SAFETY DATA SHEET

(according to Regulation (EC) No 1907/2006 (REACH), ANNEX II)

AMMONIA

Revision date: 01.05.2020 Version 4.2

SECTION 1: IDENTIFICATION OF THE SUBSTANCE AND OF THE COMPANY

1.1 Product identifier

Trade name:	Ammonia
Other names:	Ammonia anhydrous
Name IUPAC/ international chemical name	Ammonia
INDEX No. and name as listed in Annex VI of CLP:	007-001-00-5 ammonia, anhydrous
CAS No.:	7664-41-7
EINECS No.:	231-635-3
REACH registration No.:	01-2119488876-14-0048
Molecular formula	H3N

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses:	Use of the substance in the manufacture of nitric acid, alkalis, dyes, pharmaceuticals, cosmetics, vitamins, synthetic textile fibres and plastics. (*see ES 1)* Use in photochemical processes, refrigerant systems, insulation products, inks & toners, coatings, thinners & paint removers, processing aid in chemical industry. Use as an extraction agent, in NOx/SOx reduction, processing aid in nutrition, neutralising agent, textile dye, washing & cleaning products, textile treatment. Use in pulp/paper treatment, leather treatment, wood treatment, metal surface treatment, the treatment of rubber/latex, the manufacture of semiconductors/electronics. Use in adhesives & sealants, polymer preparations, aircare products & preservatives. *(see ES 2)* Use as a laboratory chemical, refrigerant in cooling systems, water treatment chemical, fertiliser, coating, paint thinner or paint remover, photochemical. Use as a cleaning product, leather or other surface treatment product, pH regulatory or neutralisation agent, process aid for nutrition *(see ES 3)* Use in coatings, paints, thinners and removers; use in fillers, putties and plasters, use of washing and cleaning products, use in cosmetic & personal care products *(see ES 4)*
Uses advised against:	None

1.3 Details of the supplier of the safety data sheet

Only Representative:	OSTCHEM GERMANY GmbH Erdmannstr. 10 222765 Hamburg, Germany Phone: +49 40 5300 300 Fax: +49 40 5300 30 33 www.ostchem.com E-mail: Irene.Nasdala@ebicon.de
Manufacturer:	PrJSC "AZOT" 72, Heroiv Kholodnoho Yaru Str., Cherkasy, Ukraine Tel.: +38 0472 39-63-03 +38 0472 39-23-33 URL website: http://www.azot.ck.ua Email: let@azot.ck.ua sale@azot.ck.ua
E-mail address of the competent person responsible for the Safety Data Sheet	PrJSC "AZOT" REACH Department onr@azot.ck.ua
National contact:	Not available

1.4 Emergency telephone number

Emergency phone number:	Tel: + 49 405 300 300 Opening hours: 9-18 (CET) Languages of the phone service: German, English, Russian Tel: + 38 (0472) 39 61 17 Opening hours: 0-24 Languages of the phone service: Russian, Ukrainian

SECTION 2: HAZARDS IDENTIFICATION

2.1 Classification of the substance

2.1.1 Classification in accordance with Regulation 1272/2008 (CLP)

Hazard statement(s):	H221 Flammable Gas [not applicable for solutions] H280 Contains gas under pressure; may explode if heated. H314 Causes severe skin burns and eye damage H331 Toxic if inhaled H400 Very toxic to aquatic life M-Factor (self-classification) = 1	Flam. Gas 2 Liquefied gas Skin Corr. 1B Acute Tox. 3 Aquatic Acute 1

2.2 Label elements

2.2.1 Labelling in accordance with Regulation 1272/2008 (CLP)

Hazard pictogram(s):	 GHS 04 GHS 05 GHS 06 GHS 09
Signal word	Danger
Hazard statement(s):	H221 Flammable gas H280 Contains gas under pressure; may explode if heated H331 Toxic if inhaled H314 Causes severe skin burns and eye damage H400 Very toxic to aquatic life

Supplemental Hazard information (EU): EUH071: Corrosive to the respiratory tract

Precautionary statement(s):

Precautionary Statement Prevention	P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking P260 Do not breathe dust, fume, gas, mist, vapours or spray. P280 Wear protective gloves, protective clothing, eye protection and face protection
Precautionary Statement Response	P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing P310 Immediately call a POISON CENTER or doctor
Precautionary Statement Storage	P403 Store in a well-ventilated place P405 Store locked up P410+P403 Protect from sunlight. Store in a well-ventilated place
Precautionary Statement Disposal	P501 Dispose of contents and container in accordance with national regulation
2.3 Other hazards:	According to Annex XIII of Regulation (EC) No.1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH): Not fulfilling PBT (persistent/bioaccumulative/toxic) criteria; Not fulfilling vPvB (very persistent/very bioaccummulative) criteria.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Name	**INDEX No. as listed in Annex VI of CLP**	**Weight % content (or range)**
Ammonia, anhydrous	007-001-00-5	Not less than 99,6 % (w/w)

SECTION 4: FIRST-AID MEASURES

4.1 Description of first aid measures

General notes:	No action shall be taken involving any personal risk or without suitable training. Gas masks with cartridges for ammonia must be used for evacuation from the hazard zone. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Clothing frozen to the skin should be thawed before being removed. Urgent hospital treatment is likely to be needed.

Following eye contact:	Immediately flush eyes with copious amounts of tepid water for at least 15 minutes. If irritation, pain, swelling, excessive tearing, or light sensitivity persists, the patient should be seen in a health care facility and referral to an ophthalmologist considered.
Following skin contact:	Immediately flush exposed area with copious amounts of tepid water for at least 15 minutes followed by washing area thoroughly with soap and water. The patient should be seen in a health care facility if irritation or pain persists.
Following ingestion:	Call a physician. If conscious, give the patient milk or water to drink immediately. Do not induce vomiting.
Following inhalation:	Move patient to fresh air. Monitor for respiratory distress. If cough or difficulty in breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. If trained to do so, administer supplemental oxygen with assisted ventilation as required. Administer artificial respiration if patient is not breathing.
Self-protection for the first aider:	None

4.2 Most important symptoms and effects, both acute and delayed

Acute effects/ Delayed effects	**Eye contact:** Exposure to the eyes may cause temporary or permanent blindness. Eye exposure may result in conjunctivitis, lacrimation and/or corneal irritation. Total corneal epithelial loss may occur.
	Skin contact: Ammonia is a severe irritant of the skin. Skin exposure to high concentrations of the gas may cause burning and blistering. Contact with liquid may cause severe skin burns. Concentrated ammonia may produce liquefaction necrosis and deep penetrating burns.
	Inhalation: Ammonia is toxic and a severe irritant of the respiratory tract. It may cause a running nose, coughing, chest pain, cessation of respiration and death. It may cause severe breathing difficulties, which may be delayed in onset. Bronchospasm, laryngitis, tracheitis, wheezing, dyspnea, and laryngeal stridor may be noted. Mucosal burns to the tracheobronchial tree, pulmonary edema and associated hypoxemia frequently occur following exposure to concentrated ammonia.

4.3 Indication of any immediate medical attention and special treatment needed

There is no specific antidote. Treat symptoms. Pulmonary edema prophylaxis.

SECTION 5: FIRE-FIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media:	Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder). Stopping the flow of gas rather than extinguishing the fire is usually the best procedure to follow when escaping gas is burning. Water spray can be used to bring down the vapour but should not be sprayed on pools of liquid ammonia.
Unsuitable extinguishing media:	None

5.2 Special hazards arising from the substance or mixture

Formation of explosive gas mixtures in air. Explosion hazard. Heat of fire can build pressure in container and cause it to rupture. Nitrogen oxides, hydrogen, nitrogen can be emitted in case of fire.

5.3 Advice for fire fighters

Do not get water inside container. Move container from fire area if you can do it without risk. Apply cooling water to sides of containers which are exposed to flames until well after fire is out. Stay away from ends of tanks due to exploding potential when tanks are exposed to fire. Isolate area until gas has dispersed. Use water spray or foam to control vapour. Positive pressure self-contained breathing apparatus (SCBA) should be used when there is a potential for inhalation of vapours and/or fumes. Chemical protective clothing that is safe for use with ammonia involved in a fire should be worn.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

6.1.1 For non-emergency personnel

Protective equipment: Gas masks with cartridges for ammonia.

Emergency procedures: Stop leak if you can do so without risk. Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind, out of low areas, and ventilate closed spaces before entering. Evaluate the affected area to determine whether to evacuate or shelter-in-place by taping windows and doors, shutting off outside air intakes (attic fans, etc.), and placing a wet towel or cloth over the face (if needed).

6.1.2 For emergency responders:

With proper training, self-contained breathing apparatus (SCBA) and structural firefighter’s protective clothing used in conjunction with water spray will provide limited protection in outdoor releases for short-term exposure. Fully encapsulating, vapor-protective clothing should be worn for spills and leaks with no fire. Use water spray or foam to control vapors. Mixing of water and liquid ammonia will increase vaporization rate. Do not put water on liquid ammonia unless more than 100 volumes of water are available for each volume of liquid ammonia.

6.2 Environmental precautions

Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations.

6.3 Methods and material for containment and cleaning up

6.3.1 For containment:
GAS: Do NOT spray water directly on the leak or ammonia container. For a small gas leak, increase ventilation and allow gas to vent to a safe area.
LIQUID: Use water spray to control vapours. Avoid any contact with liquid product. Stop the leakage. The excess of the product should be drained into suitable container. Allow the vapours to disperse. For small liquid spills, increase ventilation and allow the liquid to volatilise to safe area. For large spills, keep away from sources of ignition and sparks. Increase ventilation of spilled area. Self-contained breathing apparatus (SCBA) and appropriate protective clothing should be worn.
6.3.2 For cleaning up:
GAS: For larger gas leaks, use fire hoses equipped with fog nozzles to disperse gas down-wind.
LIQUID: Wash the affected area with great amount of water.
6.3.3 Other information: None

6.4 Reference to other sections

See section 8 for personal protective equipment and section 13 for waste disposal.

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling

Protective measures:	Use proper personal protective equipment when working with or around ammonia. Avoid contact with eyes, skin and clothing. Safety shower and eyewash fountain should be provided in the ammonia handling area.
Measures to prevent fire:	Keep away from sources of ignition.
Measures to prevent aerosol and dust generation:	Local exhaust ventilation should be provided.
Measures to protect the environment:	Prevent waste from contaminating the surrounding environment.
Advice on general occupational hygiene:	Do not eat, drink or smoke in work areas. Remove contaminated clothing and protective equipment before entering eating areas. Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/ Storage conditions:	Use transportable pressure equipment. Store in a well-ventilated area. Avoid heat, flames, sparks and other sources of ignition.
Packing materials:	Use dedicated containers - do not rinse.
Requirements for storage rooms and vessels:	
Storage class:	2A
Further information on storage conditions:	None
Incompatible products:	All strong acids and alkali, halogens, perchlorate, chloric acid, chlorine monoxide, chlorites, nitrogen tetroxide, compounds of chrome, selenium, silver, gold compounds, zinc, platinum, tin, sulphur, acetaldehyde, acrolein, boron, hydrogen, potassium and its salts, picric acid, nitrilchloride, nitrogen oxides, nitric acid, hydrazine.
7.3 Specific end use(s):	None

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

8.1.1 National occupational exposure limit values: Not available

8.1.2 National biological limit values: Not available

8.1.3 PNEC (Predicted No Effect Concentration):

Environmental protection target	PNEC
Aqua – freshwater	0.0011 mg/L
Aqua - marine water	0.0011 mg/L
Aqua – intermittent releases	0.089 mg/L
Sediment	No exposure expected
Soil	No exposure expected
Sewage treatment plant	No exposure expected
Food chain: oral (secondary poisoning)	No exposure expected
Air	No exposure expected

8.1.4 DNEL:

ACUTE (Systemic effects)

Route	Derived No Effect Level (DNEL)	
	Workers	**General population**
Oral	Not quantifiable	6.8 mg/kg bw/d
Dermal	68 mg/kg bw/d	68 mg/kg bw/d
Inhalation	47.6 mg/m^3	23.8 mg/m^3

ACUTE (Local effects)

Route	Derived No Effect Level (DNEL)	
	Workers	**General population**
Oral	Not quantifiable	Not quantifiable
Dermal	Not quantifiable	Not quantifiable
Inhalation	36 mg/m^3	7.2 mg/m^3

LONG TERM (Systemic effects)

Route	Derived No Effect Level (DNEL)	
	Workers	**General population**
Oral	Not quantifiable	6.8 mg/kg bw/d
Dermal	68 mg/kg bw/d	68 mg/kg bw/d
Inhalation	47.6 mg/m^3	23.8 mg/m^3

LONG TERM (Local effects)

Route	Derived No Effect Level (DNEL)	
	Workers	**General population**
Oral	Not quantifiable	Not quantifiable
Dermal	Not quantifiable	Not quantifiable
Inhalation	14 mg/m^3	2.8 mg/m^3

8.1.5 Monitoring procedures: Not available

8.2 Exposure controls

8.2.1 Appropriate engineering controls:

Substance/mixture related measures to prevent exposure during identified uses: Exposure should be limited using appropriate engineering controls (containment, LEV) and protective equipment (gloves, goggles/visor, protective clothing) as appropriate.

Technical measures to prevent exposure: Engineering controls should be maintained to keep ammonia concentrations within acceptable exposure levels, or respiratory protection will be required to reduce inhalation exposure. Water sources such as showers, hoses, eye wash stations, or stock tanks are acceptable.

8.2.2 Personal protection equipment:

8.2.2.1 Eye and face protection:	Face-fitting chemical safety goggles. Also, use a face shield when there is a risk of splashes. The protective items must meet the requirements of EN 166.
8.2.2.2 Skin protection: Hand protection:	Use protective gloves which are made of polyacrylonitrile rubber, latex, poly(vinyl chloride) or poly(vinyl alcohol). The gloves must satisfy the requirements of Directive 89/686/EEC and/or standard EN 374. Gloves must provide antistatic performance if they are to be used in an explosion hazard zone.
Other skin protection:	Wear protective clothing. Use protective boots (e.g. made of neoprene). Protective clothing, gloves and boots must provide antistatic performance if they are to be used in an explosion hazard zone. In emergency situations, or when the workplace concentration is not known, use the completely isolating personal protection controls (gas-tight full protective suit and self-contained breathing apparatus).
8.2.2.3 Respiratory protection:	Use appropriate gas mask and suitable protective equipment. Keep self contained breathing apparatus readily available for emergency use.
8.2.2.4 Thermal hazards:	Not available
8.2.3 Environmental exposure controls:	Enclosed systems are provided for all operations, inclusive of sampling. Forced flow ventilation protects workplaces against high ammonia concentrations. Ammonia is stored in enclosed and leak-proof tanks and tank vehicles, and it is transported under the same conditions. If ammonia is released to atmosphere, to water reservoirs, to soil and/or to sewage systems, notify the competent governmental agency.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance:	Anhydrous ammonia is a colourless gas at room temperature and pressure (liquefied under pressure)
Odour:	Specific, extremely pungent.
Odour threshold:	5 ppm
pH:	Not available
Melting point/Freezing point:	-77,7 ºC
Initial boiling point and boiling range:	-33,33 ºC
Flash-point:	The endpoint is not applicable as the substance is an inorganic gas; Aqueous solutions of ammonia did not show any flash point
Evaporation rate:	Not available
Flammability (solid, gas):	Flammable
Upper/lower flammability or explosive limits	16 % / 25 %
Vapour pressure:	8611 hPa at 20 ºC
Vapour density:	Not available
Relative density:	Not applicable. The substance is a gas at room temperature: this endpoint is not relevant. The density of ammonia is calculated to be 0.717 kg/m^3 at NTP (normal temperature and pressure); 0.769 kg/m^3 at STP (standard temperature and pressure).
Solubility in water:	482 g/L at 25 ºC, 531 g/L at 20 ºC. The substance is very soluble in water
Partition coefficient n-octanol/water:	Not applicable. As the substance is inorganic
Auto-ignition temperature	The auto flammability of anhydrous ammonia was measured to be 651ºC
Decomposition temperature:	above 400 ºC
Viscosity:	The substance is a gas at room temperature: this endpoint is not relevant. However the viscosity of anhydrous ammonia was measured to 0,475; 0,317; 0,276 & 0,255 centipoises (mPa.s) at -69, -50, -40 & -33.5ºC respectively.

Explosive properties	Non explosive (anhydrous ammonia is not predicted to be explosive based on a theoretical assessment of its chemical structure) **NB:** Risk of explosion in case of contact or reaction with some substances (hypochlorites, mercury, silver). When ammonia is mixed with such gases as: oxygen, chlorine, bromine or iodine; its explosion may be initiated by direct sunlight or by UV radiation.
Oxidising properties	No (As the substance does not contain any oxygen or halogen atoms it is not expected to be an oxidising agent).

9.2 Other information

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity

Stable under recommended storage and handling conditions (see section 7, handling and storage).

10.2 Chemical stability

Stable under recommended storage and handling conditions (see section 7, handling and storage); hazardous polymerisation will not occur.

10.3 Possibility of hazardous reactions

The fire or explosion hazard results from its reactions with: acetaldehyde, acrolein, boron trifluoride, bromine, chlorine, chloric acid, chlorine trifluoride, chlorates, chlorosilane, ethylene oxide, fluorine, hydrogen bromide, hypochlorous acid, iodine, nitric acid, nitrogen dioxide, nitrogen trichloride, nitrosyl chloride, phosphorus pentoxide, picric acid, phosphorus and phosphorus hydride, arsenic hydride, antimony hydride, sodium and sulphur dichloride.

Reacts violently with copper, tin, zinc and their alloys, especially under humid conditions.

10.4 Conditions to avoid

Incompatible materials, open flame sources, heat sources / heat - risk of bursting.

10.5 Incompatible materials

Ammonia has potentially explosive or violent reactions with interhalogens, strong oxidisers, nitric acid, fluorine and nitrogen oxide. Ammonia forms sensitive explosive mixtures with air and hydrocarbons, ethanol and silver nitrate and chlorine. Explosive products are formed by the reaction of ammonia with silver chloride, silver oxide, bromine, iodine, gold, mercury and tellurium halides. See also Clause 10.3.

10.6 Hazardous decomposition products

Nitrogen oxides, hydrogen

Hydrogen is released upon heating above 454 °C. The decomposition temperature may be lowered to 300 °C by contact with certain metals such as nickel. At 690 °C or in the presence of an electric spark, ammonia decomposes into nitrogen and hydrogen gases, which may form a flammable mixture in the air.

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

11.1.1 Acute toxicity

Route of exposure	*Species*	*Method*	*Effective dose*	*Exposure time*	*Results*
inhalation	rat male	Assessment of acute inhalation toxicity in the rat	–	1 hour	LC50: 9850 mg/m³ air
oral	rat (Wistar) male	gavage equivalent or similar to OECD Guideline 401 (Acute Oral Toxicity)	–	–	LD50: 350 mg/kg bw (male) (Probit analysis)
dermal	No data are available. A waiver is proposed as the substance is classified as corrosive. Dermal exposure to anhydrous ammonia will be dominated by local effects at the site of contact and significant systemic toxicity is unlikely.				

11.1.2 Serious eye damage/irritation	Highly irritating
11.1.3 Skin corrosion/irritation	Corrosive
11.1.4 Respiratory or skin sensitization	Not sensitising
11.1.5 Germ cell mutagenicity	Negative
11.1.6 Carcinogenicity:	There is no evidence that the substance is carcinogenic
11.1.7 Reproductive toxicity:	The available data do not indicate that ammonia is a reproductive or developmental toxin
11.1.8 STOT-single exposure	Not available
11.1.9 STOT-repeated exposure	Not available
11.1.10 Aspiration hazard	Not relevant

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity

Fish (freshwater, short-term):	LC_{50}: 0.068 mg/L
Fish (long-term):	LC50 for freshwater fish: 0.89 mg/L un-ionised ammonia

Freshwater invertebrates (short-term):	EC50/LC50 for freshwater invertebrates: 110 mg/L LC50=101 mg/L (48 h; *Daphnia* magna)
Freshwater invertebrates (long-term):	EC10/LC10 (NOEC): 0.79 mg/L
Freshwater algae:	EC50/LC50: 2700 mg/L
Terrestrial plants:	Not predicted Ammonia is used as a component of fertilisers; therefore toxicity to terrestrial plants is not predicted
Soil micro-organisms:	Not predicted Toxicity to soil microorganisms is unlikely: ammonia is an intrinsic part of the nitrate cycle
Birds:	No data are available. A waiver is proposed on grounds of exposure
Mammals:	Not available
12.2 Persistence and degradability	
Abiotic degradation:	
Hydrolysis:	Not predicted. In aqueous solution, ammonia is in equilibrium with the ammonium ion.
Excretion:	Ammonia is rapidly detoxified in mammals by conversion to urea by the urea cycle in liver cells, and is subsequently excreted (as urea) in urine following glomerular filtration.
Phototransformation/photolysis:	
Phototransformation in air:	Photolytic degradation and reaction with photolytically produced hydroxyl radicals (OH) in the troposphere are major pathways for the removal of atmospheric ammonia
Phototransformation in water:	Not available
Phototransformation in soil:	Not available
Biodegradation:	
Biodegradation in water:	Readily biodegradable
Biodegradation in sediments:	No data are available and none are required
Biodegradation in soil:	Ammonia is rapidly biodegraded in soil by the process of ammonification or mineralisation
12.3 Bioaccumulative potential	
Ammonia does not bioaccumulate and is a product of normal metabolism	
12.4 Mobility in soil: In ground water, ammonia levels are usually low as a consequence of the strong adsorption of the ammonium ion on clay minerals, or bacterial oxidation to nitrate, both processes which limit mobility in soil.	
12.5 Results of PBT and vPvB assessment	
According to Annex XIII of Regulation (EC) No 1907/2006, no PBT and vPvB assessment has been conducted since ammonia is inorganic.	
12.6 Other adverse effects: None	
12.7 Additional information: None	

SECTION 13: DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods:	
13.1.1 Product / Packaging disposal:	Dispose of according to local authority regulations.
Waste codes / waste designations according to LoW (Commission Decision 2001/118/EC):	06 10 99 Wastes not otherwise specified
13.1.2 Waste treatment-relevant information:	Waste must be disposed of in line with local regulations and should not be discharged to surface water without prior treatment by STP.
13.1.3 Sewage disposal-relevant information:	Sewage disposal should be made in accordance with local authority regulations.
13.1.4 Other disposal recommendations:	None

SECTION 14: TRANSPORT INFORMATION

	ADR/RID	**ADN/ADNR**	**IMDG**	**IATA**
14.1 UN number	UN1005	Not regulated	UN 1005	Not regulated
14.2 UN proper shipping name	Ammonia, anhydrous	-	Ammonia, anhydrous	-
14.3 Transport hazard class(es)	2.3, 8	-	2.3, 8	-
14.4 Packing group	None	-	-	-
14.5 Environmental hazards	No	No	No	No

14.6 Special precautions for user	Not available	Not available	Not available	Not available
Additional information	Classification code: 2TC Label 2.3: toxic substance. Label 8: corrosive substance.	-	EmS number: 2-08 Label FS: 2-03 Marine pollutant: No	Transport forbidden on passenger aircraft - cargo aircraft only

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not available

SECTION 15: REGULATORY INFORMATION

15.1 Safety, health and environmental regulation/legislation specific for the substance or mixture

EU Regulations

Authorisations and\or restrictions on use: ***Authorisation*:** EU Regulation (EC) No. 1907/2006 (REACH) Annex XIV - List of substances subject to authorisation Substances of very high concern	None of the components are listed
***Restrictions on use*:** Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles	Not applicable

Other EU Regulations:

Annex I of Seveso II Directive 96/82/EC:

Dangerous substances	*CAS number*	*Qualifying quantity (tonnes) for the application of*	
		Lower tier	Upper tier
Anhydrous ammonia	7664-41-7	50	200

National regulations (*country*): Not available

***15.2 Chemical safety assessment*:**	In accordance with REACH Article 14, a Chemical Safety Assessment has been carried out for this substance.

SECTION 16: OTHER INFORMATION

The information provided in this safety data sheet is correct to the best of our knowledge, information, and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal, and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any proceed, unless specified in the text.

16.1 Indication of changes:	v. 3.0: Changes were made to comply with the Guidance on the compilation of safety data sheets (version 1.1) v. 3.1: Changes were made to comply with Article 61 (CLP) v. 4.0: Changes were made taking into account 5th and 8th ATP to CLP

v. 3.0: Page header; 1.1; 1.2; 1.3; 1.4; 2.1; 2.2; 2.3; 3.1; 4.1; 4.3; 6.1; 6.3; 7.1; 7.2; 8.1; 8.2; 9.1; 11.1; 12.2; 12.4; 12.6; 12.7; 13.1; 15.1
v. 3.1: Page header; 2.1.2; 2.2.2; 16.2
v. 4.0: Page header; 1.3; 2.2.1
v. 4.1: Page header; 1.3
v. 4.2: Page header; 1.3

16.2 Abbreviations and acronyms:

- ADN - European Agreement concerning the International Carriage of Dangerous Goods on Inland Waterway
- ADNR - ADN Rhine
- ADR - Agreement on Dangerous Goods by Road
- CAS - Chemical Abstracts Service
- CLP - Classification, Labelling and Packaging of chemicals
- EC - European Commission
- EC50 - half maximal effective concentration
- EINECS - European Inventory of Existing Commercial Chemical Substances
- EmS number - Emergency schedule number
- ES - Exposure Scenario
- GHS - Globally Harmonized System of Classification and Labelling of Chemicals
- IATA - International Air Transport Association

- IBC Code - International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk
- IMDG - International Maritime Dangerous Goods
- IUPAC - International Union of Pure and Applied Chemistry
- LC50 - Lethal Concentration
- LD50 - Lethal Dose
- LEV - local exhaust ventilation
- LoW - List of Wastes
- MARPOL - International Convention for the Prevention of Pollution From Ships
- OECD - Organization for Economic Co-operation and Development
- PBT - Persistent, bioaccumulative, toxic chemical
- PJSC - Public Joint-Stock Company
- REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals
- RID - International Rule for Transport of Dangerous Substances by Railway
- STOT - Specific Target Organ Toxicity
- STP - sewage treatment plant
- UN - United Nations
- vPvB - very persistent, very bioaccumulative

16.3 Key literature references and sources for data: CSR (Chemical Safety Report), Guidance on safe use etc.

16.4 Training advice:	In accordance with the local regulations
16.5 Further information:	None

Exposure Scenario No. 1: Use of ammonia as an intermediate in the chemicals industry

1.1 Exposure Scenario

Ammonia is used by the chemicals industry to manufacture a range of other substances including: nitric acid, alkalis, dyes, pharmaceuticals, cosmetics, vitamins, synthetic textile fibres and plastics.

Ammonia is used as an intermediate in the synthesis of a number of chemicals. It is used in the manufacture of nitric acid (HNO_3) which is used in making explosives such as TNT (2,4,6-trinitrotoluene); nitro-glycerine (which is also used as a vasodilator) and PETN (pentaerythritol nitrate). Ammonia is also used in the synthesis of alkalis: sodium hydrogen carbonate (sodium bicarbonate; $NaHCO_3$), soda ash (sodium carbonate, Na_2CO_3), hydrogen cyanide (hydrocyanic acid; HCN) and hydrazine (N_2H_4) used in rocket propulsion systems.

Ammonia is used to manufacture explosives such as ammonium nitrate (NH_4NO_3). It is also used as an intermediate in the synthesis of dyes, and synthetic 'man-made' fibres such as nylon, rayon and acrylics. It is also used in the manufacture of plastics such as phenolics and polyurethanes.

Ammonia is used in the manufacture of drugs such as sulphonamide which inhibit the growth and multiplication of bacteria that require *p*-aminobenzoic acid (PABA) and for the biosynthesis of folic acids, antimalarials and vitamins (e.g. B vitamins: nicotinamide and thiamine).

Ammonia is also used in the production of ammonium and nitrate salts used in fertilisers.

1.1.1 Description of Activities and Processes Covered in the Exposure Scenario

Processes using ammonia as an intermediate are carried out at large chemical manufacturing facilities. Due to the large size of these facilities, vessels and reactors for chemical synthesis and processing are housed outdoors. Some processes are carried out indoors. Processes are continuous or batch and are carried out in closed systems.

Most chemical manufacturing processes and units are operated automatically by a small number of operators located in separate control rooms. Operators may also carry out routine 'field' inspections around the facility to check that equipment is operating correctly. Other manual operations in the field may also be undertaken such as: preparation of equipment for mechanical or other work (e.g. maintenance), or taking samples or measurements. Workers unload ammonia stored in spheres onto tankers. Tanker unloading generally takes place in the open air and involves connecting or disconnecting pipes or hoses and opening or closing valves.

1.1.2 Operational Conditions Related to Frequency and Duration of Use

Chemical processes using ammonia as an intermediate are closed, continuous or batch processes which can run for long periods without interruption indoors or outdoors, for up to 24 hours/day, 330-360 days per year. Operational control and some field operations such as inspection tours are therefore also carried out continuously (e.g. in shifts covering 24 hour periods daily, without interruption of the processes). Although operators generally work standard shifts of 8 hours/day and a normal working week, with production continuing at weekends, longer shifts up to 12 hours /day can also be carried out. Operators will typically work for 220 days/year. During a typical shift, operators may spend 80 % of their time in a control room and 20 % of their time in the field. Field operation tours can be up to 6 hours/shift, every day. Sampling (10 minutes/sample) for quality control is routinely carried out. Other activities such as maintenance work, are carried out intermittently. Workers also unload ammonia from transportation vehicles into containers. All processes are supervised.

1.1.3 Risk Management Measures

Chemical processes using ammonia as an intermediate involve special equipment and high integrity contained systems with little or no potential for worker exposure. These facilities are usually housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in separate control rooms.

Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points where emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise.

All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.

Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the manufacture, sampling and transfer of anhydrous ammonia to road tankers are well-trained in these procedures and use appropriate protective equipment.

1.2 Exposure Estimation

1.2.1 Workers Exposure

The assessment of worker exposure to anhydrous and aqueous forms of ammonia used as an intermediate in chemical synthesis was carried out for processes relevant to this scenario as identified by PROC codes reflecting: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), maintenance and clean-down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9) and analysis of samples (PROC 15). A screening-level (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m^3) associated with each process defined by PROC codes.

Exposure to workers was assessed taking into account different operational conditions that may be associated with the use of ammonia as an intermediate in chemical synthesis and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (LEV) or indoors with the use of LEV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.

The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposure where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35g.mol^{-1} and 17 g.mol^{-1} for aqueous and anhydrous forms respectively and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6 x 10^5 Pa at 20^{o}C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5 x 10^3 Pa to 4x10^4 Pa at 20^{o}C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.

1.2.2 Acute/Short-term and Long-term Exposure

Potential systemic dermal exposures and inhalation exposure concentrations predicted by the ECETOC TRA model for processes associated with the use of ammonia in chemical synthesis are shown in Tables 87 and 88 respectively. ECETOC predicts a daily systemic dose following dermal exposure and a typical daily inhalation exposure concentration and does not specifically predict acute (short-term) and chronic (long-term) exposures.

Table 1.1 Dermal exposures to anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia predicted using the ECETOC TRA model for industrial workers during chemical synthesis

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.07	0.01
Maintenance, clean down	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Transfer (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01

Table 1.2 Inhalation exposure concentrations for anhydrous and aqueous (in preparations of 5-25 % w/w) ammonia predicted using the ECETOC TRA model for industrial workers during chemical synthesis

				Anhydrous ammonia		**Aqueous ammonia (5-25% w/w)**	
Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentrations mg/m3**			
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Used in a closed process, no likelihood of	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	NA

exposure: Storage (closed bulk or container)		1-4 hrs or >4 hrs	Indoors without LEV	0.01	NA	0.01	NA
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.53	0.18	4.38	0.22
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without LEV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13
Use in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Maintenance, clean down	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with LEV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without LEV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with LEV	1.91	0.1	2.36	0.12
Transfer into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without LEV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with LEV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without LEV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with LEV	8.5	0.43	10.50	0.53
Quality control in a laboratory	PROC 15	>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without LEV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13

1.3 General Public / Consumer Exposure

Industrial uses of anhydrous and aqueous ammonia are carried out at industrial sites from which members of the public are excluded. Members of the public will not be exposed to anhydrous or aqueous ammonia during industrial end-use.

1.3.1 Indirect Exposure of Humans via the Environment (oral)

Ammonia is ubiquitous in the environment with <30% of emissions resulting from fertiliser uses and from non-agricultural sources (ref. 'Ammonia in the UK' - DEFRA).
In addition, there is no evidence that ammonia bioaccumulates as the log Kow value is 0.23. Since the trigger of BCF >100 (log Kow>3) is not met, the derivation of PNECs to protect against secondary poisoning is not required.
The risk of indirect exposure of humans via the environment is therefore not considered.

1.4 Environmental Exposure

First tier conservative environmental exposure estimations were carried out using EUSES 2.1 and with the specified defaults.
Second tier worst case environmental exposure estimations were carried out using EUSES 2.1 to take into account more realistic factors that affect the environmental concentrations.

1.4.1 Environmental Releases

The environmental releases are determined primarily by tonnage and the ERC in the first tier with conservative estimations and defaults being implemented in EUSES. For the second tier assessments in EUSES, more realistic inputs were chosen to best suit the description of the production and uses of anhydrous ammonia. Emission defaults are those specified by the ECHA "Guidance on information requirements and chemical safety assessment: Chapter R.16: Environmental Exposure Estimation". Regional data and emission fractions were calculated using EUSES. Full EUSES inputs are shown below.

Table 1.3 Predicted Releases to the Environment Tier 1

ERC	**Compartments**	**Predicted releases**	**Measured release**	**Explanation / source of measured data**
6A	Release to air	1.21×10^5 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6A.
	Release to wastewater	4.85×10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6A.
	Soil (direct only) Agricultural soil	NA	-	No directly loss to soil is expected for this ERC.

**The predicted releases were estimated using the EUSES 2.1 program.*

In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. Complete consumption within the STP can be assumed and this has been used in the tier 2 assessment within EUSES.

Table 1.4 Predicted Releases to the Environment Tier 2

ERC	**Compartments**	**Predicted releases**	**Measured release**	**Explanation / source of measured data**
6A	Release to air	1.21×10^5 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6A.
	Release to wastewater	4.85×10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6A.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC

1.4.2 Exposure concentration in sewage treatment plants (STP)

Table 1.5 Tier 1 Concentrations in sewage

ERC for Compartment:	**Estimated exposure concentrations**		**Measured exposure concentrations**		**Explanation / source of measured data**
	Value	**unit**	**value**	**unit**	
Waste water before treatment ERC 6A	2.42×10^{-4}	mg/L	NA	mg/L	
ERC 6A Sewage (STP effluent)	3.02×10^3	mg/L	NA	mg/L	
ERC 6A Local freshwater	302	mg/L	NA	mg/L	10-fold dilution by receiving waters

Table 1.6 Tier 2 Concentrations in sewage

ERC for Compartment:	**Estimated exposure concentrations**		**Measured exposure concentrations**		**Explanation / source of measured data**
	Value	**unit**	**value**	**unit**	
Waste water before treatment ERC 6A	2.42×10^{-4}	mg/L	NA	mg/L	
ERC 6A Sewage (STP effluent)	0	mg/L	NA	mg/L	Based on efficient removal by STP
ERC 6A Local freshwater	0	mg/L	NA	mg/L	10-fold dilution by receiving waters

1.4.3 Exposure concentration in aquatic pelagic compartment

Table 1.7 Tier 1 Predicted Environmental Concentrations (PEC) in aquatic compartment

Compartments	PEC aquatic (local mg/L)	Justification
ERC6A Freshwater (in mg/L)	302	
ERC 6A Marine water (in mg/L)	30.2	10-fold dilution by receiving waters

Table 1.8 Tier 2 Predicted Environmental Concentrations (PEC) in aquatic compartment

Compartments	PEC aquatic (local mg/L)	Justification
ERC6A Freshwater (in mg/L)	2.19×10^{-3}	
ERC6A Marine water (in mg/L)	5.37×10^{-4}	

1.4.4 Exposure concentration in sediments

Table 1.9 Tier 1 Predicted Environmental Concentrations (PEC) in aquatic sediment compartment

Compartments	PEC aquatic (local)
ERC6A Freshwater sediment (in mg/kg)	327
ERC6A Marine sediment (in mg/kg)	32.7

Table 1.10 Tier 2 Predicted Environmental Concentrations (PEC) in aquatic sediment compartment

Compartments	PEC aquatic (local)
ERC6A Freshwater sediment (in mg/kg)	2.37×10^{-3}
ERC6A Marine sediment (in mg/kg)	5.82×10^{-4}

1.4.5 Exposure concentrations in soil and groundwater

Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.

1.4.6 Atmospheric compartment

Table 1.11 Tier 1 local concentrations in air

ERC		Estimated local exposure concentrations	Explanation / source of data
6A	During emission (mg/m3)	33.7	Estimated using EUSES 2.1
	Annual average (mg/m3)	30.5	Estimated using EUSES 2.1
	Annual deposition (mg/m²/d)	43.9	Estimated using EUSES 2.1

Table 1.12 Tier 1 Predicted Exposure Concentration (PEC) in air

ERC		Local concentration	PEC air (local+regional)	Justification
6A	Annual average PEC in air, total (mg/m3)	30.5	30.5	Estimated using EUSES 2.1.

Table 1.13 Tier 2 local concentrations in air

ERC		Estimated local exposure concentrations	Explanation / source of data
6A	During emission (mg/m3)	33.7	Estimated using EUSES 2.1
	Annual average (mg/m3)	30.5	Estimated using EUSES 2.1
	Annual deposition (mg/m²/d)	43.8	Estimated using EUSES 2.1

Table 1.14 Tier 2 Predicted Exposure Concentration (PEC) in air

ERC		Local concentration	PEC air (local+regional)	Justification
6A	Annual average PEC in air, total (mg/m3)	30.5	30.5	Estimated using EUSES 2.1.

1.4.7 Exposure concentration relevant for the food chain (Secondary poisoning)

In terms of secondary poisoning, there is no evidence that ammonia bioaccumulates as the log Kow value is 0.23. Since the trigger of BCF >100 (log Kow>3) is not met, the derivation of PNECs to protect against secondary poisoning is not required. Risk characterisation ratios cannot therefore be derived.

1.4.8 Regional exposure levels and environmental concentrations.

Anhydrous ammonia is produced and used at many sites throughout a region and this may lead to a degree of regional exposure. Regional exposure has been modelled for this exposure scenario using the regional module of EUSES 2.1.

Table 1.15 Tier 1 regional concentrations in the environment

	Predicted regional Exposure Concentrations		**Measured regional exposure concentrations**		**Explanation / source of measured data**
	PEC value	**unit**	**Measured value**	**unit**	
ERC 6a Freshwater	2.68×10^{-2}	mg/L	NA	mg/L	
ERC 6a Marine water	2.67×10^{-3}	mg/L	NA	mg/L	
ERC 6a Freshwater sediments	2.56×10^{-2}	mg/kg	NA	mg/kg	
ERC 6a Marine sediments	2.56×10^{-3}	mg/kg	NA	mg/kg	
ERC 6a Agricultural soil	1.00×10^{-3}	mg/kg	NA	mg/kg	
ERC 6a Grassland	1.47×10^{-3}	mg/kg	NA	mg/kg	
ERC 6a Air	2.24×10^{-3}	mg/m^3	NA	mg/m^3	

Table 1.16 Tier 2 regional concentrations in the environment

	Predicted regional Exposure Concentrations		**Measured regional exposure concentrations**		**Explanation / source of measured data**
	PEC value	**unit**	**Measured value**	**unit**	
ERC 6a Freshwater	2.19×10^{-3}	mg/L	NA	mg/L	
ERC 6a Marine water	5.37×10^{-4}	mg/L	NA	mg/L	
ERC 6a Freshwater sediments	2.09×10^{-3}	mg/kg	NA	mg/kg	
ERC 6a Marine sediments	5.15×10^{-4}	mg/kg	NA	mg/kg	
ERC 6a Agricultural soil	9.88×10^{-4}	mg/kg	NA	mg/kg	
ERC 6a Grassland	1.39×10^{-3}	mg/kg	NA	mg/kg	
ERC 6a Air	2.12×10^{-3}	mg/m^3	NA	mg/m^3	

Exposure Scenario No. 2: Industrial end-use: Use of ammonia as a processing aid, non-processing aid and auxiliary agent

2.1 Exposure scenario

Anhydrous liquid and aqueous solutions of ammonia are used by a range of industry sectors in a broad number of applications. These include industrial use as a reactive or non-reactive processing aid in continuous or batch processes, as an auxiliary agent or as substance in a closed system. Common industrial end-uses of ammonia are shown below in table 2.1.

Table 2.1 Common industrial end-uses of ammonia

Industrial end-use	**Type of use**					**Description of use**
	Pr	**No**	**Re**	**A**	**Us**	
Use as developing agent in photochemical processes	X					Ammonia is used as a developing agent in photochemical processes such as white printing, blue printing and in the diazo duplication press.
Use of refrigerant systems		X			X	Anhydrous liquid ammonia is used as a refrigerant in household, commercial and industrial systems due to its high heat of vaporisation and relative ease of liquefaction.
Insulation products		X				
Inks and toners	X	X				Ammonia vapours are used as a reagent in treating writing or ink marks
Coatings, thinners, paint removers	X	X				
Processing aid in chemicals industry			X			
Use as an extraction agent			X			Ammonia is used as an extraction agent in the mining industry to extract metals like copper, nickel and molybdenum from their ores.
Treatment of gas (NOx and SOx reduction)			X		X	Ammonia is used in stack emission control systems to neutralise sulphur oxides from combustion of sulphur-containing fuels, as a method of NOx control in both catalytic and non-catalytic applications and to enhance the efficiency of electrostatic precipitators for particulate control.
Processing aid in nutrition			X		X	The food and beverage industry use ammonia as a source of nitrogen required for yeast and micro-organism
Use as neutralising agent			X		X	Ammonia is used by the petrochemical industry in neutralizing the acid constituents of crude oil and in the protection of equipment from corrosion
Textile dyes			X			
Treatment of water	X		X			Aqueous ammonia is used in water and waste-water treatment areas to control pH, to regenerate weak anion exchange resins and as an oxygen scavenger in boiled water treatment. In water disinfection, aqueous ammonia is added to water containing free chlorine to produce a chloramines disinfectant.
Use as washing and cleaning products	X		X			Weak ammonia solutions are used extensively within industry, by professionals and consumers as commercial and household cleaners and detergents cleaning products. Commercial ammonia cleaning products contain up to 30% ammonia whereas household products contain 5-10% ammonia
Treatment of textiles		X	X			Liquid ammonia is used to increase the quality of textiles
Treatment of pulp and paper		X	X			Ammonia is used in the pulp and paper industry to pulp wood and as a casein dispersant to coat paper.
Treatment of leather		X	X			The leather industry utilises ammonia as a curing agent, as a slime and mould preservative in tanning liquors and as a protective agent for leather and furs in storage
Treatment of wood	X		X			Anhydrous ammonia fumes are used to darken wood in a process called "ammonia fuming"
Treatment of metal surfaces	X		X			Ammonia is used in metal treatment processes such as nitriding, carbonitriding, bright annealing, furnace brazing, sintering, sodium hydride descaling, atomic hydrogen welding and other application where protective atmospheres are required.
Treatment of rubber/latex		X	X			Concentrated aqueous ammonia is used in the rubber industry as a preservative for natural and synthetic latex due to its antibacterial and alkaline properties and as a stabiliser to prevent pre-mature coagulation (e.g. "ammoniation" of natural rubber latex.
Manufacture of semiconductors/electronics				X		Ammonia is used in the electronics industry in the manufacturing of semiconductor chips.

Adhesives, sealants	X			X		
Polymer preparations	X			X		
Aircare products					X	
Preservatives		X				Ammonia is uses as a preservative for the storage of high moisture corn

2.1.2 Description of activities and processes covered in the exposure scenario

Operational conditions pertaining to the broad range of industrial end-use scenarios involving anhydrous and aqueous forms of ammonia vary considerably across applications and industrial sector of use. A full characterisation of the frequency and duration of tasks is beyond the scope of this report. For the purpose of worker exposure estimation, activities and processes associated with the industrial end-use of ammonia have been represented generically, based on the process categories (e.g. PROC codes) defined by REACH guidance. Processes and activities relevant to ES 2 are described as: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in close, continuous process with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), industrial spraying (PROC 7), maintenance and clean down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9), brush and roller applications (PROC 10), treatment of articles by dipping and pouring (PROC 13), and analysis of samples (PROC 15) and hand-mixing (PROC 19).

2.1.3 Operational conditions related to frequency and duration of use

Operational conditions pertaining to the broad range of industrial end-use scenarios involving anhydrous and aqueous forms of ammonia vary considerably across applications and industrial sector of use. A full characterisation of the frequency and duration of tasks is beyond the scope of this report. For the purposes of worker exposure estimation, operational conditions have been represented generically based on the assumptions that tasks may be either 1-4 hours or >4 hours in duration and processes can be carried out either outdoors, indoors without LEV or indoors with LEV.

2.1.4 Risk Management Measures

Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room.

Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise.

All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.

Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the manufacture, sampling and transfer of anhydrous ammonia to road tankers are well-trained in these procedures and use of appropriate protective equipment.

2.2 Exposure Estimation

The assessment of worker exposure to anhydrous and aqueous forms of ammonia in industrial end-use applications was carried out for processes relevant to this scenario as identified by PROC codes reflecting: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), industrial spraying (PROC 7), maintenance and clean down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9), brush and roller applications (PROC 10), treatment of articles by dipping and pouring (PROC 13), and analysis of samples (PROC 15) and hand-mixing (PROC 19).

A screening-level (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m3) associated with each process defined by PROC codes.

Exposure to workers was assessed taking into account different operational conditions that may be associated with the industrial end-use of ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (LEV) or indoors with the use of LEV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.

The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposure where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35 g.mol^{-1} and 17 g.mol^{-1} for aqueous and anhydrous forms respectively) and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6 x 10^{5} Pa at 20^{o}C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5 x 10^{3} Pa to 4 x10^{4} Pa at 20^{o}C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.

2.2.1 Acute/Short term and long-term exposure

Potential systemic dermal exposures and inhalation exposure concentrations predicted by the ECETOC TRA model for the industrial end-use of ammonia are shown in Tables 2.2 and 2.3 respectively. ECETOC predicts a daily systemic dose following dermal exposure and a typical daily inhalation exposure concentration and does not specifically predict acute (short-term) and chronic (long-term) exposures.

Table 2.2 Dermal exposures to anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia predicted using the ECETOC TRA model for industrial workers during industrial end-use processes

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.07	0.01
Industrial spraying	PROC 7	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	42.86	4.29
		1-4 hrs or >4 hrs	Indoors with LEV	2.14	0.21
Maintenance, clean down	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Transfer (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Roller application or brushing	PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	27.43	2.74
		1-4 hrs or >4 hrs	Indoors with LEV	1.37	0.14
Treatment of articles by dipping and pouring	PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01
And-mixing with intimate contact and PPE only	PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	141.73	14.13

Table 2.3 Inhalation exposure concentrations for anhydrous and aqueous (in preparations of 5-25 % w/w) ammonia predicted using the ECETOC TRA model for industrial workers during industrial end-use processes

Description of activity	**PROC**	**Exposure assumptions**		**Anhydrous ammonia**		**Aqueous ammonia (5-25% w/w)**	
				Estimated Exposure Concentration mg/m3		**Estimated Exposure Concentration mg/m3**	
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Used in a closed process, no likelihood of exposure	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	0.00

		1-4 hrs or >4 hrs	Indoors without LEV	0.01	NA	0.01	0.00
Use of ammonia in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.53	0.18	4.38	0.22
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without LEV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13
Use of ammonia in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Use of ammonia in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Industrial spraying	PROC 7	>4hrs	Outdoors	NA	NA	306.25	15.31
		>4hrs	Indoors without LEV	NA	NA	437.5	21.88
		>4hrs	Indoors with LEV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	183.75	9.19
		1-4 hrs	Indoors without LEV	NA	NA	262.5	13.13
		1-4 hrs	Indoors with LEV	NA	NA	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at non-dedicated facilities	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with LEV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without	63.75	3.19	78.75	3.94

			LEV				
		1-4 hrs	Indoors with LEV	1.91	0.1	2.36	0.12
Transfer of ammonia into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without LEV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with LEV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without LEV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with LEV	8.5	0.43	10.50	0.53
Roller application or brushing	PROC 10	>4hrs	Outdoors	NA	NA	153.13	7.66
		>4hrs	Indoors without LEV	NA	NA	218.75	10.94
		>4hrs	Indoors with LEV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without LEV	NA	NA	131.25	6.56
		>4hrs	Outdoors	NA	NA	13.13	0.66
Treatment of articles by dipping and pouring	PROC 13	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Use as a laboratory agent	PROC 15	>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without LEV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13
Hand-mixing with intimate contact and PPE only	PROC 19	<4 hrs	Outdoors	NA	NA	153.13	7.66
		<4 hrs	Indoors without LEV	NA	NA	218.75	10.94
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without LEV	NA	NA	131.25	6.56

2.3 General public / consumer exposure

Industrial uses of anhydrous and aqueous ammonia are carried out at industrial sites from which members of the public are excluded. Members of the public will not be exposed to anhydrous or aqueous ammonia during industrial end-use.

2.3.1 Indirect exposure of humans via the environment (oral)

Ammonia is ubiquitous in the environment with <30% of emissions resulting from fertiliser uses and from non-agricultural sources (ref. ‘Ammonia in the UK’ - DEFRA).

In addition, there is no evidence that ammonia bioaccumulates as the log Kow value is 0.23. Since the trigger of BCF >100 (log Kow>3) is not met, the derivation of PNECs to protect against secondary poisoning is not required.

The risk of indirect exposure of humans via the environment is therefore not considered.

2.4 Environmental exposure

First tier conservative environmental exposure estimations were carried out using EUSES 2.1 and with the specified defaults.

Second tier worst case environmental exposure estimations were carried out using EUSES 2.1 to take into account more realistic factors that affect the environmental concentrations.

2.4.1 Environmental releases

The environmental releases are determined primarily by tonnage and the ERC in the first tier with conservative estimations and defaults being implemented in EUSES. For the second tier assessments in EUSES, more realistic inputs were chosen to best suit the description of the production and uses of anhydrous ammonia. Emission defaults are those specified by the ECHA “Guidance on information requirements and chemical safety assessment: Chapter R.16: Environmental Exposure Estimation”. Regional data and emission fractions were calculated using EUSES. Full EUSES inputs are shown below.

Table 2.4 Predicted Releases to the Environment Tier 1

ERC	Compartments	Predicted releases	Measured release	Explanation / source of measured data
4	Release to air	7.15 x 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC4.
	Release to wastewater	7.52 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC4.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
5	Release to air	3.76 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC5.
	Release to wastewater	3.76 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC5.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
6B	Release to air	75.2 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6B.
	Release to wastewater	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6B.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
7	Release to air	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC7.
	Release to wastewater	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC7.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
**The predicted releases were estimated using the EUSES 2.1 program.*				
In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. Complete consumption within the STP can be assumed and this has been used in the tier 2 assessment within EUSES.				

Table 2.5 RMMs and measured values for tier 2 assessment

Description of RMM	**Details**	**Effect taken into account in EUSES**	**Comments**
Efficient removal of ammonia in STP.	0 mg/L (Local) 0 kg/d (Regional)	Lowering of calculated concentration in STP effluent. Applied at both a local and a regional level. All regional emissions to STP.	

Table 2.6 Predicted Releases to the Environment Tier 2

ERC	**Compartments**	**Predicted releases**	**Measured release**	**Explanation / source of measured data**
4	Release to air	7.15 x 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC4.
	Release to wastewater	7.52 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC4.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
5	Release to air	3.76 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC5.
	Release to wastewater	3.76 X 10^4 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC5.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
6B	Release to air	75.2 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6B.
	Release to wastewater	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC6B.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.
7	Release to air	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC7.
	Release to wastewater	3760 kg/day	-	Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC7.
	Soil (direct only) Agricultural soil	NA	-	No direct loss to soil is expected for this ERC.

2.4.2 Exposure concentration in sewage treatment plant (STP)

Table 2.7 General emission fractions from the municipal STP

Fraction description	**Fraction amount**	
	value	**unit**
Fraction of emission directed to air by STP	0.583	%
Fraction of emission directed to water by STP	12.4	%
Fraction of emission directed to sludge by STP	0.13	%
Fraction of emission degraded by STP	86.8	%

2.4.3 Exposure concentration in aquatic pelagic compartment

Table 2.8 Tier 1 Predicted Environmental Concentrations (PEC) in aquatic compartment

Compartments	**PEC aquatic (local mg/L)**	**Justification**
ERC4 Freshwater (in mg/L)	468	
ERC4 Marine water (in mg/L)	46.8	
ERC5 Freshwater (in mg/L)	234	
ERC5 Marine water (in mg/L)	23.4	
ERC6B Freshwater (in mg/L)	23.4	
ERC6B Marine water (in mg/L)	2.34	
ERC7 Freshwater (in mg/L)	23.4	
ERC7 Marine water (in mg/L)	2.34	

Table 2.9 Tier 2 Predicted Environmental Concentrations (PEC) in aquatic compartment

Compartments	**PEC aquatic (local mg/L)**	**Justification**
ERC4 Freshwater (in mg/L)	2.82 x 10^{-3}	
ERC4 Marine water (in mg/L)	6.06 x 10^{-4}	
ERC5 Freshwater (in mg/L)	1.46 x 10^{-3}	

ERC5 Marine water (in mg/L)	3.17 x 10^{-4}	
ERC6B Freshwater (in mg/L)	4.54 x 10^{-5}	
ERC6B Marine water (in mg/L)	5.19 x 10^{-6}	
ERC7 Freshwater (in mg/L)	1.46x 10^{-4}	
ERC7 Marine water (in mg/L)	3.17 x 10^{-5}	

2.4.4 Exposure concentration in sediments

Table 2.10 Tier 1 Predicted Environmental Concentrations (PEC) in aquatic sediment compartment

Compartments	**PEC aquatic (local)**
ERC4 Freshwater sediment (in mg/kg)	507
ERC4 Marine sediment (in mg/kg)	50.7
ERC5 Freshwater sediment (in mg/kg)	253
ERC5 Marine sediment (in mg/kg)	25.3
ERC6B Freshwater sediment (in mg/kg)	25.3
ERC6B Marine sediment (in mg/kg)	2.53
ERC6D Freshwater sediment (in mg/kg)	0.026
ERC6D Marine sediment (in mg/kg)	0.00274
ERC7 Freshwater sediment (in mg/kg)	25.3
ERC7 Marine sediment (in mg/kg)	2.53

Table 2.11 Tier 2 Predicted Environmental Concentrations (PEC) in aquatic sediment compartment

Compartments	**PEC aquatic (local)**
ERC4 Freshwater sediment (in mg/kg)	3.05 x 10^{-3}
ERC4 Marine sediment (in mg/kg)	6.56 x 10^{-4}
ERC5 Freshwater sediment (in mg/kg)	1.58 x 10^{-3}
ERC5 Marine sediment (in mg/kg)	3.43 x 10^{-4}
ERC6B Freshwater sediment (in mg/kg)	4.91 x 10^{-5}
ERC6B Marine sediment (in mg/kg)	5.62 x 10^{-6}
ERC7 Freshwater sediment (in mg/kg)	1.58 x 10^{-4}
ERC7 Marine sediment (in mg/kg)	3.43 x 10^{-5}

2.4.5 Exposure concentrations in soil and groundwater

Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.

Table 2.12 Tier 1 Predicted Exposure Concentration (PEC) in air

ERC		**Local concentration**	**PEC air (local+regional)**	**Justification**
4	Annual average PEC in air, total (mg/m3)	18	18	Estimated using EUSES 2.1.
5	Annual average PEC in air, total (mg/m3)	9.45	9.45	Estimated using EUSES 2.1.
6B	Annual average PEC in air, total (mg/m3)	0.0189	0.0189	Estimated using EUSES 2.1.
6D	Annual average PEC in air, total (mg/m3)	6.62	6.62	Estimated using EUSES 2.1.
7	Annual average PEC in air, total (mg/m3)	0.945	0.945	Estimated using EUSES 2.1.

Table 2.13 Tier 2 Predicted Exposure Concentration (PEC) in air

ERC		**Local concentration**	**PEC air (local+regional)**	**Justification**
4	Annual average PEC in air, total (mg/m3)	18	18	Estimated using EUSES 2.1.
5	Annual average PEC in air, total (mg/m3)	9.45	9.45	Estimated using EUSES 2.1.
6B	Annual average PEC in air, total (mg/m3)	0.0189	0.0189	Estimated using EUSES 2.1.
7	Annual average PEC in air, total (mg/m3)	0.945	0.945	Estimated using EUSES 2.1.

2.4.6 Exposure concentration relevant for the food chain (Secondary poisoning)

In terms of secondary poisoning, there is no evidence that ammonia bioaccumulates as the log Kow value is 0.23. Since the trigger of BCF >100 (log Kow>3) is not met, the derivation of PNECs to protect against secondary poisoning is not required. Risk characterisation ratios cannot therefore be derived.

2.4.7 Regional exposure levels and environmental concentrations

Anhydrous ammonia is produced and used at many sites throughout a region and this may lead to a degree of regional exposure. Regional exposure has been modelled for this exposure scenario using the regional module of EUSES 2.1.

Exposure Scenario No. 3: Wide dispersive end-use: Professional uses of anhydrous and aqueous ammonia

3.1 Exposure scenario

Anhydrous liquid ammonia (>99.5 % wt) and aqueous ammonia solution (5-25% wt) are used by professional workers in a broad number of applications. Common applications include: use as a laboratory chemical, a refrigerant in cooling systems, a water treatment chemical, a fertiliser, a coating, paint thinner or paint remover, a photochemical, a cleaning product, a leather or other surface treatment product, a pH regulator or neutralisation agent and a process aid for nutrition.

Typical activities associated with the professional uses of ammonia where exposures can arise include operating equipment containing ammonia (e.g. opening and closing valves), transferring ammonia from storage containers using pipe or hoses, maintaining equipment and applying ammonia-based products (e.g. fertiliser, cleaning or surface treatment products).

3.1.1 Operational conditions related to frequency and duration of use

Operational conditions pertaining to the broad range of professional end-use scenarios involving anhydrous and aqueous forms of ammonia vary considerably across applications. A full characterisation of the frequency and duration of tasks is therefore beyond the scope of this report. For the purposes of worker exposure estimation, operational conditions have been represented generically based on the assumption that tasks may be either 1-4 hours or >4 hours in duration and that processes may be carried out either outdoors, indoors without LEV or indoors with LEV.

3.1.2 Risk management measures

Activities involving the use of ammonia by professionals can be regarded as wide dispersive uses: e.g. activities which deliver uncontrolled exposures. Professional workers are expected to follow good occupational hygiene practices and apply appropriate exposure control measures to minimise the potential for exposure. Workers should be trained in procedures involving the handling, sampling and transfer of ammonia and in the use of appropriate protective equipment. A good standard of general or controlled ventilation should be applied. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise. Any professional working directly with anhydrous ammonia as required to wear eye, face and respiratory protection.

3.2 Exposure estimation

3.2.1 Workers exposure

The assessment of worker exposure to anhydrous and aqueous ammonia during professional uses was carried out for process categories relevant to this scenario as identified by PROC codes: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), maintenance and clean-down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9), brush and roller applications (PROC 10), spraying (PROC 11), treatment of articles by dipping and pouring (PROC 13), and analysis of samples (PROC 15), hand-mixing (PROC 19) and heat and pressure transfer in closed systems (PROC 20).

A screening-level (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m^3) associated with each process defined by PROC codes.

Exposure to workers was assessed taking into account different operational conditions that may be associated with the professional use of ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (LEV) or indoors with the use of LEV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposures concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.

The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposures where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35 g.mol^{-1} and 17 g.mol^{-1} for aqueous and anhydrous forms respectively and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6 x 10^5 Pa at 20^{o}C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5 x 10^3 Pa to 4 x10^4 Pa at 20^{o}C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.

3.2.2 Acute/Short Term and Long Term Exposure

Potential systemic dermal exposures and inhalation exposure concentrations predicted by the ECETOC TRA model for processes associated with the professional use of ammonia are shown in Tables 3.1 and 3.2 respectively. ECETOC predicts a daily systemic dose following dermal exposure and a typical daily inhalation exposure concentration and does not specifically predict acute (short-term) and chronic (long-term) exposures.

Table 3.1 Dermal exposures to anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia predicted using the ECETOC TRA model for professional workers

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Used in a closed process, no likelihood of exposure	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03
Use of ammonia in a closed, continuous	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14

process with occasional controlled exposure (e.g. sampling)		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Use of ammonia in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01
Use of ammonia in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.07	0.01
Transfer of ammonia (charging/discharging) from/to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Transfer of ammonia into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Roller application or brushing	PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	27.43	0.14
		1-4 hrs or >4 hrs	Indoors with LEV	1.37	10.71
Non industrial spraying	PROC 11	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	107	10.71
		1-4 hrs or >4 hrs	Indoors with LEV	2.14	0.21
Treatment of articles by dipping and pouring	PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Use as a laboratory agent	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with LEV	0.03	<0.01
Hand-mixing with intimate contact and PPE only	PROC 19	1-4 hrs or >4 hrs	Indoors with LEV	141.73	14.14
Heat and pressure transfer fluids in dispersive use but closed systems	PROC 20	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	1.71	0.17
		1-4 hrs or >4 hrs	Indoors with LEV	0.14	0.01

Table 3.2 Inhalation exposure concentrations for anhydrous and aqueous ammonia (in preparations of 5-25 % w/w) predicted using the ECETOC TRA model for professional workers

Description of activity	**PROC**	**Exposure assumptions**		**Anhydrous ammonia**		**Aqueous ammonia (5-25% w/w)**	
				Estimated Exposure Concentration mg/m3		**Estimated Exposure Concentration mg/m3**	
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Used in a closed process, no likelihood of exposure	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	0.00
		1-4 hrs or >4 hrs	Indoors without LEV	0.01	NA	0.01	0.00
Use of ammonia in a closed, continuous process with occasional controlled exposure (e.g.	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.53	0.18	4.38	0.22

sampling)		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without LEV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13
Use of ammonia in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Use of ammonia in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without LEV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without LEV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at non-dedicated facilities	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with LEV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without LEV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with LEV	1.91	0.1	2.36	0.12
Transfer of ammonia into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without LEV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with LEV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without LEV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with LEV	8.5	0.43	10.50	0.53
Roller application or brushing	PROC 10	>4hrs	Outdoors	NA	NA	153.13	7.66
		>4hrs	Indoors without LEV	NA	NA	218.75	10.94
		>4hrs	Indoors with LEV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without LEV	NA	NA	131.25	6.56
		>4hrs	Outdoors	NA	NA	13.13	0.66
Non-industrial spraying	PROC 11	>4hrs	Outdoors	NA	NA	613.20	30.66
		>4hrs	Indoors without LEV	NA	NA	876.00	43.80
		>4hrs	Indoors with LEV	NA	NA	175.20	8.76

		1-4 hrs	Outdoors	NA	NA	367.92	18.40
		1-4 hrs	Indoors without LEV	NA	NA	525.60	26.28
		>4hrs	Outdoors	NA	NA	105.12	5.26
Treatment of articles by dipping and pouring	PROC 13	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without LEV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with LEV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without LEV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with LEV	10.63	0.53	13.13	0.66
Use as a laboratory agent	PROC 15	>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without LEV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	2.13	0.11	2.63	0.13
Hand-mixing with intimate contact and PPE only	PROC 19	<4 hrs	Outdoors	NA	NA	153.13	7.66
		<4 hrs	Indoors without LEV	NA	NA	218.75	10.94
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without LEV	NA	NA	131.25	6.56
Heat and pressure transfer fluids in dispersive use but closed systems	PROC 20	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without LEV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with LEV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without LEV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with LEV	4.25	0.21	5.25	0.26

3.3 General public / Consumer exposure

Professional workers are expected to conduct risk assessment to ensure that members of the public are excluded from operational activities and are not inadvertently exposed to ammonia.

3.3.1 Indirect exposure of humans via the environment (oral)

Ammonia is ubiquitous in the environment with <30% of emissions resulting from fertiliser uses and from non-agricultural sources (ref. ‘Ammonia in the UK’ - DEFRA).

In addition, there is no evidence that ammonia bioaccumulates as the log Kow value is 0.23. Since the trigger of BCF >100 (log Kow>3) is not met, the derivation of PNECs to protect against secondary poisoning is not required.

The risk of indirect exposure of humans via the environment is therefore not considered.

3.4 Environmental exposure

The majority of ammonia in the environment originates from natural sources, predominantly decaying organic matter.

Wide dispersive professional uses of ammonia are diverse and widespread. The resulting environmental exposure is not expected to add significantly to already present background levels of ammonia in the environment. An additional assessment for environmental exposure for wide dispersive uses has therefore not been performed.

Exposure Scenario No. 4: Wide-dispersive end-use: Consumer use of aqueous ammonia

4.1 Exposure scenario

Consumers may be exposed to aqueous solutions of ammonia (containing up to 25 % w/w ammonia) when using a variety of products. In this section, exposures have been assessed for the consumer use of representative common products for which default data and scenarios are available (e.g. in the ECETOC TRA model or the ConsExpo 4.1 model and RIVM Factsheets). Although data are not available for other uses (e.g. inks and toners, water treatment chemicals etc.) exposures arising from these uses is not expected to be any worse than for the representative products and is therefore considered to be addressed by this assessment.

Consumers may be exposed to aqueous ammonia when using a variety of common household products including Do-It-Yourself (DIY) products such as coatings, paints, thinners and removers (PC9a) and fillers, putties and plasters (PC 9b), washing and cleaning products (e.g. all-purpose liquid; PC 35), cosmetic, personal care products such as hair dyes (PC 39) and fertilisers (PC12). Aqueous ammonia (at concentrations up to 25 % w/w) is added to water-based paints and other DIY products as a stabiliser. The composition of these products typically contains 0.2 % ammonia solution (at 25 % w/w ammonia) giving a final concentration in the product of 0.05 % w/w ammonia. Cleaning products are typically aqueous solutions containing 5 -10 % ammonia and will be diluted with water prior to use. Cosmetic products such a hair dyes contain ammonia at a maximum concentration of 4 % w/w.

Primary routes of exposure for consumers using common household products containing ammonia are the dermal and inhalation routes. Consumers are not expected to ingest ammonia during the normal use of household products and oral exposures are unlikely.

Consumer exposure to ammonia will depend on a number of factors including the frequency and duration of use. DIY products are likely to be used intermittently during the year, for several consecutive days. Cleaning products are expected to be used more frequently e.g. several times per week. Consumers are likely to use hair dye products several times per year, possibly up to once/ month. The durations of product use per day are likely to vary across the applications.

4.2 Exposure estimation

Consumer exposure to aqueous ammonia associated with the use of common household products (e.g. DIY, cleaning and cosmetic products) was assessed using ConsExpo version 4.1 and default assumptions presented in RIVM Factsheets relevant to the scenario being assessed. Dermal exposures were assessed using either the constant rate, dermal contact with product model or the instant application model, as appropriate. Inhalation exposure concentrations were assed using either the evaporation model or the spraying model as appropriate. To assess possible worst case scenarios, it was assumed that consumers will use DIY product at least once per month. Consumer exposure from the use of cleaning products has been assessed using the default scenario in ConsExpo 4.1 for the application of an all-purpose liquid cleaner: e.g. Household ammonia (10 % w/w ammonia) is diluted 1:80 times with water to give a final concentration of 0.125 % w/w. It is assumed that consumers will use cleaning products daily. In a worst case scenario, consumers are assumed to use hair dye once per month.

Consumer exposure arising from the use of fertilisers (containing up to 25% w/w ammonia) was assessed using the ECETOC TRA model and default parameters for the scenario PC12 fertilisers: lawn and garden preparations. It is assumed that amateur gardeners will apply fertilisers twice per year.

It is reasonable to assume that consumers will not always read product labels or follow advice recommended by the manufacturer. In a worst-case assessment of consumer exposure, no use of gloves or other PPE has been assumed.

Table 4.1 shows the dermal exposures predicted by ConsExpo for consumer uses of common household products containing aqueous ammonia. Dermal exposures are presented as: acute systemic dermal exposures reflecting the total exposure during one event and as chronic systemic exposures reflecting the exposure per event averaged over a year taking into account the use frequency. In a conservative assessment of dermal exposures, it was assumed that 100 % of the dose is absorbed dermally.

Table 4.1 also shows the inhalation exposure concentrations predicted by ConsExpo for consumer uses of common household products containing aqueous ammonia. Inhalation exposure concentrations are presented as acute airborne concentrations of ammonia associated with one event and as chronic exposure concentrations reflecting the concentration per event averaged over a year taking into account the use frequency.

Table 4.1 Dermal exposures to aqueous ammonia and inhalation exposure concentrations predicted by ConsExpo for consumers using common household products (e.g. DIY, cleaning and cosmetic products)

Scenario	Ammonia % w/w	Use frequency	Acute	Chronic	Acute	inhalation Chronic
PC9 Coatings, paints, thinners, removers (0.05% w/w ammonia)						
Applying waterborne paint using brush and roller	0.05	1 event /month	0.03	8.2x 10^{-5}	7	0.0018
Spraying paint from a can (application)	0.05	1 event /month	0.013	6.8x 10^{-5}	0.67	5.1x10^{-5}
Applying general coatings	0.05	1 event /month	0.0021	1.9x10^{-6}	6.7	2.4x10^{-4}
Applying paint remover	0.05	1 event /month	0.0042	1.1x10^{-5}	3.2	3.6x10^{-4}
PC9b Fillers, putties, plasters etc (0.05 % w/w ammonia)						
Applying filler	0.05	1 event /month	4.2x10^{-4}	3.4x10^{-6}	0.37	5.1x10^{-3}
PC35 Washing and cleaning products (0.125 % w/w ammonia)						
Applying all-purpose liquid	0.125	104 times/	0.41	0.12	3.3	0.16

cleaner / detergent		year				
PC39 Cosmetics, personal care products (4% w/w ammonia)						
Applying hair dye	4	1 event / month	67	2.203	NA	NA
PC12 Fertilisers: lawn and garden preparations (25 % w/w ammonia)						
Applying fertilisers	25	2 events/year	35.7		NA	NA

4.3 Environmental exposure

The majority of ammonia in the environment originates from natural sources, predominantly decaying organic matter.

Wide dispersive consumer uses of ammonia are diverse and widespread. The resulting environmental exposure is not expected to add significantly to already present background levels of ammonia in the environment. An additional assessment for environmental exposure for wide dispersive uses has therefore not been performed.