal degradation and reaction products such as hydrochloric acid, chlorine and carbon monoxide.

All phosgene-containing vessels should be removed from the vicinity of a fire, if this can be done without risk, and kept below 50 °C by water cooling unless phosgene is leaking from a cylinder. Do not allow water to enter the containers. Fire-fighters must wear protective clothing and a self-contained breathing apparatus. For small fires use dry chemical or carbon dioxide. Use water spray, fog or foam for larger fires.

4.3 Storage

Phosgene should be stored in appropriately labelled corrosion-resistant steel cylinders that conform to rigid safety-design specifications for this chemical. Storage should be in cool, dry, and well-ventilated fire-proof rooms isolated from the work area. Ambient air monitoring should be provided and ventilation should be located at floor level. Protect cylinders against physical damage, and secure to prevent falling or rolling. Because phosgene reacts with water, great care should be taken to prevent contamination with water, since this could lead to increased pressure in the tanks with possible resultant rupture. Phosgene containers should be frequently inspected for damage and prolonged storage should be avoided.

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.4 Transport

Phosgene may be transported in appropriately designed cylinders as a compressed gas. Transport must comply with guidelines from international bodies, as well as regulations at the national and local levels regarding the movement of hazardous materials. It should be in rigid corrosion-resistant steel containers regularly inspected for damage and conforming to design specifications specific for phosgene. All containers must be well-labelled and protected from damage in shipment. Acceptable modes of transportation are road and water.

4.5 Spillage and disposal

4.5.1 Spillage

Skin contact with liquid and inhalation of gaseous phosgene should be avoided. Non-essential people should be kept away and the area isolated. People in the immediate vicinity should be moved to an area upwind until the gas has dispersed. Those involved in clean-up operations of large spills without fire should be provided with fully encapsulated protective clothing, and self-contained breathing apparatus. Fire-fighter's normal protective clothing will provide limited protection for short-term exposures only. For large spills a dyke should be made well ahead of liquid spill for later disposal. Water should not be allowed to enter the area inside the dyke or to enter any containers.

Liquid spills can be covered with sodium hydrogen carbonate or an equal mixture of soda ash and slake lime or crystallized urea. Water from an atomizer can then be added cautiously and the mixture transferred to a large volume of water. Gas spills can be mitigated by gaseous ammonia, aqueous ammonia or an ammonia steam curtain or sprays.

There should be a holding area beneath any storage or handling installation that can contain a liquid spill. This should have an impermeable flexible membrane liner and must already contain lime, limestone, sodium hydrogen carbonate, urea or any other suitable neutralizing absorbent, sufficient to eliminate the spill.

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.5.2 *Disposal*

Dilute aqueous phosgene wastes can best be handled through caustic scrubbing in packed columns or by scrubbing in towers with activated carbon and water. Phosgene or aqueous phosgene wastes should never be disposed of into sewers without prior alkaline neutralization.

Phosgene should not be introduced into an incinerator. However, if a product containing, or capable of producing phosgene is entering an incinerator, then there must be an adequate scrubbing installation to remove phosgene and/or HCl from the issuing gases. These techniques must conform to all local and national regulations.

Welding and disposal of tanks and equipment used to handle phosgene should take place only after all residual phosgene has been purged from these materials.

4.6 Other protective measures

Paint removers and non-flammable dry cleaning solvents (e.g., carbon tetrachloride, chloroform, tri- and tetrachloroethylene and methylene chloride) should never be used in closed areas in the presence of fire or heaters of any kind since they can decompose to phosgene. Welding or heat-treating vessels or equipment that may have contained such materials should be avoided until they have been purged of all residual chemical.

Contaminated protective clothing should not be taken home. It must be decontaminated on site with care to avoid direct contact with cleaning staff or other employees. It should be segregated in the workplace in such a manner so as to avoid direct contact with cleaning staff or other employees.

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

Phosgene hydrolyses in the presence of water or after adsorption onto soil and vegetation to form hydrochloric acid and carbon dioxide. However, plants can be killed by phosgene or hydrochloric acid after exposure to spills or high levels of industrial emissions. Aquatic organisms are at little risk from phosgene levels normally found in industrial effluents. However, concentrations of hydrochloric acid arising from spills will be high enough to alter significantly the pH of the water and to alter aquatic life cycles. The physico-chemical properties of phosgene preclude its bioaccumulation or biomagnification.

6. SUMMARY OF CHEMICAL SAFETY INFORMATION

The material in this section is based on the IPCS International Chemical Safety Card number 7. This card should be easily available to all health workers concerned with, and users of, phosgene. It should be displayed at, or near, entrances to areas where there is potential exposure to phosgene and on processing equipment and containers. The card should be translated into the appropriate language(s). All persons potentially exposed to the chemical should also have the instructions on the chemical safety card clearly explained.

SUMMARY OF CHEMICAL SAFETY INFORMATION

PHOSGENE
COCl₂

PHYSICAL PROPERTIES

Relative molecular mass 98.9
Melting point (°C) -127.8
Boiling point (°C) 7.5
Relative density of the liquid (water = 1) 1.4
Solubility in water Reaction
Vapour pressure, kPa at 20 °C 161.6
Relative vapour density (air = 1) 3.42

OTHER CHARACTERISTICS

Colourless gas, or colourless compressed liquefied gas with characteristic odour. However, the odour warning when the exposure limit value is exceeded is insufficient. The vapour is heavier than air and may travel along the ground. Decomposes above 300 °C to corrosive and toxic gases (chlorine, hydrogen chloride, and carbon monoxide). Reacts rapidly with ammonia, amines, aluminium and many other chemicals; in some cases, forming shock-sensitive products

ACUTE HAZARDS/SYMPTOMS

SKIN: Corrosive redness, skin burns, pain, in cases of frostbite from liquid; blisters

PREVENTION AND PROTECTION

Cold-insulating gloves, protective clothing

FIRST AID/FIRE-FIGHTING

ON FROSTBITE: rinse with plenty of water, do NOT remove clothes, rinse skin with plenty of water or shower, and immediately refer for medical attention

<p>EYES: Redness, pain, blurred vision</p> <p>Face shield or eye protection in combination with breathing protection</p> <p>First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor</p> <p>INHALATION: Pungent cough, laboured breathing, shortness or breath, sore throat</p> <p>Ventilation, local exhaust, or breathing protection. Wear indicator badges</p> <p>Fresh air, complete rest, half-upright position, artificial respiration if indicated and refer for medical attention as soon as possible. The symptoms of lung oedema often do not become manifest for up to 24 h and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorized by him/her, should be considered</p>	<p>SPILLAGE</p> <p>Evacuate danger area, create an aqueous ammonia spray curtain to neutralize gas cloud, consult an expert, ventilation; cautiously neutralize spilled liquid with sodium hydrogen carbonate or an equal mixture of soda ash and slaked lime or crystallized urea (extra personal protection: complete protective clothing including self-contained breathing apparatus)</p>	<p>STORAGE</p> <p>Fire-proof if in building, isolated from work area and other chemicals on a perforated floor over disposal tank containing soda ash/ slaked lime in cool dry location with ventilation along the floor. Ambient air monitoring should be provided</p>	<p>FIRE AND EXPLOSION</p> <p>No open flames or other sources of high temperatures. Phosgene is non-flammable and non-oxidative but cylinders may rupture if heated. Therefore, in case of fire in surroundings remove all phosgene-containing vessels. If not possible, keep cylinders cool by spraying with water. On flames use foam, powder or carbon dioxide</p>
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7. CURRENT REGULATIONS, GUIDELINES AND STANDARDS

The information in this section has been extracted from the International Register of Potentially Toxic Chemicals (IRPTC) legal file and other UN sources. It is a representative but non-exhaustive overview of current regulations, guidelines and standards. Regulations and guidelines about chemicals can be fully understood only within the framework of a country's legislation, and are always subject to change. Therefore, they should always be verified with the appropriate authorities.

7.1 Occupational exposure limit values

Some examples of exposure limit values in several countries are given in the table.

7.2 Labelling, packing and transport

Internationally, transportation of phosgene is limited on passenger-carrying ships and is forbidden on passenger and cargo aircraft. Some countries extend this to passenger railcars.

Phosgene is classed as an IMO Class 2 hazard requiring labelling with UN number 1076 and labels showing it to be a poisonous gas and corrosive.

CURRENT REGULATIONS, GUIDELINES AND STANDARDS

Occupational Exposure Limit Values ^a	Exposure limit description ^b	Value (mg/m ³)	Effective date ^c
Australia	Time-weighted average (TWA)	0.4	1990
Belgium	Time-weighted average (TWA)	0.4	1991 ^R
Czech Republic	Time-weighted average (TWA)	0.5	1985
Denmark	Short-term exposure limit (STEL)	0.2	1991 ^R
Finland	Short-term exposure limit (STEL)	0.2	1991 ^R
France	Short-term exposure limit (STEL)	0.4	1991 ^R
Germany	Time-weighted average (TWA)	0.4	1994
Japan	Time-weighted average (TWA)	0.4	1991 ^R
Poland	Time-weighted average (TWA)	0.5	1991 ^R
United Kingdom	Time-weighted average (TWA)	0.4	1991 ^R
USA: ACGIH	Time-weighted average (TWA)	0.4	1995
USA: NIOSH/OSHA	Time-weighted average (TWA)	0.4	1990
USSR	Time-weighted average (TWA)	0.4	1991 ^R
	Short-term exposure limit (STEL)	0.5	1991 ^R

^a From: ILO (1991) and national lists.

^b TWA = time-weighted average (8 h or 10 h shift); STEL = short-term (15 min TWA) exposure limit not to be exceeded at any time during a shift.

^c Where effective date is not reported, the date given is for the reference publication and marked 1991^R.

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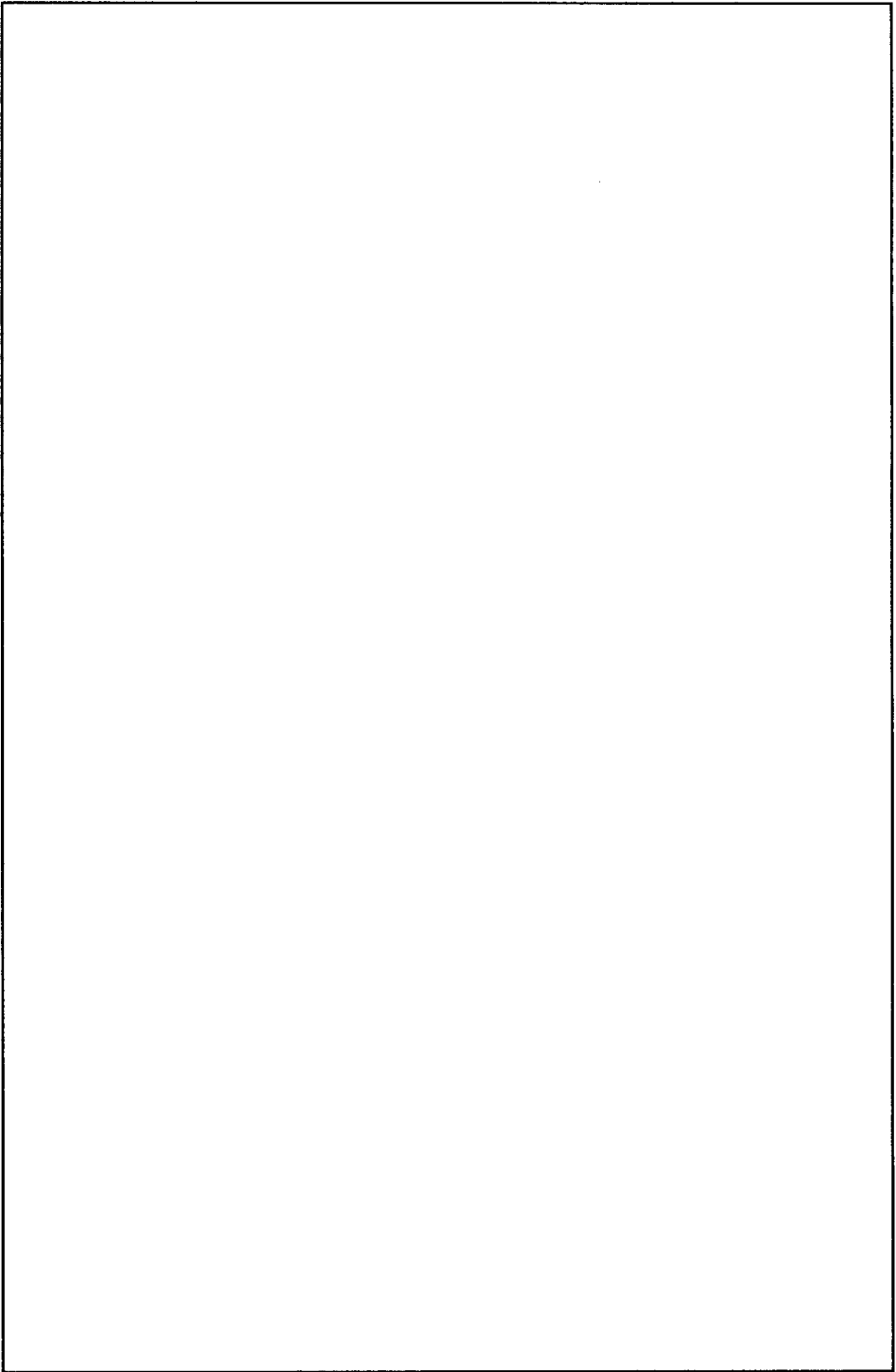
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