

IPCS INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

Health and Safety Guide No. 37

AMMONIA HEALTH AND SAFETY GUIDE



UNITED NATIONS
ENVIRONMENT PROGRAMME



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WORLD HEALTH ORGANIZATION, GENEVA 1990

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**AMMONIA
HEALTH AND
SAFETY GUIDE**

This is a companion volume to
Environmental Health Criteria 54: Ammonia

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INTRODUCTION

The Environmental Health Criteria (EHC) documents 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. 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:

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1211 Geneva 27
Switzerland

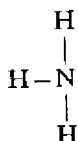
**THE INFORMATION IN THIS GUIDE
SHOULD BE CONSIDERED AS A
STARTING POINT TO A COMPREHENSIVE
HEALTH AND SAFETY PROGRAMME**

1. PRODUCT IDENTITY AND USES

1.1 Identity

Chemical formula: NH_3

Chemical structure:



Common synonyms: none

CAS registry number: 7664-41-7

RTECS number: BO 0875000

UN number: 1005

Conversion factor: $1 \text{ ppm} = 0.70 \text{ mg/m}^3$; $1 \text{ mg/m}^3 = 1.42 \text{ ppm}$ approximately, depending on temperature and pressure

1.2 Physical and Chemical Properties

Ammonia is a colourless acrid-smelling gas at room temperature and normal atmospheric pressure. Most people can identify its odour at 35 mg/m^3 in air. It can be stored and transported as a liquid at a pressure of 10 atmospheres at 25°C . Spilled liquid ammonia boils immediately, cooling its surroundings as it vaporizes. The gas dissolves readily in water; in solution it forms, and is in equilibrium with, ammonium ions (NH_4^+). Ammonia solutions are alkaline and react with acids to form ammonium salts.

Gaseous ammonia is usually very pure and the purity of solutions depends on the purity of the water used, e.g., chlorinated water may give rise to chloramines and nitrogen trichloride.

PRODUCT IDENTITY AND USES

1.3 Analytical Methods

1.3.1 *Air*

In the alkalimetric method, air is drawn through sulfuric acid until the bromophenol indicator changes colour. The volume of air causing the change is inversely proportional to the ammonia concentration. The method is subject to interference by acidic or alkaline contaminants. With the Nesslerization technique, the ammonia/ammonium is collected in dilute sulfuric or boric acid and reacted with alkaline mercuric and potassium iodide solution; distillation can precede analysis. Absorbance at 440 nm is compared with a standard curve. Interference can be caused by amines, cyanates, alcohols, aldehydes, ketones, colour, turbidity, and residual chlorine. Ammonia can be measured using the indophenol reaction in which ammonia in solution is reacted with hypochlorite and phenol. The method is subject to interference by monoalkyl amines and formaldehyde.

In the potentiometric method, the ionization potential of $\text{NH}_3 \rightarrow \text{NH}_4^+$ is measured. There can be interference from mercury and volatile amines. Chemiluminescent, ultraviolet spectrophotometric, or fluorescent derivatization techniques are available for the continuous measurement of ammonia concentrations in air. In the chemiluminescent method, air is passed through high- and low-temperature catalytic converters, which respectively measure $\text{NO}_x + \text{NH}_3$, and NO_x . The ammonia concentration is obtained by subtraction. In ultraviolet spectrophotometry, ammonia (gas) exhibits several strong absorption bands between 190 and 230 nm. Absorption at 204.3 nm is usually used. In the fluorescent derivatization technique, 1-phthaldehyde derivatization is used. Gas chromatography, with a thermal conductor detector, has been used, for example, to measure ammonia in tobacco smoke.

1.3.2 *Water*

Ammonia at high concentrations can be measured by a titrimetric method. The ammonia in water is distilled into distilled water, which is titrated with acid to a methyl red/methylene blue end-point. The Nesslerization, indophenol, and potentiometric methods are also suitable for measuring ammonia in water.

PRODUCT IDENTITY AND USES

1.4 Production and Uses

Ammonia is one of the most extensively used industrial chemicals, production in the USA alone being of the order of 20 million tonnes per year. Most of this is used in fertilizers, fibres and plastics, and explosives. It is also widely used as a cleaning and descaling agent and in food additives, applications that may result in general population exposure.

2. SUMMARY AND EVALUATION

2.1 Exposure to Ammonia

Ammonia is present in the environment as a result of natural processes and industrial activity, including certain types of intensive farming. Atmospheric ammonia is volatilized from the earth's surface in quantities of about 10^8 tonnes/year, mostly from natural biological activity. Industrial activity may cause local and regional elevations in emission and atmospheric concentrations. Surface waters receive ammonia from point sources, such as effluent from sewage treatment and industrial plants, and also through atmospheric deposition, the breakdown of vegetation and animal wastes, applied artificial fertilizers, and urban run-off.

Exposure of the skin and eyes or the respiratory tract may occur, but the chief effect of ammonia is local irritation due to its alkalinity when dissolved in body fluids. Ammonia is an important molecule in the intermediate metabolism of nitrogenous compounds and large amounts are produced within the intestine each day by the digestion and bacterial breakdown of food and food residues. Amounts absorbed from this source are much greater than amounts absorbed through occupational exposure or the ingestion of food or drinking-water. Atmospheric concentrations of ammonia in the community are normally lower than $25 \mu\text{g}/\text{m}^3$ but, in areas with intensive manure production or use, levels may be as high as $200 \mu\text{g}/\text{m}^3$. Occupational atmospheric exposure is usually regulated to a limit within the range of $18\text{--}40 \text{ mg}/\text{m}^3$, but exposures of up to $100 \text{ mg}/\text{m}^3$ are well tolerated for short periods in such situations as poultry houses. Ammonia is present in raw foods and is added to processed foods. It has been calculated that the daily human intake of ammonia and ammonium salts from this source is about $18 \text{ mg}/\text{day}$.

2.2 Fate

Ammonia released into the atmosphere is deposited on the ground, chiefly as ammonium sulfate and ammonium nitrate. Ammonia applied to the ground as fertilizer and discharged from point sources, such as sewage treatment plants, is similarly converted, though high levels of ammonia may occur locally. Ammonia is a key compound in the nitrogen cycle. It is converted by soil bacteria to nitrate, which is then taken up by plants and incorporated into amino acids and other nitrogenous compounds. Plants cannot excrete ammonia and levels exceeding those that can be incorporated are toxic.

SUMMARY AND EVALUATION

2.3 Uptake, Metabolism, and Excretion

Ammonia is absorbed readily through mucous membranes and the intestinal tract, but not through the skin. About 80% of inhaled ammonia dissolves in the mucous lining of the upper respiratory tract and does not reach the alveoli. Absorbed ammonia joins the body pool of ammonia and is rapidly distributed throughout the body. It reacts with hydrogen ions, according to the pH, to form ammonium ions. These are less mobile than ammonia but are taken up by glutamic acid in many tissues and thereafter take part in various transamination reactions. In mammals, most ammonia nitrogen is excreted in the urine as urea together with a small quantity of ammonium ions. Some is lost in desquamated skin; elimination in exhaled air and in faeces is insignificant.

2.4 Effects on Animals and Human Beings

Acute effects on mammalian and human health occur because of the caustic nature of concentrated solutions, the irritant effects of ammonia gas, and the extreme cooling that arises on contact with liquid ammonia. There are no significant long-term problems for terrestrial animals and human beings; atmospheric levels of ammonia seldom reach sustained toxic levels.

The extreme corrosiveness of ammonia has precluded most types of toxicological testing, but a 2-h LC₅₀ of 5137 mg/m³ and oral LD₅₀s in the range of 4070–5020 mg/kg body weight have been reported for rats. A dermal LD₅₀ of > 1000 mg/kg body weight (corrosive) has been reported. Because of the physiological nature of its hydrolytic products, complex toxicological effects, such as mutagenic, reproductive, or carcinogenic effects, would not be expected from exposures insufficient to cause local effects.

Because of the predominance of local effects of little clinical interest in cases of accidental contamination, very few clinical cases have been described in the literature. Nevertheless, the effects on human beings are well known. Skin contact with liquid ammonia results in cold burns, usually without blistering or charring. Concentrated solutions produce caustic burns on the skin and cause severe corrosive injury to the eyes. Long-term contact with more dilute ammonia solutions that are not immediately irritant may produce damage to the skin as a result of alkaline saponification of protective fats. The vapour is irritant to the eyes and the respiratory tract at concentrations above about 50 mg/m³ (70 ppm).

SUMMARY AND EVALUATION

Mild irritation can occur with short-term exposure to concentrations below about 150 mg/m^3 (210 ppm). Irritant damage to the bronchial epithelium produces oedema and bronchospasm resulting in bronchial narrowing, which will be manifested progressively by tightness of the chest, wheeze, and dyspnoea. Reactive hypersecretion of mucus produces cough and sputum and there is the possibility of bronchial obstruction and atelectasis. Irritant damage to the alveolar membrane leads to exudative pulmonary oedema with restricted diffusion and hypoxia, frothy blood-tinged sputum, and the possibility of healing by scarring with a permanent restrictive defect. Severe acute over-exposures can lead to death within minutes. It is possible that repeated exposure to irritant levels insufficient to cause severe immediate symptoms may give rise to progressive impairment of lung function. Apart from scarring at the site of contact (including corneal opacity and pulmonary fibrosis), permanent or delayed effects following over-exposure are not expected in survivors.

2.5 Effects on Organisms in the Environment

Concern regarding ammonia is related to its environmental effects; there is extensive literature on the effects on both plant and aquatic life and on the circumstances giving rise to high levels in the aquatic environment, air, or soil.

Ammonia in the form of a liquid, concentrated solution, or at a high vapour concentration, will destroy most living organisms. However, the material is so readily diluted and degraded in the environment that accidental spillages or emissions will not persist or be widely dispersed and will not have any impact other than the degradation processes. Nevertheless, persistently high concentrations of ammonia may occur in the atmosphere where there is intensive use or production of animal manure in farming. High concentrations may also occur in water in certain elevated, isolated lakes, and where sewage is discharged. Ammonia present in water as ammonium ions at sufficiently high concentrations can be highly toxic for fish and toxic for aquatic plants.

3. CONCLUSIONS AND RECOMMENDATIONS

The effects of ammonia on human beings are mainly due to its alkaline corrosiveness. Severe vapour exposures may leave a residual restrictive defect in lung function. Strict adherence to an occupational exposure limit of about 20 mg/m^3 (25 ppm) and care in the handling of solutions and liquid ammonia effectively prevent health effects. Spillages will sterilize the area immediately affected; long-term discharges and/or emissions may have adverse effects on organisms in the environment.

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

4.1 Main Human Health Hazards, Prevention and Protection, First Aid

The main human health hazard is the extreme irritancy and corrosiveness of both concentrated solutions and the vapour, and the possibility of cold burns from splashes with liquid ammonia.

As far as possible, ammonia, in the form of a liquid, gas, or concentrated solution, should be handled remotely in entirely closed systems. Impervious clothing and gloves, and eye and face protection, should be used for sampling and other operations where there is open exposure. Particular care should be taken to wash out thoroughly pumps and other equipment that has contained or been used for transferring ammonia prior to disassembly or maintenance.

The human health hazards, together with preventive and protective measures and first-aid recommendations, are listed in the Summary of Chemical Safety Information (pages 17–21).

4.1.1 *Advice to physicians*

No specific antidote is known. Irrigate affected eyes and skin burns with water and treat conventionally. Severe and extensive burns will require fluid replacement and correction of metabolic acidosis and will benefit from treatment in a specialist burns unit. Eye injuries should be assessed by an ophthalmologist, where possible. In case of ingestion of ammonia solution, the oral cavity should be examined for burns. If burns are noted, the oesophagus and stomach should be examined (gastroscope/fibreoptoscope). Treat symptomatically according to the degree and extent of burns.

After severe vapour exposure, the risk of delayed pulmonary oedema may be sufficient to admit the patient to hospital for observation for 24–48 h. An initial chest X-ray will be useful for later assessment of the development of pulmonary oedema. Bronchodilators by nebulizer or metered-dose aerosol may be given to reduce bronchospasm and dyspnoea. Where there are immediate respiratory symptoms suggesting lower airway exposure, it will probably be beneficial to administer steroids to minimize chemical

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

pneumonitis and scarring. Steroid administration may be by the intravenous injection of methylprednisolone in doses up to 30 mg/kg initially with subsequent smaller doses, or by the use of steroids in metered-dose aerosol form at several times the normal maintenance dosage. Prophylactic antibiotics are generally indicated in all but mild cases, since secondary bacterial infection of the airways often occurs.

If pulmonary oedema develops, the patient should be nursed with the torso upright and oxygen should be administered. Diuretics, morphine, and theophylline derivatives are of little benefit, since the oedema is an exudate rather than a transudate arising from raised pulmonary capillary pressure. If further measures are necessary, intermittent positive-pressure ventilation combined with bronchial toilet and suction are the important elements of treatment.

4.1.2 *Health surveillance advice*

It may be advisable to exclude persons with pre-existing respiratory disease from working with respiratory irritants such as ammonia.

Wherever measured exposures are close to the occupational exposure limit or there is dependence on personal respiratory protection to limit exposure, it is wise to undertake regular measurements of pulmonary function to ensure that there is no deterioration beyond that normally expected with ageing.

4.2 **Explosion and Fire Hazards**

Ammonia does not readily burn or explode. Fire-fighters should wear compressed-air breathing apparatus.

4.3 **Storage**

Ammonia solutions should be stored in suppliers' properly sealed and labelled drums or in a suitable bulk container. These should be housed in a cool, dry, well-ventilated place. Handle drums carefully to avoid puncturing. Liquid ammonia can only be stored in pressure vessels at ambient temperature or refrigerated. Refrigeration systems should be able to withstand pressures of the order of 10 bar, in case the refrigeration

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

fails. Precautions appropriate for the inspection and maintenance of pressure vessels should be taken to prevent rupture or leaks.

4.4 Transport

In case of accident, stop the engine and keep upwind. If the vapour cloud drifts towards an inhabited area, warn the inhabitants. Evacuate areas close to spillage if this can be done without risking exposure.

4.5 Spillage and Disposal

4.5.1 *Spillage*

Spillages of liquid or concentrated solutions should only be dealt with by trained personnel wearing protective clothing and full-face mask, positive-pressure breathing apparatus. Liquid spillages will rapidly vaporize and disperse.

4.5.2 *Disposal*

Liquid spillages may be washed into a drain and vapour may be “knocked down” with water spray. Drainage into a sewer or large water body is possible when the effect of the resulting solution is judged to be less severe than the effect of the vapour. Spillages of solutions should be washed away with plenty of water. If ammonia has entered a watercourse or sewer, or has contaminated soil or vegetation, advise the police or public authorities.

SUMMARY OF CHEMICAL SAFETY INFORMATION

AMMONIA

CAS registry number: 7664-41-7; RTECS number: BO 0875000

In aqueous solution, ammonia forms ammonium (NH_4^+) and hydroxyl (OH^-) ions

PHYSICAL PROPERTIES

| | |
|--|--------------|
| Melting point ($^{\circ}\text{C}$) | -77.7 |
| Boiling point ($^{\circ}\text{C}$) | -33.35 |
| Solubility in water | high; reacts |
| Relative density (0°C) | 0.771 |
| Relative density (-79°C) | 0.817 |
| Relative vapour density (25°C) | 0.6 |
| Vapour pressure (25.7°C) | 10 bar |
| Autoignition point ($^{\circ}\text{C}$) | 651 |
| Lower explosion limit | 16% |
| Upper explosion limit | 25% |
| Relative molecular mass | 17.03 |

OTHER CHARACTERISTICS

Ammonia is a colourless, acrid-smelling, low density gas at ambient temperature and pressure; it can be stored and transported as a liquid at a pressure of 10 atm; ammonia dissolves readily in water where it forms and is in equilibrium with ammonium ions; solutions are highly alkaline; splashes of liquid ammonia evaporate rapidly, extracting latent heat of vaporization from their surroundings and thus causing cold burns when splashed on the skin; ammonia burns to form oxides of nitrogen and water and will explode within a rather narrow range of concentrations

SUMMARY OF CHEMICAL SAFETY INFORMATION (continued)

HEALTH HAZARDS/SYMPTOMS PREVENTION AND PROTECTION FIRST AID

Ammonia vapour/fumes

EYES: severe irritation and lacrimation

Proper containment or efficient local exhaust ventilation so that breathing zone concentrations are below the occupational exposure limit; otherwise, positive-pressure demand compressed-air breathing apparatus or other effective respiratory protection with a full facepiece should be worn so that complete protection of the eyes and respiratory tract is assured

Remove patient from exposure; irrigate eyes for at least 15 minutes with a gentle flow of fresh potable water or sterile eye-irrigation fluid; seek medical attention

INHALATION: sensory irritation at lower concentrations; at higher concentrations, bronchial and lower airway irritation leading to tightness in the chest, coughing, wheezing, breathing difficulty, blueness of the lips

See above

Remove patient from exposure; if not breathing, give artificial respiration; maintain airway; keep patient at rest and seated upright if conscious and breathless; administer oxygen; send to hospital or a doctor

HEALTH HAZARDS/SYMPTOMS PREVENTION AND PROTECTION FIRST AID

Anhydrous liquid ammonia

SKIN/EYES: severe cold and possibly frostbite, in which skin will be pale and usually anaesthetic, but without blistering

Proper containment in well-maintained pressure vessels and lines; when sampling, making connections, and at other times when exposure could occur, full eye, face, and respiratory protection, gloves, boots, and an impervious suit should be worn

Do not overheat affected part; apply dry dressing; usually, healing will take place without grafting or other intervention; irrigate eyes as for any chemical splash; send patient to a doctor, preferably an ophthalmological specialist

Ammonia solutions

EYES: injuries from concentrated solutions are severe; conjunctival and corneal damage and penetration of the bulb will occur

Solutions must be held in properly constructed and vented containers; hand and full-face protection and boots, gloves, and an impervious apron or suit should be worn whenever containers or pipework are opened; if local exhaust ventilation is inadequate to reduce vapour concentrations below the occupational exposure limit, respiratory protection should be worn

Irrigate eyes immediately and thoroughly with large quantities of fresh potable water for at least 15 minutes; seek medical advice; if there is corneal damage, instill antibiotics and, if possible, obtain advice from an ophthalmological specialist

SUMMARY OF CHEMICAL SAFETY INFORMATION (continued)

HEALTH HAZARDS/SYMPTOMS PREVENTION AND PROTECTION FIRST AID

SKIN: irritation, redness, and caustic burns

See above

Remove all contaminated clothing immediately, wash skin liberally with water; hydrocortisone cream may reduce pain and inflammation in areas of superficial damage and erythema; full-thickness damage may require grafting, according to its extent and position

INGESTION: irritation, caustic burns

Avoid ingestion of ammonia solutions

Do not induce vomiting; rinse the mouth with water; if the concentration of the ammonia solution is known to be 10% or less, give water by mouth to dilute the solution; if the concentration is unknown or is greater than 10%, give nothing by mouth and send the patient to hospital without delay for examination and treatment

| SPILLAGE | STORAGE | FIRE AND EXPLOSION |
|---|--|--|
| <p>Take appropriate personal precautions; spillages will tend to vaporize and disperse; to assist disposal, liquid may be washed away and vapour "knocked down" by water spray; if ammonia enters a watercourse or sewer, public authorities must be informed</p> | <p>Ammonia solutions should be stored in sealed drums or bulk containers in a dry, well-ventilated place; liquid ammonia must be stored in pressure vessels and refrigerated</p> | <p>Fire: not flammable under normal conditions Explosion: none Fire-extinguishing agents: foam, carbon dioxide, dry chemical</p> |

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

Ammonia is alkaline and is toxic for animals and plants, causing convulsions in the former and interference with carbohydrate metabolism in the latter. Potassium transport across membranes is affected in both animals and plants. Persistently high levels of discharge into the atmosphere or into water bodies will have adverse effects on the environment, animals, and plants. There will only be a localized environmental hazard in the vicinity of a spillage, emission, or improper disposal (see section 4.5).

6. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The information given in this section has been extracted from the International Register of Potentially Toxic Chemicals (IRPTC) legal file. A full reference to the original national document from which the information was extracted can be obtained from IRPTC. When no effective date appears in the IRPTC legal file, the year of the reference from which the data are taken is indicated by (r).

The reader should be aware that regulatory decisions about chemicals taken in a certain country can only be fully understood in the framework of the legislation of that country. The regulations and guidelines of all countries are subject to change and should always be verified with appropriate regulatory authorities before application.

6.1 Exposure Limit Values

Some exposure limit values are given in the table on pp. 24-28.

6.2 Specific Restrictions

In Japan, Sweden, the United Kingdom, and the USA, ammonia is listed as a poison and sale is controlled. In Czechoslovakia and the EEC, the use of ammonia in cosmetics is restricted.

In Sweden and the USA, the use of ammonia as a pesticide is regulated.

In the EEC, the United Kingdom, and the USA, the storage of ammonia is regulated. For the EEC and the United Kingdom, the levels at which regulations apply are 60 tonnes and 100 tonnes, respectively.

6.3 Labelling, Packaging, and Transport

In the EEC, anhydrous ammonia is classified as toxic and flammable for labelling and packaging purposes. The label must read:

Toxic by inhalation. Keep container tightly closed and in a well ventilated place. Keep away from sources of ignition. No smoking; in case of insufficient ventilation, wear suitable respiratory equipment.

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

EXPOSURE LIMIT VALUES

| Medium | Specification | Country/ organization | Exposure limit description | Value | Effective date |
|--------|---------------|--------------------------|---|----------------------|-------------------|
| AIR | Occupational | Argentina | Maximum permissible concentration (MPC) | 18 mg/m ³ | 1979 |
| | | | - Time-weighted average (TWA) | 27 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | | |
| | | Austria | Threshold limit value (TLV) | 18 mg/m ³ | 1985 (r) |
| | | | - Time-weighted average (TWA) | 27 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | | |
| | | Belgium | Threshold limit value (TLV) | 18 mg/m ³ | 1989 (r) |
| | | | - Time-weighted average (TWA) | 27 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | | |
| | | Canada | Threshold limit value (TLV) | 18 mg/m ³ | 1980 |
| | | | - Time-weighted average (TWA) | 27 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | | |
| | | Czechoslovakia | Maximum allowable concentration (MAC) | 20 mg/m ³ | 1985 |
| | | | - Time-weighted average (TWA) | 40 mg/m ³ | |
| | | | - Ceiling value (CLV) | | |
| | | Finland | Maximum permissible concentration (MPC) | 18 mg/m ³ | 1989 (r) |
| | | | - Time-weighted average (TWA) | | |

| | | | |
|------------------------------|--|--|----------|
| German Democratic Republic | <ul style="list-style-type: none"> Maximum allowable concentration (MAC) - Short-term exposure limit (STEL) | 20 mg/m ³ | 1988 (r) |
| Germany, Federal Republic of | <ul style="list-style-type: none"> Maximum workplace concentration (MAK) - Time-weighted average (TWA) - Short-term exposure limit (STEL) (5 min, 8x/shift) | 35 mg/m ³ 70 mg/m ³ | 1989 (r) |
| Hungary | <ul style="list-style-type: none"> Maximum allowable concentration (MAC) - Time-weighted average (TWA) - Short-term exposure limit (STEL) (30 min) | 20 mg/m ³ 20 mg/m ³ | 1985 (r) |
| Italy | <ul style="list-style-type: none"> Threshold limit value (TLV) - Time-weighted average (TWA) | 20 mg/m ³ | 1985 (r) |
| Japan | <ul style="list-style-type: none"> Maximum allowable concentration (MAC) - Time-weighted average (TWA) | 18 mg/m ³ | 1986 (r) |
| Netherlands | <ul style="list-style-type: none"> Maximum limit (MXL) - Time-weighted average (TWA) | 18 mg/m ³ | 1987 (r) |
| Poland | <ul style="list-style-type: none"> Maximum permissible concentration (MPC) - Ceiling value (CLV) | 20 mg/m ³ | 1985 (r) |

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

EXPOSURE LIMIT VALUES (continued)

| Medium | Specification | Country/ organization | Exposure limit description | Value | Effective date |
|--------|---------------|--------------------------|---|----------------------|-------------------|
| AIR | Occupational | Romania | Maximum permissible concentration (MPC) | | 1985 (r) |
| | | | - Time-weighted average (TWA) | 20 mg/m ³ | |
| | | | - Ceiling value (CLV) | 30 mg/m ³ | |
| | | Sweden | Hygienic limit value (HLV) | | 1983 |
| | | | - Time-weighted average (TWA) | 18 mg/m ³ | |
| | | | - Ceiling value (CLV) | 35 mg/m ³ | |
| | | | (5-min time-weighted average) | | |
| | | Switzerland | Maximum workplace concentration (MAK) | | 1987 (r) |
| | | | - Time-weighted average (TWA) | 18 mg/m ³ | |
| | | United Kingdom | Recommended exposure limit (RECL) | | 1987 (r) |
| | | | - Time-weighted average (TWA) | 18 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | 27 mg/m ³ | |
| | | | (10-min time-weighted average) | | |
| | | USA (ACGIH) | Threshold limit value (TLV) | | 1987 |
| | | | - Time-weighted average (TWA) | 18 mg/m ³ | |
| | | | - Short-term exposure limit (STEL) | 27 mg/m ³ | |

| | | | | |
|-------|----------------|--|----------|--|
| | USA (OSHA) | Permissible exposure limit (PEL) - Time-weighted average (TWA) | 1987 | 35 mg/m ³ |
| | USSR | Maximum allowable concentration (MAC) - Ceiling value (CLV) | 1977 | 20 mg/m ³ |
| AIR | Ambient | Maximum allowable concentration (MAC) - Daily average - Peak concentration (1 per day) | 1984 | 0.04 mg/m ³ 0.12 mg/m ³ |
| | Emissions | Maximum limit (MXL) | 1982 (r) | 3.5 mg/m ³ |
| WATER | Surface | Maximum allowable concentration (MAC) | 1975 | 3.0 mg/litre |
| | EEC | Quality standard for surface water intended for abstraction of drinking- water - Normal water treatment - Intensive water treatment Guideline values - Simple water treatment - Normal water treatment - Intensive water treatment | 1977 | 1.5 mg NH ₄ /litre 4.0 mg NH ₄ /litre 0.05 mg NH ₄ /litre 1.0 mg NH ₄ /litre 2.0 mg NH ₄ /litre |
| | Czechoslovakia | Maximum allowable concentration (MAC) | 1975 | 3.0 mg/litre |

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

EXPOSURE LIMIT VALUES (*continued*)

| Medium | Specification | Country/ organization | Exposure limit description | Value | Effective date |
|--------|---------------|--------------------------|--|------------------------------------|-------------------|
| WATER | Surface | Netherlands | Basic quality standard for surface water in general | 0.02 mg N/litre | 1986 |
| | | USSR | Maximum allowable concentration (MAC) | 2.0 mg N/litre | 1983 |
| | Drinking- | Czechoslovakia | Maximum allowable concentration (MAC) | 0.5 mg/litre | 1975 |
| | | EEC | Maximum allowable concentration (MAC) | 0.5 mg NH ₄ / litre | 1982 |
| | | | Guideline value | 0.05 mg NH ₄ / litre | |
| FOOD | | Netherlands | Limit value | 10.0 mg N/ litre | 1986 |
| | | FAO/WHO | No ADI allocated | | 1982 (r) |

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

For ammonia solutions with concentrations of more than 35%, the percentage concentration must be stated on the label which must read:

Causes burns; irritating to respiratory system and skin; keep container tightly closed and dry. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

For ammonia solutions with concentrations of 10–35%, the percentage concentration must be stated on the label which must read:

Irritation to eyes, to respiratory system and skin; keep out of reach of children; in case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

The maximum concentration of ammonia in finished cosmetic products must not exceed 6% calculated as NH_3 . If the concentration exceeds 2%, the label must read:

Contains ammonia.

In the EEC, paints, varnishes, printing inks, adhesives, and similar products that contain ammonia in solution at concentrations greater than 35% are considered toxic and corrosive and, at concentrations of 10–35%, as harmful and irritant, and must be packaged and labelled accordingly. Ammonia is also controlled by the EEC Dangerous Products Directive (88/379/EEC).

6.4 Waste Disposal

No recommendations made by IRPTC.

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