

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING**1.1 Product identifier**

- Trade name: **AMMONIA**
- Chemical name: Ammonia, anhydrous
- Registration number REACH: 01-2119488876-14-0060
- Index number: 007-001-00-5
- CAS number: 7664-41-7
- EC number: 231-635-3

1.2 Relevant identified uses of the substance or mixture and uses advised against**1.2.1 Identified uses**

Intermediate product for the production of chemical substances; component for preparing mixtures; procedural, non-procedural and auxiliary agent (for example, for cooling, reducing nitrogen oxides and sulphur, nitriding metal surfaces, extraction and neutralization agent, etc.).

1.2.2 Non-recommended uses

There are no non-recommended uses stated in the registration. The product may not be used in any way other than that specified in point 1.2.1 or subsection 7.3.

1.3 Details of the supplier of the safety data sheet

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- Person professionally qualified to compile a SDS: e-mail: reach.unirpa@orlenunipetrol.cz

1.4 Emergency telephone number

- ORLEN Unipetrol RPA s.r.o. ☎: +420 476 163 111 (NON STOP)
- Toxicological Information Center (TIS) ☎: +420 224 919 293 (NON STOP)
Na bojišti 1, 120 00 Prague 2, Czech Republic ☎: +420 224 915 402 (NON STOP)
e-mail: tis@vfn.cz
- Transport Information & Accident System (TRINS) ☎: +420 476 163 111 (NON STOP)

Note: Emergency telephone numbers for EU countries are listed in section 16.

SECTION 2: HAZARDS IDENTIFICATION**2.1 Classification of the substance or mixture**

The product is classified as hazardous pursuant to CLP Regulation (EC) No. 1272/2008 CLP:

FLAMMABLE GAS, CATEGORY 2

Flam. Gas 2, H 221

GASES UNDER PRESSURE (LIQUEFIED GAS)

Press. gas (Liquefied gas), H 280

ACUTE TOXICITY, CATEGORY 3

Acute Tox. 3, H 331

AMMONIA

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006 (REACH), as amended

Valid Issue: 2/1/2021 – version 8(4)

Revision: 2/1/2018 – 8(3)th issue
replaces: 1/8/2014 – 8th issue
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SKIN CORROSION / IRRITATION, CATEGORY 1B

Skin Corr. 1B, H 314

HAZARDOUS TO THE AQUATIC ENVIRONMENT, CATEGORY ACUTE 1

Aquatic Acute 1, H 400

HAZARDOUS TO THE AQUATIC ENVIRONMENT, CATEGORY CHRONIC 2





Aquatic Chronic 2, H 411

Additional information about the related health hazards pursuant to Appendix II of Regulation (EC) No. 1272/2008 CLP:

EUH071

Note: The full text of the H-sentence and / or EUH-sentences is stated in Section 16.

2.2 Label elements

Product identifiers		<p>AMMONIA AMMONIA, ANHYDROUS Index number: 007-001-00-5</p>
Warning hazard symbol		   
Signal word		DANGER
H-phrases (standard hazard phrases)	H221 H280 H314 H331 H410	Flammable gas. Contains gas under pressure: may explode if heated. Causes severe skin burns and eye damage. Toxic if inhaled. Very toxic to aquatic life with long lasting effects.
P-statements (precautionary statements)	P210 P260 P273 P280 P303+P361+P353 P304+P340 P305+P351+P338 P377 P403+P233	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Do not breathe gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. IF INHALED: Remove person to fresh air and keep comfortable for breathing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Store it in a well ventilated place. Keep container tightly closed.
Additional information		EUH071: Corrosive to the respiratory tract.
		ORLEN Unipetrol RPA s.r.o. Záluží 1, 436 70 Litvínov, Czech Republic ☎: +420 476 161 111, +420 476 163 111

2.3 Other hazards

Staying in an environment with a high concentration of the gas leads to respiratory arrest that can be temporary but can also result in sudden death. Inhaling the gas can result in swelling of larynx or lungs (sometimes delayed) may cause suffocation. Contact with the liquefied product can cause not only chemical burns but also frost bites, which can heal very badly and which are especially dangers for your eyes since you can become blind. The product forms explosive mixtures with the air. Leaks of the product can pollute the environment even far away from the leak source. The product dissolves in water and can thus create caustic mixtures. Product assessments for PBT / vPvB criteria see Subsection 12.5 ("Results of PBT and vPvB assessment").

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS**3.1 Substances**

Name of the substance:	AMMONIA, ANHYDROUS	
Concentration [% hm.] :	min. 99.8	
Index number (index):	007-001-00-5	
CAS number:	7664-41-7	
EC number:	231-635-3	
IMPURITIES	NAME:	IDENTIFIER :
The product does not contain any impurities, stabilizing additives or other components, which would have an impact on its classification.		

3.2 Mixtures

Not applicable, the product is a substance.

SECTION 4: FIRST AID MEASURES**4.1 Description of first aid measures****4.1.1 General instructions**

When providing first aid pay attention to self-protection.

Call emergency medical services (☎155 ČR, ☎120 EU) and follow their instructions until their arrival. Secure the vital body functions. If the affected person is not breathing normally even after the head has been tilted back (just so that the head is back into the normal, resting position and no longer tucked down on to the chest) perform resuscitation by compressing the chest to a depth of about 5 cm at a frequency of 100-120 per minute. If you are trained in artificial respiration do 2 insufflations (known as rescue breaths) after every 30 chest compressions. Do not stop the heart massage until the rescue service arrives.

If the person is in unconscious or if he/she has spasms, do not put anything in his/her mouth, just put him/her into a stabilised position.

4.1.2 When inhaled

Move the affected person to fresh air, rinse his/her mouth and nose, do not let him/her get cold and secure professional medical help.

4.1.3 Skin contact

Immediately rinse the affected areas using sufficient volume of water and remove the contaminated clothes and footwear. Wash the skin thoroughly but without any great mechanical irritation with a large volume of lukewarm water until medical assistance arrives, if possible, however, at least 20 minutes. In the case of frostbites, do not remove the frozen clothes and do not rub the affected areas, only rinse them. Cover the burned or frostbitten areas with sterile dressing or clean cloth. Secure professional medical assistance.

4.1.4 Contact with eyes

Immediately start rinsing the eyes with widely open eyelids using running lukewarm water. Holding the eyelids forcefully open, continue rinsing them in the direction from the inside to the outside corner of the eyes until a doctor arrives. If the affected person wears contact lenses, remove them prior to rinsing. In the case of a contact with the liquefied gas, secure professional medical assistance immediately because the eyes can be seriously damaged by the possible frostbite.

4.1.5 When ingested

Ingestion does not represent a probable way of an exposure. However, in the case of a contact with the liquefied gas, your mouth and lips can get frostbites. In this case, rinse your mouth using lukewarm water and immediately secure professional medical assistance.

4.2 Most important symptoms and effects, both acute and delayed

Inhalation of the gas causes a burning feeling and pain of the burned mucous membranes, persistent and irritant cough and shortness of breath. Even with a long delay, lung edema may occur. In the case of frostbites, the affected areas are pale, cold and insensitive. Later on, they can become red and swollen and the affected person can feel tingling, burning and pain. Frostbites are often related to burns because the product is a strong caustic substance.

4.3 Indication of any immediate medical attention and special treatment needed

Immediate medical assistance is necessary if the product is inhaled, skin burned or if the product gets into your eyes.

The worksite must be equipped with a safety shower and a device for rinsing eyes.

SECTION 5: FIREFIGHTING MEASURES**5.1 Extinguishing media**

Suitable extinguishing media: heavy foam, water spray or water fog.

Unsuitable extinguishing media: direct water stream.

Extinguishing small fires: powder or snow (CO₂) fire extinguishers, dry sand or fire extinguishing foam.

5.2 Special hazards arising from the substance or mixture

Do not extinguish fire until the leak source is removed. If this is not possible, let the fire burn out and use water only for cooling containers around the fire. Keep cooling them even after the fire is extinguished for a sufficient period of time. Closed containers with the substance can explode from heat. When on fire, nitrogen oxides can be created and, if the temperature exceeds 450°C, highly flammable hydrogen is formed.

5.3 Advice for firefighters

Limit the amount of the extinguishing liquid that gets into the sewerage system, surface and underground water and in the soil as much as possible. Water contaminated with the gas forms a toxic and caustic product. Cool down the substance reservoirs with water spray. Otherwise, they could explode as a result of the heat. Coagulate the released vapors using a water screen.

When water comes into contact with the cooled liquefied gas, it can result in substantial foaming and fast forming of vapors.

Protective aids for the firefighters: complete protective clothing, protecting against fire and the impacts of the chemical substance, and an insulation breathing apparatus.

SECTION 6: ACCIDENTAL RELEASE MEASURES**6.1 Personal precautions, protective equipment and emergency procedures**

Seal the accident location and prevent access to the endangered area. Stay on the windward side. Product leaks represent a fire hazard and that is why you need to remove all possible ignition sources. Do not smoke and do not handle open fire. If possible, stop the leak source, secure sufficient ventilation of enclosed areas and monitor the gas concentration. Avoid contact with the substance and its vapors. When liquidating leaks, use chemical-protective clothes and an insulation breathing apparatus. When liquidating consequences of extraordinary events/accident, use all recommended protective aids (see Subsection 8.2). In areas where the gas concentration is not known or where it exceeds the exposure limits, use an insulation breathing apparatus. Adopt measures that will prevent spreading of the gas to given adjoining buildings (for example, seal windows and doors, turn of exterior air intakes). In the case of a large accident, evacuate people from the entire endangered area. To protect people from inhaling the substance, use protective masks with filters that are efficient against ammonia or, at least, wet towels or rags, put over people's faces.

6.2 Environmental precautions

Prevent any further leaks of the substance and fence off the location of the leak. Reduce the spread of the ammonia vapors to the surroundings by creating a water screen. Make sure that mixing water and the liquefied product will accelerate the forming of the fog/vapors.

For this reason, use water with liquefied ammonia only if you can secure that the ratio between water and ammonia is 100 to 1. Prevent penetration of the liquefied gas and contaminated water into the sewerage system and surface and underground water by covering the sewerage system inlets.

6.3 Methods and material for containment and cleaning up

When the liquefied gas leaks, it evaporates quickly, which is a process that cannot be stopped. You thus need to form a water screen, which will coagulate the escaping vapors. Safely extract the substance mixed with water, put in marked and enclosed containers and transport it for liquidation. Liquidate the mixture in accordance with the valid legal regulation applicable to waste (see Section 13). Intensify ventilation at the leak location, especially if it is an enclosed area, and monitor the gas concentration in the air. Upon liquidating the leak, wash the contaminated area with water.

6.4 Reference to other

For recommended personal protective aids – see Subsection 8.2 (“Exposure controls”).

For recommended manner of removing waste – see Section 13 (“Disposal considerations”).

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling

Handle the substance as well as empty containers (there can be product residues in them) in well ventilated areas and comply with all fire protection measures (no smoking, no open flame, removal of all possible ignition sources). Do not conduct activities such as welding, cutting, sending, etc. in the proximity of the product packages (even empty ones). Eliminate any static electrical discharges. Use the product only with such technological devices, which have been made of suitable structural materials, designed for the appropriate pressure and furnished with a protection mechanism, which prevents a reverse flow. Prior to using the product, make sure that the entire gas system has been inspected with regard to possible leaks. Use the recommended personal protective aids and observe all instructions issued with the objective to eliminate any possible contact with the skin and eyes and inhalation of the product. **Always enter all production areas and, if applicable, other areas where there is a risk of the presence of ammonia only with a protective mask in a ready-to-use position.**

Secured all pressurized bottles, filled with the product, against falling or tipping. Only when you do that, you can take off the protective valve covers. Open the valve slowly and carefully, making sure it does not get damaged. Inform the given supplier about any defects and never attempt to repair the valves yourself. Close the valve after each use. Keep the valve clean and especially prevent possible contamination with water or oil. General hygienic measures: Comply with the personal hygiene rules. Take off contaminated clothes immediately. While working, do not eat, drink or smoke! After work and prior to eating or drinking, thoroughly wash your hands and uncovered parts of your body with soap and water and, if possible, apply a regeneration cream. Do not bring polluted clothes, footwear and protective aids to eating areas.

7.2 Conditions for safe storage, including any incompatibilities

Storage areas shall comply with the requirements for the building fire safety and electrical devices shall comply with the given valid regulations. Store the product at a cool, well ventilated location with an efficient exhaust system, out of the reach of heat and all ignition sources. Keep the product away from direct sunlight. Stored packages shall be enclosed and duly marked and grounded. Do not store the product in the proximity of incompatible materials, such as oxidation agents (oxygen, air, etc.), or other flammable materials. The storage temperature shall not drop under -30°C or exceed 50°C. Pressurized bottles must be firmly enclosed, stored vertically and secured against falling.

7.3 Specific end use(s)

The substance and / or its aqueous solutions are intended for industrial use as an intermediate (Exposure scenario 3), as processing aid, non-processing aid and auxiliary agent in industrial (Exposure scenario 4) or professional sector (Exposure scenario 5). Aqueous solutions may be used by the consumer as part of cleaning, hygienic or cosmetic preparations and the like (Exposure scenario 6). All of these exposure scenarios are part of the annex to this Safety Data Sheet.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

8.1.1 Occupational exposure limit values

The following Permissible Exposure Limits (PELs) and Maximum Allowable Concentrations (NPK-P) of Chemicals in the Atmosphere of Workplaces within the Czech Republic are set by the Government Regulation No. 361/2007 Coll., determining conditions of occupational health protection, as amended:

Name	CAS number	PEL [mg.m ⁻³]	NPK-P [mg.m ⁻³]	Note
Ammonia	7664-41-7	14	36	

Note 1: An explanation of the meaning of the PEL and NPK-P abbreviations is in section 16.

Note 2: Occupational exposure limit values for EU countries are listed in section 16.

8.1.2 DNEL/DMEL values

EXPOSURE OF WORKERS / EMPLOYEES				EXPOSURE OF THE GENERAL POPULATION / CONSUMERS			
EXPOSURE	IMPACTS	POINT OF ENTRY	DNEL	EXPOSURE	IMPACTS	POINT OF ENTRY	DNEL
acute	system	skin	68 mg/kg.bw/d	acute	system	skin	68 mg/kg.bw/d
acute	system	inhaling	47.6 mg.m ⁻³	acute	system	inhaling	23.8 mg.m ⁻³
/	/	/	/	acute	system	mouth	6.8 mg/kg.bw/d
acute	local	skin	not specified	acute	local	skin	not specified
acute	local	inhaling	36 mg.m ⁻³	acute	local	inhaling	7.2 mg.m ⁻³
long-term	system	skin	68 mg/kg.bw/d	long-term	system	skin	68 mg/kg.bw/d
long-term	system	inhaling	47.6 mg.m ⁻³	long-term	system	inhaling	23.8 mg.m ⁻³
/	/	/	/	long-term	system	mouth	6.8 mg/kg.bw/d
long-term	local	skin	not specified	long-term	local	skin	not specified
long-term	local	inhaling	14 mg.m ⁻³	long-term	local	inhaling	2.8 mg.m ⁻³

Note 1: There isn't insufficient information to determine the dermal, inhalation (or oral) DNEL / DMEL value for acute systemic and local effects and long-term local effects. The risk characterization focused on the possibility of causing serious long-term systemic effects.

Note 2: An explanation of the meaning of the DNEL/DMEL abbreviations is in section 16.

8.1.3 PNEC values

ENVIRONMENTAL COMPONENT	PNEC	NOTE
Fresh water	0.0011 mg.l ⁻¹	
Sea water	0.0011 mg.l ⁻¹	
Water – discontinuous release	0.0890 mg.l ⁻¹	
Sediment	not specified	Ammonia does not accumulate in sediments.
Soil	not specified	Due to bacteria, ammonia in the soil quickly transforms to other forms; it forms an integral part of nitrogen metabolism and no exposure of the soil organisms is thus expected.
Water treatment plant	not specified	Ammonia is used as a source of nitrogen for the bacteria.
Food chain	not specified	The n-octanol/water distribution coefficient (log Kow) for ammonia is smaller than 3 and no bio-accumulation of the product is thus expected.

Note: An explanation of the meaning of the PNEC abbreviation is in section 16.

8.1.4 Recommended monitoring of concentrations in the workplace

Spectrophotometry in accordance with the ČSN EN 689 and ČSN EN 482 technical standards.

8.2 Exposure control

8.2.1 Technical protective measures for limiting the exposure of people and the environment

Exposure control of unwanted exposure of humans and the environment shall be secured by keeping the substance under strict control using technical aids and procedural and control technologies, which reduce emissions and consequent exposure, with the objective to prevent releases of the substance vapors in the air, penetration of the substance to water and soil and possible exposure of people. Areas, where the substance is handled and stored, shall be furnished with impermeable floors and catchment basins for the cases of emergency leaks of the substance. It is necessary to secure general and local ventilation and an efficient exhaust system.

8.2.2 Individual protective measures

If there is an increased risk of exposure when handling the product, or shall the exposure increase as a result of, for example, an accident or extraordinary events, employees have to have personal protective aids (PPA) for the protection of their air passages, eyes, hands and skin available to them. These aids shall correspond to the character of the conducted activities. They shall be also equipped with a suitable protection of air passages whenever it is not possible to secure, by technical means, compliance with the exposure limits specified for the work environment or when it is not possible to guarantee that the health of people is protected as a result of exposure via air passages. Shall these aids be used permanently during uninterrupted work activities, safety breaks shall be included if the character of the used PPA requires it. All PPA shall be constantly maintained in usable conditions and damaged or polluted aids shall be immediately replaced. **Always enter all production areas and, if applicable, other areas where there is a risk of the presence of ammonia only with a protective mask in a ready-to-use position.**

RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT (PPE):

(the specific type of protective equipment must be chosen according to the type of activity being carried out and the quantity and concentration of the dangerous substance / mixture at the workplace)

- *Respiratory protection:* Protective mask compliant with EN 140 with a filter that is suitable against ammonia, insulation breathing apparatus (use the mask in case of insufficient ventilation and / or local exhaustion and product leakage);
- *Eye/face protection:* Protective chemical goggles compliant with EN 166 or, in the case of an increased risk of burning, protective face shield;
- *Hand protection:* Protective gloves against cold and possible frostbites;
The following materials protect against chemical effects of the substance:

	<i>Glove material</i>	<i>Material thickness</i>	<i>Penetration time</i>
Regular work activities (staining risk)	nitrile	0.4 mm	10 minutes
Leak / accident liquidation	butyl	0.7 mm	480 minutes

- *Protection of other body parts:* Antistatic, inflammable protective clothes, protective footwear with antistatic modification, full anti-chemical clothes in the case of a leak;
- *Thermal risk:* Not relevant for the given manner of the use;
- *Other measures:* Workplaces shall be equipped with a safety shower and a device for rinsing eyes.

8.2.3 Environmental exposure controls

Avoid product leakage to the environment with all available means. See section 6.2.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

The information is taken from the registration dossier (CSR) unless otherwise stated.

CHARACTERISTIC	UNIT	VALUE	SOURCE	NOTE
Physical state		Gas	CSR	at 20°C
Colour		Colorless	CSR	
Odour		Very strong, pungent and irritant	CSR	
Odour threshold	[mg.m ⁻³]	0.0266	HSDB	CSR does not specify
pH value		11.6	HSDB	CSR does not specify 1 N aqueous solution
Melting point/freezing point	[°C]	-77.7	CSR	
Initial boiling point / boiling range	[°C]	-33.3	CSR	
Flash point		Irrelevant		CSR-DW/su
Evaporation rate		Irrelevant		CSR does not specify
Flammability (solid, gas)		Irrelevant	CSR	
Upper flammability / explosive limits	[% obj]	25	CSR	
Lower flammability / explosive limits	[% obj]	16	CSR	
Vapour pressure	[kPa]	614.9-1170	CSR	at 10-30°C
Vapour density	[kg.m ⁻³]	0.7	CSR	by calculation
Relative density		Irrelevant		CSR-DW/su
Solubility in water	[g.l ⁻¹]	482-531	CSR	at 20-25°C
Partition coefficient: n-octanol/water	[log Kow]	0.23	CSR	at 20°C
Auto-ignition temperature	[°C]	651	CSR	
Decomposition temperature		Does not decompose at normal usage temperatures		CSR does not specify
Dynamic viscosity	[cP]	0.255-0.475	CSR	at -33.5 to -50°C
Explosive properties		Substance is not explosive		CSR - DW
Oxidising properties		None		CSR - DW

9.2 Other information

Not required.

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity

No risk is imminent provided the handling and storage conditions described in Section 7 are complied with. If the temperature exceeds 450°C, highly flammable hydrogen is formed.

The decomposition temperature can even decrease if substances that work as catalysts are present (for example, if nickel is present, the temperature can decrease to 300°C). If there is a spark or if the temperature reaches 690 °C, ammonia decomposes to hydrogen and nitrogen, resulting in highly explosive mixtures with the air.

10.2 Chemical stability

If the handling and storage conditions described in Section 7 are complied with, the product is chemically stable.

10.3 Possibility of hazardous reactions

Hazardous reactions occur in contact with oxidation agents. Hazardous and explosive reactions also occur in contact with other substances (for example, alkaline metals, copper, silver, cadmium, zinc and its alloys, mercury, tin, alcohols, aldehydes, azides, halogens, etc.). Strong neutralization reactions occur in contact with acids. The substance and water form caustic alkalis.

10.4 Conditions to avoid

Ignition sources (including static electricity), high temperature, sunlight, water, atmospheric humidity.

10.5 Incompatible materials

Oxidation agents and several other substances – see Subsection 10.3.

10.6 Hazardous decomposition products

Thermal decomposition at high temperatures, for example, during fires, can create nitrogen oxides, highly flammable hydrogen and nitrogen.

SECTION 11: TOXIKOLOGICAL INFORMATION**11.1 Information on toxicological effects****11.1.1 Toxicological effects of the substance / mixture**

HAZARD CLASS	DATA FROM REGISTRATION DOCUMENTATION		EVALUATION
	DESCRIPTION	RESULT	
Acute toxicity	Oral, dermal: Inhalation:	For corrosive products irrelevant LC ₅₀ (1h) (rat)= 9850 mg/m ³	Meets the classification criteria
Skin corrosion/irritation	12% aqueous solution (rat) 10% aqueous solution (rat)	Conclusion: it has corrosive effects Conclusion: it has not corrosive effects	Meets the classification criteria
Serious eye damage/irritation	Not tested - DW/su	Included in corrosion	See skin corrosion
Sensitisation	Not tested - DW/su	Conclusion: non-sensitizing	Does not meet the classification criteria
Germ cell mutagenicity	OECD 471 OECD 474	No adverse effects were found	Does not meet the classification criteria
Carcinogenicity	OECD 453	No adverse effects were found	Does not meet the classification criteria
Reproductive toxicity	OECD 422 OECD 414	No adverse effects were found	Does not meet the classification criteria
STOT-single exposure		There is no information currently available, which would demonstrate that the substance has the given characteristic	Does not meet the classification criteria
STOT-repeated exposure		There is no information currently available, which would demonstrate that the substance has the given characteristic	Does not meet the classification criteria

AMMONIA

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006 (REACH), as amended

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HAZARD CLASS	DATA FROM REGISTRATION DOCUMENTATION		EVALUATION
	DESCRIPTION	RESULT	
Aspiration hazard		The product does not form hydrocarbons with a kinematic viscosity $\leq 20.5 \text{ mm}^2 \cdot \text{s}^{-1}$ at 40°C	Does not meet the classification criteria

11.1.2 Information on likely routes of exposure

An important exposure route is inhaling.

11.1.3 Delayed and immediate effects as well as chronic effects from short and long-term exposure

Inhalation of the gas causes a burning feeling and pain of the burned mucous membrane, persistent and irritant cough and shortness of breath. Inhaling the gas can result in swelling of larynx or lungs (sometimes delayed) may cause suffocation. Staying in an environment with a high concentration of the gas leads to respiratory arrest that can be temporary but can also result in sudden death. Burning of the eyes can damage your cornea. It can even lead to blindness.

In the case of frostbites, the affected areas are pale, cold and insensitive. Later on, they can become red and swollen and the affected person can feel tingling, burning and pain. Frostbites are often related to burns because the product is a strong caustic substance.

11.1.4 Interactive effects

If the substance is used pursuant to the specified usage manner, no interactions occur.

11.1.5 Toxicokinetics

Gaseous ammonia is quickly absorbed by lungs. It is metabolized into urea and excreted in urine.

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity

Water environment	Fish	LC ₅₀ (96 h, fish) = 0.75-3.4 mg/l	<i>Pimephales promelas</i>
	Invertebrates	EC ₅₀ (48 h, invertebrates) = 101 mg/l	<i>Daphnia magna</i>
	Algae	ErC ₅₀ (18 d, algae) = 2700 mg/l	<i>Chlorella vulgaris</i>
Microbiological activity (STP)	Activated sludge	The test does not have to be conducted because ammonia is used as a source of nitrogen by present microorganisms and, at the same time, it is also produced by bacteria from other compounds that contain nitrogen	

Note: An explanation of the meaning of the LC₅₀, EC₅₀ a ErC₅₀ abbreviations is in section 16.

12.2 Persistence and degradability

Biologic degradability: ammonia is easily biologically degradable.

Abiotic degradability:

- Hydrolysis as a pH function: the product is not subject to hydrolysis (in an aqueous solution, ammonia and ammonium ion are balanced);
- Photolysis: photolysis and reactions with radicals occurred as a result of the photolysis in the troposphere represent the main way of removing atmospheric ammonia.

12.3 Bioaccumulative potential

Ammonia is a product with regular metabolism. Since the n-octanol/water (log Kow) distribution coefficient is smaller than 3, bioaccumulation of the product is not expected.

12.4 Mobility in soil

Bacteria quickly transform ammonia applied directly to the soil to other forms, which are used by plants and return to the atmosphere as a result of the denitrification process. That is why exposure of the soil microorganisms is not expected. Ammonia does not accumulate in sediments.

12.5 Results of PBT and vPvB assessment

The obligation to assess persistence, bioaccumulation, toxicity, high persistence and high bioaccumulation pursuant to Appendix XIII of Directive (EC) No. 1907/2006 REACH does not apply to inorganic substances.

12.6 Other adverse effects

Pursuant to Appendix 1 of the Water Act No. 254/2001 Coll., the product is considered a hazardous and harmful substance.

SECTION 13: DISPOSAL CONSIDERATIONS**13.1 Waste treatment methods**

If the remainder of the product is to be disposed (eg unused or leaked product), the valid European Union and national legislature as well as locally valid regulations have to be complied with. Deliver the waste for disposal to a professionally qualified person with the appropriate authorization.

Recommended waste classification pursuant to Regulation No. 8/2021 Coll. on Waste Catalogue:

13.1.1 Catalogue number

Gases, which are not delivered in pressurized bottles, cannot be put in waste and assigned a number in accordance with the catalogue.

Catalogue number for the product delivered in a pressurized bottle, which becomes waste:

16 05 04* Gases in pressurized bottles (including halons) containing hazardous substances.

Catalogue number for the product mixed with water (ammonia water):

06 02 03* Ammonium hydroxide.

13.1.2 Recommended waste removal method

Return the gas in pressurized bottles to the supplier.

In other cases, burn the gas using a suitable burner with a protection against flames.

Treat the product mixed with water (ammonia water) in a waste water treatment plant with a biological level.

13.1.3 Recommended method for removing polluted packages

Return empty pressurized bottles to the supplier, provided the bottles belong to the supplier.

This point is irrelevant in other cases since the product is transported by railway and road tankers and is thus not packaged.

13.1.4 Measures for limiting exposure when handling waste

Never release the product into an environment where it could create explosive mixtures with the air. Do not flush cooled down, liquefied product leaked during an accident or extraordinary event to a sewerage system. Proceed in compliance with the instructions stated in Section 6 (“Accidental release measures”) and Subsection 8.2 (“Exposure control”) and observe all valid legal regulations related to the protection of people, the air and water.

NOTE: This information is recommendation only. The stated information applies to the delivered, still unused material. Should an already used material become waste, it is up to the waste originator to assign a code to it pursuant to the given field and usage process and to determine its liquidation method.

SECTION 14: TRANSPORT INFORMATION

The listed information applies to road transport (ADR) and rail (RID) transport of dangerous goods:

14.1 UN number: 1005

14.2 UN proper shipping name: AMMONIA, ANHYDROUS

14.3 Transport hazard class(es): 2

14.4 Packing group: not specified

14.5 Environmental hazards:

based on the criteria of the UN sample regulations, the product is harmful to the environment

14.6 Special precautions for user:

none

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code: the product is not designated for bulk transport pursuant to the International Maritime Organization (IMO) documents

14.8 Other information

Hazard identification number:

268

Classification code:

2TC

Labels:

2.3 + 8 + symbol for environmental hazard (symbol: fish and tree) + (13)*



Note: * label for a shift "SHIFT CAREFULLY" (valid only for RID)

SECTION 15: REGULATORY INFORMATION

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

15.1.1 European Union

Regulation of the European Parliament and Council (EC) No. 1907/2006 (REACH), as amended
REGISTRATION (TITLE II OF THE REACH REGULATION)

the product has been fully registered as a substance

AUTORISATION (TITLE VII OF THE REACH REGULATION)

the product is not on the list stated in Annex XIV of Regulation (EC) No. 1907/2006 REACH, and is therefore not subject to the approval obligation

RESTRICTION (TITLE VIII OF THE REACH REGULATION)

the product shall not be used in aerosol dispensers for amusement and decorative purposes intended for sale to the public

Regulation of the European Parliament and Council (EC) No. 1272/2008 (CLP), as amended

the product has been classified in compliance with the stated regulation, when delivered in pressurized bottles, the package shall be marked in compliance with this regulation

Regulation of the European Parliament and Council (EC) No. 649/2012 on the export and import of dangerous chemicals, as amended

the product is not subject to special import or export restrictions

15.1.2 Czech Republic

Act No. 350/2011 Coll. on Chemical Substances and Chemical Mixtures, as amended

the product is not subject to the obligation of notification to the information system CHLAP („Chemical Substances and Preparations“) /PCN

Act No. 258/2000 Coll. on the Protection of Public Health, as amended

Act No. 254/2001 Coll., on Water, as amended

Act No. 201/2012 Coll., on Air Protection, as amended

Act No. 541/2020 Coll., on Waste, as amended

Decree of Ministry of Environment no. 8/2021 Coll. laying down Waste Catalogue, as amended

Governmental decree no. 361/2007 Coll., laying down occupational health and safety conditions

product has exposure limit; the product is not subject to the obligation to establish a controlled zone

Act no. 224/2015 Coll., on prevention of serious accidents caused by selected dangerous chemical substances or mixtures

15.2 Chemical safety assessment

The appropriate chemical safety assessment was conducted when the substance was registered. The substance fulfills the criteria for being classified as a hazardous substance pursuant to Directive (EC) No. 1272/2008 CLP. Exposure assessment and the consequent risk characterization procedure were executed.

SECTION 16: OTHER INFORMATION

Changes adopted as a part of the revision process

- 12/01/2006: Revision (2): Editing information in the sections 1, 2, 4, 8, 12.5, 13, 15.2 and 16
- 03/01/2007: Revision (3): Editing information in the sections 1 and 16
- 06/01/2007: Revision (4): Complete revision of the document in relation to the Regulation (EC) No 1907/2006 of the European Parliament and of the Council
- 12/01/2009: Revision (5): Editing information in the sections 1, 2.1, 8.1, 15, 16 and the „Declaration“
- 12/01/2010: Revision (6): Editing information in the sections 1 (registration number), 2 (classification and labeling according to CLP), 14 and 16
- 08/01/2011: Revision (7): Complete revision of the document in relation to the updating of Annex II of Regulation (EC) No 1907/2006 REACH in accordance with Annex I of Commission Regulation (EU) No 453/2010
- 01/01/2012 / 7(1): Section 15.1.2 – updating legislation
- 01/06/2012 / 7(2): Section 1.1 - identifiers, Section 1.3 – update contact and Section 16 – abbreviations
- 08/01/2014: Revision (8): Editing information in the sections 2.1, 2.2, 15.1 a 16
- 05/31/2015 / 8(1): Section 1 (contact information), Section 2, Section 15.1 (update of legal regulations) and 16 (text deletion)
- 01/11/2016 / 8(2): Section 1 (contact information), Section 14 and 15 (editing in accordance with Regulation (EC) no. 830/2015), Section 15 (legislation update)
- 02/01/2018 / 8(3): Unification of SDS format after the Čer merger into UNIPETROL RPA, including the editing of data in sections 1, 8, 9, 11, 12, 13 15 and 16
01. 02. 2021 / 8(4): the change of company's business name; updating the new regulations in Section 13 and Section 15;

Acronyms and abbreviations used in the text

ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
CAS	Registration number assigned to the substance by the Chemical Abstracts Service of the American Chemical Society
CLP	EU Directive No. 1272/2008 on Classification, Labeling and Packaging of chemical substances and mixtures, which is implemented into the European legislature by the means of GHS (United Nations' Globally harmonized System) for classifying and labeling chemical substances
CMR	Carcinogenic, mutagenic or toxic for reproduction
ČSN EN (ISO)	European standard incorporated into the Czech technical standards
CSR	Chemical Safety Report
DMEL	Derived minimal effect level - an exposure level that corresponds to a low and possibly theoretical risk, which should be considered as an acceptable risk (for thresholdless effects, i.e. there is no exposure level without effect))
DNEL	Derived no-effect level - level of exposure derived from toxicological data that does not produce any adverse effects on human health
DW	Data waiving
EC ₅₀	Effective concentration EC ₅₀ is the concentration of substance that causes immobilization of 50% of individuals
ErC ₅₀	Effective concentration EC ₅₀ is the concentration of substance that causes 50 % decrease of Algae growth
ECHA	European Chemicals Agency
ES	Official number of the chemical substance in the European Union: EINECS from the European Inventory of Existing Commercial Substances, or ELINCS from the European List of Notified Chemical Substances, or NLP from the No Longer Polymer list
HSDB	Hazardous Substances Data Bank

IATA	International Air Transport Association
IBC	Intermediate Bulk Container
IC ₅₀	Inhibition concentration IC ₅₀ that causes inhibition of 50% of individuals
ICAO	International Civil Aviation Organization
ICE	"Intervention in Chemical Transport Emergencies" system providing both professional and practical assistance in dealing with emergency situations related to the transport and storage of hazardous chemicals
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
ISO	International Organization for Standardization
LC ₅₀ /LD ₅₀	Lethal concentration/level is the concentration/level of substance that causes mortality of 50 % individuals
LOEC/LOEL	Lowest Observed Effect Concentration/Level
log K _{ow}	Logarithm of distribution coefficient n-octanol/water
MARPOL	International convention on preventing boat pollution, as amended by the 1978 protocol
nf	Not feasible
NOAEC/NOAEL	No Observed Adverse Effect Concentration/No Observed Adverse Effect Level
NOEC/NOEL	No Observed Effect Concentration/No Observed Effect Level
NPK-P	The highest permitted concentration of the chemical substance in the air (the concentration of the substance that a worker may be exposed to for a maximum of 15 minutes but which must never be exceeded)
OECD	Organization for Economic Co-operation and Development
OOP	Recommended personal protective aids
OSN	United Nations
(Q)SAR	Quantitative Structure-Activity Relationship
PBT, vPvB	Persistent, bioaccumulative and toxic; high persistent and high bioaccumulative
PEL	Permitted exposure limit of the chemical substance in the air (the exposure value that an employee may be exposed to during the entire working shift (8 hours), without endangering his health during lifetime occupational exposure)
PNEC	Predicted No Effect Concentration
REACH	EU Directive No. 1907/2006 on Registration, Evaluation and Authorization of Chemicals
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
SDS	Safety Data Sheet
STOT	Specific Target Organ Toxicity
STP	Sewage treatment plant
su	Scientifically Unjustified
TRINS	Transport Information and Accident System of the Czech Republic, providing professional and practical assistance in dealing with emergency situations related to transport and storage of hazardous chemical substances, included in ICE
UACRON	Chemical database (The University of Akron).
UN číslo	The four-digit identification number of the substance or object identifying hazardous material in international transport
UVCB	Substances of Unknown or Variable composition, Complex reaction products or Biological materials

Data sources used for preparing the material safety sheet

Annexes I, IV, VI and VII to Regulation (EC) No. 1272/2008 CLP, as amended

Principles for providing first aid upon being exposed to chemical substances (doc. MUDr. Daniela Pelclová and collective)

Substance registration documentation pursuant to Regulation (EC) No. 1907/2006 REACH

Decision of the European Chemicals Agency (ECHA) No. SUB-D-2114168289-36-01/F on registration pursuant to Directive (EC) No. 1907/2006 REACH

Research data sources (Hazardous Substances Data Bank HSDB, University of Akron Chemical UAKRON, Gestis Hygienic Limits)

Full text of H-/ EUH-sentences and abbreviations of hazard classes stated in Section 2 and/or 3

H 221	Flammable gas.
H 280	Contains gas under pressure; may explode if heated.
H 314	Causes severe skin burns and eye damage.
H 315	Causes skin irritation.
H 331	Toxic if inhaled.
H 335	May cause respiratory irritation.
H 400	Very toxic to aquatic life.
H 410	Very toxic to aquatic life with long lasting effects.
H 411	Toxic to aquatic life with long lasting effects.
H 412	Harmful to aquatic life with long lasting effects.
EUH 071	Corrosive to the respiratory tract.
Acute Tox.	Acute toxicity
Aquatic Acute	Hazardous to the aquatic environment, category Acute toxicity
Aquatic Chronic	Hazardous to the aquatic environment, category Chronic toxicity
Flam. Gas	Flammable gas
Press Gas	Gases under pressure
Skin Irrit.	Skin irritation
Skin Corr.	Skin corrosion
STOT SE	Specific target organ toxicity — single exposure

Specific concentration limits specified for ammonia

The concentration limits are used for calculating classifications of mixtures that consist of multiple substances. Specific concentration limits are concentration limits and corresponding classifications, which were determined for a particular substance and which replace the generally valid concentration limits. The following specific concentration limits were determined for ammonia as a part of the registration process:

- $c \geq 25.0\%$ Skin Corr. 1B; H 314
STOT SE 3; H 335
Aquatic Acute 1; H 400
Aquatic Chronic 2; H 411
- $5.0 \leq c < 25.0\%$ Skin Corr. 1B; H 314
STOT SE 3; H 335
Aquatic Chronic 3; H 412
- $2.5 \leq c < 5.0\%$ Skin Irrit. 2; H 315
Aquatic Chronic 3; H 412
- $1.0 \leq c < 2.5\%$ Skin Irrit. 2; H 315

Multiplication factor (M-factor) specified for ammonia

M-factor is a multiplication coefficient, which is used for calculating classifications of mixtures that include a substance, which is highly toxic for water environments (i.e. acutely or chronically dangerous for water environments, category 1). For ammonia, M-factor = 1 was determined during the registration process.

Training instructions

Persons handling the product must be advised of the risks involved in handling the product and the health and environmental protection requirements (see applicable provisions of the Labor Code).

Access to information

Pursuant to Article 35 of Directive (EC) No. 1907/2006 REACH, every employer is obliged to allow access to the information stated on the given material safety sheet to all workers who use this product or are exposed to its impacts while working, and also to representatives of these workers.

AMMONIA

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006 (REACH), as amended

Valid Issue: 2/1/2021 – version 8(4)

Revision: 2/1/2018 – 8(3)th issue
replaces: 1/8/2014 – 8th issue
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Occupational exposure limit values for EU countries (see point 8.1.1) data for ammonia anhydrous (number CAS 7664-41-7)

	8-hour limit [mg.m ⁻³]	Short-term limit [mg.m ⁻³]
European Union (Regulation No. 2000/39/EC as amended)	14	36
Italy	14	36
Hungary	14	36
Germany	14	28
Poland	14	28
Austria	14	36
Slovakia	14	36
Slovenia	14	-

8-hour limit: Measured or calculated in relation to the 8-hour reference period as a timely weighted average
Short-term limit: Exposure limit value, which shall not be exceeded and which corresponds to a 15-minute period

Emergency telephone number for EU countries (see subsection 1.4)

National Centers (NON STOP)		TOXICOLOGY (first aid information)	ICE (information from SDS)	
Belgium		☎+32/70245245	Belintra	☎+32/35699232
Bulgaria		☎+359/29154378		
Croatia		☎+385/12348342		
Czech Republic		☎+420/224-919293; 915402	TRINS	☎+420/47 6163111; 6163267
Denmark		☎+45/82121212	PIBF/RVK	☎+45/45906000
Estonia		☎+372/6269379		
Finland		☎+358/9471977		
France		☎+33/(0)140054848	Transaid	☎+33/298331010
Ireland		☎+353/18092566		
Italy		☎+39/063054343	SET	☎+39/0362512868
Cyprus		☎+357/1401		
Lithuania		☎+370/52362052		
Latvia		☎+371/67042473		
Luxembourg		☎+32/70245245 (viz Belgie)		
Hungary		☎+36/80201199	VERIK	☎+36/23552205
Malta		☎+356/21450000		
Germany		☎+49/3019240	TUIS	☎+49/6216043333
Netherlands		☎+31/302748888	TRC	☎+31/102468642
Poland		☎+48/226196654	SPOT	☎+48/243657032
Portugal		☎+351/808250143		
Austria		☎+43/14064343	TUIS	☎+49/6216043333
Greece		☎+30/2107793777		
Romania		☎+40/212106282		
Slovakia		☎+421/254774166	DINS	☎+421/317754112; 2771
Slovenia		☎+386/41635500		
Spain		☎+34/915620420	CERET	☎+34 915373 248; 238
Sweden		☎+46/(0)104566700	KEMIAKUTEN	☎+46/8337043; 170970
Great Britain		☎ 8448920111	Chemsafe	☎+44/123 5836002; 5753363



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Inspecting and verifying the content of the material safety sheet

Inspection and verification of the compliance of this document with the requirements of Directive (EC) No. 1907/2006 REACH and Directive (EC) No. 1272/2008 CLP was executed by an independent, professionally competent person - Ing. Oldřich Petira, CSc., authorized expert in the field of chemistry and the protection of the environment, specializing in industrial toxicology and chemical safety of the environment.

Prohlášení: The material safety sheet has been prepared in compliance with Directive (EC) No. 1907/2006 REACH. It includes data that are necessary for securing occupational health and safety and the protection of the environment. These data have been provided in good faith, correspond to the current state of knowledge and experience and are in accordance with our valid legal regulations. The data provided does not replace the quality specification and can not be considered as a guarantee of the suitability and usability of this product for a specific application. It is the responsibility of the product user to assess the accuracy of the information in a particular application where the product's properties can influence different factors. The consumer is responsible for compliance with the appropriate, regionally valid legal regulations.



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SAFETY DATA SHEET

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ANNEX OF SAFETY DATA

EXPOSURE SCENARIOS ACCORDING TO ARTICLE 31 OF REGULATION (EC) NO 1907/2006 (REACH) OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

The annex contains exposure scenarios applied from chapter 9 of the report on chemical safety presented at the registration of this substance for its designated use.

Exposure scenario ES1:	
Manufacturing of anhydrous ammonia	pgs 19-24
Exposure scenario ES2:	
Distribution and formulation (mixures), including the production of aqueous ammonia solution	pgs 25-33
Exposure scenario ES3:	
Use ammonia and aqueous ammonia solutions as an intermediate in the chemicals industry	pgs 34-42
Exposure scenario ES4:	
Industrial end-uses – processing aid, non-processing aid and auxiliary agent	pgs 43-53
Exposure scenario ES5:	
Professional end-uses of anhydrous and aqueous ammonia	pgs 54-64
Exposure scenario ES6:	
Consumer end-uses of anhydrous and aqueous ammonia	pgs 65-69

EXPOSURE SCENARIO 1: MANUFACTURING OF ANHYDROUS AMMONIA

Section 1	Exposure Scenario Title
Title	Manufacturing of Anhydrous Ammonia; CAS: 7664-41-7
Use Descriptor	Sector of Use: Industrial (SU8, SU9, C20.1.5) Process Categories: PROC1, PROC2, PROC8a, PROC8b Environmental Release Categories: ERC1
Processes, tasks, activities covered	Processes are continuous and are carried out in closed pipelines and vessels, housed outdoors/indoors. During the manufacturing of anhydrous ammonia, operators monitor and control processes across a number of units: gas compression, methanation, synthesis loop, ammonia cooling units, ammonia management, which may include also the production of ammonia water (aqueous ammonia solution) and storage. Most manufacturing processes and plant 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. Operators load ammonia stored in spheres onto tankers for distribution by rail or road. The operators load ammonia onto rail tankers, tank containers or stainless steel bottles. Tanker loading generally takes place in the open air and involves opening and closing valves and connecting and disconnecting pipes and hoses. The loading itself is remote controlled from a closed loading station.
Section 2	Operational conditions and risk management measures
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Gas or liquefied gas.
Concentration of substance in product	>99,5 %
Amounts used	Not applicable
Frequency and duration of use	Continuous process 24 h/day, 330-360 days/year. The operators work in a normal working week (i.e. 40 h/week), i.e. ca. 220 days/year. Covers daily exposures up to 8 hours (unless stated differently) [G2].
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting worker exposure	Assumes a good basic standard of occupational hygiene is implemented [G1]. Assumes use at a temperature exceeding the ambient one by max. 20 °C (unless stated otherwise) [G17].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135]. PROC 1 PROC 2 PROC 8a PROC 8b	Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Enter all the production areas having a protective mask with a filter effective against ammonia at the the standby position. Use chemically resistant gloves. Use suitable eye protection [PPE26]. Wear suitable coveralls to prevent exposure to the skin [PPE27]. Wear appropriate footwear.

	Conduct operator vocational as well as safety training.
PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems) [CS15]. Continuous process [CS54].	Handle substance within a closed system [E47].
PROC2: Use in closed, continuous process with occasional controlled exposure (for instance sampling) General exposures (closed systems) [CS15]. Continuous process [CS54]. With sample collection [CS56]	Handle substance within a closed system [E47]. Ensure samples are obtained under containment or extract ventilation [E76]. When sampling wear suitable gloves.
PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance. [E55]. Provide extract ventilation to points where emissions occur [E54]. Use prescribed respiratory protection corresponding with potential exposures during cleaning work before handing over the equipment into maintenance. Wear suitable gloves
PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities Material transfers [CS3].	Use dedicated equipment [E85]. Ensure material transfers are under containment or extract ventilation [E66]. Wear suitable gloves.
Section 2.2	Control of environmental exposure
Product characteristics	Gas or liquefied gas.
Amounts used	6 591 429 tonnes/annum (total tonnage across the industry) 950 000 tonnes/annum (regional tonnage)
Frequency and duration of use	Continuous use/release.
Environmental factors not influenced by risk management	
	The default flow rate of sewage treatment plants (STP) is 20,000 m ³ /day.
Local freshwater	10-fold dilution by receiving waters. Local concentration with atmospheric deposition not yet taken into account.
Marine water	100-fold dilution by receiving waters.
Other Operational Conditions of use affecting environmental exposure	Process design: General exposures (closed systems) [CS15]. Effectiveness of protection against leak: covered systems with high integrity
Technical conditions and measures at process level (source) to prevent release	
Release to air	1.44 x 10 ⁵ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC1.) Default Release to Air for ERC 1 = 5%
Release to wastewater	1.73 x 10 ⁵ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC1.) Default Release to Water for ERC 1 = 6%
Soil (direct only)Agricultural soil	0 (No direct loss to soil is expected for this ERC1)
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.

Organisation measures to prevent/limit release from site	No special measures are necessary. Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.
Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations.
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation
3.1. Health	<p>The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity. In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere where there is a risk of contact. The system effects of ammonia – i.e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.</p> <p>The exposure estimates were made using ECETOC TRA assessment method. The data for exposure estimation and risk characterization are given in Tables 1 and 2. The operating conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.</p> <p>Appendix for the assessment of exposure by inhalation: If the control measurements show that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the contrary, it may be due to the fact that this method is not able to include the forced extraction of the outdoors into the assessment.</p> <p>Appendix for the dermal exposure assessment: Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure, that 100% of the dose is dermally absorbed.</p>
3.2. Environment	Assessment method: EUSES 2.1
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<p>It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.</p> <p>(Processes associated with the manufacturing of anhydrous ammonia are unlikely to pose an unacceptable health risk to industrial workers when dermal and inhalation exposures are controlled using appropriate operational conditions (e.g. task duration, use of ventilation) and risk management measures (e.g. PPE and RPE) such that exposures do not exceed the specified DNEL values.)</p> <p>Where an adjustment measures for risk management / operational conditions, users must ensure that risks are managed at least equivalent levels.</p>
4.2. Environment	It is not expected that the estimated exposure exceeds the PNEC, if implemented risk management / operational conditions described in Section 2

HEALTH – WORKERS ES1

Table 1: Quantitative risk characterisation of **dermal exposures** to anhydrous ammonia for industrial workers (ES 1 – manufacturing)

PROC code	Exposure assumptions		ES 1- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d	
					Risk characterisation ratio	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	No gloves worn	Gloves worn (90% reduction)
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14	0.20	0.02
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01

Notes: PROC process category code
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, gloves), under which the estimated dermal exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that when transferring the substance without the use of gloves in a space with emissions, where there is no device for local forced extraction, one is in danger of ammonia toxic effects after its penetration through the skin into the body.

Table 2: Quantitative risk characterisation of **inhalation exposure** concentrations of anhydrous ammonia for workers (ES 1 – manufacturing)

PROC code	Exposure assumptions		ES 1- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
					RCR		RCR		RCR	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.001	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.001	NA	<0.01	NA	<0.01	NA

PROC code	Exposure assumptions		ES 1- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
					RCR		RCR		RCR	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05
		Indoors without LEV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.6	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8b	>4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	3.19	0.16	0.07	0.00	0.09	<0.01	0.23	0.01
	1-4 hrs	Outdoors	44.63	2.23	0.94	0.05	1.24	0.06	3.19	0.16
		Indoors without LEV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with LEV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01

Notes: PROC process category code
RPE Respiratory Protect. Equipment
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
NA not available
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection

PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary

PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary



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Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

EXPOSURE SCENARIO 2: DISTRIBUTION AND FORMULATION

Section 1	Exposure Scenario Title
Title	Distribution and formulation (preparing the mixtures) Including preparation of aqueous ammonia solutions (ammonia water)
Use Descriptor	Sector of Use: Industrial (SU1, SIU10, SU24) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC15 Environmental Release Categories: ERC2
Processes, tasks, activities covered	Manufactured anhydrous liquid ammonia is stored and transported as a liquid under pressure by rail, road or water in specialised, authorised containers (e.g. tanks and tank trucks approved for transporting ammonia). When transported in tanks, the pressure on the tank is the liquid pressure and remains the same whether the tank is 10% or 80% full. The maximum filling level of an anhydrous ammonia tank is 85%. Anhydrous liquid ammonia may also be distributed to end-user industries via pipeline systems. In chemical manufacturing facilities Anhydrous liquid ammonia is blended with deionised water to produce aqueous ammonia solutions (5-25% w/w). Another method of preparing an aqueous ammonia solution is washing out expansion gas from the ammonia synthesis and off-gases from ammonia containers and storage tanks using a condensate (i.e., condensed water vapor) and then mixing the washed out product with additional condensate to the desired concentration. Aqueous ammonia solution products are distributed to a wide range of industrial users by road or rail. Distributors of anhydrous and aqueous ammonia can operate on a regional or national level.
Section 2	Operational conditions and risk management measures
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquefied gas (distribution of anhydrous ammonia). Liquid (aqueous ammonia solutions).
Concentration of substance in product	>99,5 % (anhydrous ammonia) 5-25% (aqueous ammonia solutions)
Amounts used	Not applicable
Frequency and duration of use	Continuous process 24 h/day, 330-360 days/year. The operators work in a normal working week (i. e. 40 h/week), i. e. ca. 220 days/year. Covers daily exposures up to 8 hours (unless stated differently) [G2].
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting worker exposure	Assumes use at a temperature exceeding the ambient one by max. 20 °C (unless stated differently) [G17]. Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135]. PROC 1 PROC 2 PROC 3 PROC 4 PROC 5 PROC 8a	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Enter all the production areas having a protective mask with a filter effective against ammonia at the standby position. Use chemically resistant gloves. Use suitable eye protection [PPE26]. Wear suitable coveralls to prevent exposure to the skin [PPE27]. Wear appropriate footwear. Conduct operator vocational as well as safety training.

PROC 8b PROC 9 PROC 15	
PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems) [CS15]. Continuous process [CS54].	Handle substance within a closed system [E47].
PROC2: Use in closed, continuous process with occasional controlled exposure (for instance sampling) General exposures (closed systems) [CS15]. Continuous process [CS54]. With sample collection [CS56]	Handle substance within a closed system [E47]. Ensure samples are obtained under containment or extract ventilation [E76]. When sampling wear suitable gloves.
PROC3: Use in closed batch process (synthesis or formulation) General exposures (closed systems) [CS15]. Use in contained batch processes [CS37]. With sample collection [CS56]	Handle substance within a predominantly closed system provided with extract ventilation [E49]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76].
PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises Batch process [CS55]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) Mixing operations (closed systems) [CS29]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. Use prescribed respiratory protection corresponding with potential exposures during cleaning work before handing over the equipment into maintenance. Wear suitable gloves
PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities Material transfers [CS3].	Use dedicated equipment [E85]. Ensure material transfers are under containment or extract ventilation [E66]. Wear suitable gloves.
PROC9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	Use semi-automated and predominantly enclosed filling lines [E41]. Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51] Wear suitable gloves.
PROC15: Use a laboratory reagent Laboratory activities [CS36].	Handle in a fume cupboard or under extract ventilation [E83].
Section 2.2	Control of environmental exposure
Product characteristics	Liquefied gas (distribution of anhydrous ammonia). Liquid (aqueous ammonia solutions).
Amounts used	3 829 950 tonnes/annum, r
Frequency and duration of use	Continuous use/release.

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Environmental factors not influenced by risk management	
	The default flow rate of sewage treatment plants (STP) is 20,000 m ³ /day.
Local freshwater	10-fold dilution by receiving waters. Local concentration with atmospheric deposition not yet taken into account.
Marine water	100-fold dilution by receiving waters.
Other Operational Conditions of use affecting environmental exposure	Process design: General exposures (closed systems) [CS15]. Effectiveness of containment: high integrity contained systems
Technical conditions and measures at process level (source) to prevent release	
Release to air	7.58 x 10 ⁴ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC.) Default Release to Air for ERC 1 = 2.5%
Release to wastewater	6.06 x 10 ⁴ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC.) Default Release to Water for ERC 1 = 2%
Soil (direct only)Agricultural soil	0 (No direct loss to soil is expected for this ERC)
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed
Organisation measures to prevent/limit release from site	No special measures are necessary. Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.
Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations.
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation
3.1. Health	<p>The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity. In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere where there is a risk of contact. The system effects of ammonia – i.e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.</p> <p>The exposure estimates were made using ECETOC TRA assessment method. The data for exposure estimation and risk characterization are given in Tables 1 and 2. The operating conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.</p> <p>Appendix for the assessment of exposure by inhalation: If the control measurements show that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the</p>

	<p>contrary, it may be due to the fact that this method is not able to include the forced extraction of the outdoors into the assessment.</p> <p>Appendix for the dermal exposure assessment:</p> <p>Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure, that 100% of the dose is dermally absorbed.</p>
3.2. Environment	Assesment method: EUSES 2.1
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<p>It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.</p> <p>(Processes associated with the manufacturing of anhydrous ammonia are unlikely to pose an unacceptable health risk to industrial workers when dermal and inhalation exposures are controlled using appropriate operational conditions (e.g. task duration, use of ventilation) and risk management measures (e.g. PPE and RPE) such that exposures do not exceed the specified DNEL values.)</p> <p>Where an adjustment measures for risk management / operational conditions, users must ensure that risks are managed at least equivalent levels.</p>
4.2. Environment	It is not expected that the estimated exposure exceeds the PNEC, if implemented risk management / operational conditions described in Section 2
Section 5 (optional)	

HEALTH – WORKERS ES2

Table 3: Quantitative risk characterisation of **dermal exposures to anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia** for industrial workers (ES 2 – formulation and distribution)

PROC code	Exposure assumptions		ES 2- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d	
					Risk characterisation ratio	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	No gloves worn	Gloves worn (90% reduction)
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14	0.20	0.02
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.07	0.01	0.01	<0.01
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8b		Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10

PROC code	Exposure assumptions		ES 2- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	Risk characterisation ratio	
					No gloves worn	Gloves worn (90% reduction)
	1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07	0.10	0.01
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01

Notes: PROC process category code
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, gloves), under which the estimated dermal exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that when transferring the substance without the use of gloves in a space with emissions, where there is no device for local forced extract ventilation, one is in danger of ammonia toxic effects after its penetration through the skin into the body.

Table 4: Quantitative risk characterisation of **inhalation** exposure concentrations of **anhydrous ammonia** for industrial workers (ES 2 – formulation and distribution)

PROC code	Exposure assumptions		ES 2- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE - 95% reduction	RCR		RCR		RCR	
					No RPE	RPE - 95% reduction	No RPE	RPE - 95% reduction	No RPE	RPE - 95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05
		Indoors without LEV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

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PROC code	Exposure assumptions		ES 2- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duratio n	Use of ventilati on	No RPE	RPE - 95% reductio	No RPE	RPE - 95% reductio	No RPE	RPE - 95% reductio	No RPE	RPE - 95% reductio
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 4	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8b	>4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	3.19	0.16	0.07	0.00	0.09	<0.01	0.23	0.01
	1-4 hrs	Outdoors	44.63	2.23	0.94	0.05	1.24	0.06	3.19	0.16
		Indoors without LEV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with LEV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without LEV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with LEV	14.17	0.71	0.30	0.01	0.39	0.02	1.01	0.05
	1-4 hrs	Outdoors	59.50	2.98	1.25	0.06	1.65	0.08	4.25	0.21
		Indoors without LEV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with LEV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
PROC 15	>4 hrs	Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without LEV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

Notes: PROC process category code
RPE Respiratory Protection Equipment
LEV Local exhaust ventilation
RCR Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
NA not available
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

Table 5: Quantitative risk characterisation of **inhalation exposure** concentrations of **aqueous ammonia** (in preparations of **5-25 % w/w**) in industrial workers (ES 2 – formulation and distribution)

PROC code	Exposure assumptions		ES 2- exposure concentrations (EC) mg/m ³		Acute /long-term systemic effects DNEL = 47.6 mg/m3		Acute – local effects DNEL = 36 mg/m3		Long-term local effects DNEL = 14 mg/m3	
	Duration	Use of ventilation	No RPE	RPE -95% reduction)	No RPE	RPE - 95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.0001	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
	1-4 hrs	Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
		Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07
		Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
PROC 3	>4hrs	Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
		Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
	1-4 hrs	Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
PROC 4	>4hrs	Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
		Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
	1-4 hrs	Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
PROC 5	>4hrs	Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
		Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
	1-4 hrs	Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
PROC 8a	>4hrs	Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
		Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
	1-4 hrs	Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
PROC 8b	>4 hrs	Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
		Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
	1-4 hrs	Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
PROC 9	>4 hrs	Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
	1-4 hrs	Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
		Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
		Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
PROC 15	>4 hrs	Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
		Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
		Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
	1-4 hrs	Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
		Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
		Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28

Notes:	PROC	process category code
	RPE	Respiratory Protection Equipment
	LEV	Local exhaust ventilation
	RCR	Risk Characterisation Ratio
	DNEL	derived exposure level with no adverse effects (Derived No Effect Level)
	NA	not available
Adverse effects on health:		
	acute	immediate effect after contact with the substance
	chronic	effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
	local	effect at the point of contact with the substance
	system	effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

EXPOSURE SCENARIO 3: USE OF AMMONIA AS AN INTERMEDIATE IN THE CHEMICALS INDUSTRY

Section 1	Exposure Scenario Title
Title	Use of ammonia as an intermediate in the chemicals industry
Use Descriptor	<p>Sector of Use: Industrial (SU1, SU5, SU8, SU9, SU12, SU15, SU24, C21, C20.1.5)</p> <p>Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC15</p> <p>Environmental Release Categories: ERC6a</p>
Processes, tasks, activities covered	<p>Industrial uses of anhydrous ammonia as an intermediate</p> <p>Ammonia is used for manufacturing of a variety of other chemical substances such as urea, nitric acid, ammonium carbonate, hydrogen cyanide. Processes take place in large chemical facilities located both in outdoor and indoor spaces. They can be continuous or batch and often take place in closed systems.</p> <p>Most manufacturing processes and equipment are operated automatically by several operators in a separate control room. Operators can also carry out routine inspections of all technological equipment directly at the individual production sections at the site to ensure that the device is working normally, or even to perform mechanical tasks if necessary.</p> <p>Other manual activities may be implemented in the process equipment such as preparation of equipment before performing maintenance, taking control samples or control measurements.</p> <p>Discharge of ammonia from the tanks usually takes place outdoors and includes opening and closing of valves, connecting and disconnecting the pipes and hoses. Discharge itself is controlled remotely from a closed station. Ammonia may be distributed to the users also by pipeline system.</p>
Section 2	Operational conditions and risk management measures
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	<p>Liquefied gas (distribution of anhydrous ammonia).</p> <p>Liquid (aqueous ammonia solutions).</p>
Concentration of substance in product	<p>>99,5 % (anhydrous ammonia)</p> <p>5-25% (aqueous ammonia solution)</p>
Amounts used	Not applicable
Frequency and duration of use	<p>Continuous process 24 h/day, 330-360 days/year. The operators work in a normal working week (i.e. 40 h/week), i.e. ca. 220 days/year.</p> <p>Covers daily exposures up to 8 hours (unless stated differently) [G2].</p>
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting worker exposure	Assumes use at a temperature exceeding the ambient one by max. 20 °C (unless stated differently) [G17].

	Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135]. PROC 1 PROC 2 PROC 3 PROC 4 PROC 5 PROC 8a PROC 8b PROC 9 PROC 15	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Enter all the production areas having a protective mask with a filter effective against ammonia at the standby position. Use chemically resistant gloves. Use suitable eye protection [PPE26]. Wear suitable coveralls to prevent exposure to the skin [PPE27]. Wear appropriate footwear. Conduct operator vocational as well as safety training.
PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems) [CS15]. Continuous process [CS54].	Handle substance within a closed system [E47].
PROC2: Use in closed, continuous process with occasional controlled exposure (for instance sampling) General exposures (closed systems) [CS15]. Continuous process [CS54]. With sample collection [CS56]	Handle substance within a closed system [E47]. Ensure samples are obtained under containment or extract ventilation [E76]. When sampling wear suitable gloves.
PROC3: Use in closed batch process (synthesis or formulation) General exposures (closed systems) [CS15]. Use in contained batch processes [CS37]. With sample collection [CS56]	Handle substance within a predominantly closed system provided with extract ventilation [E49]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76].
PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises Batch process [CS55]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) Mixing operations (closed systems) [CS29]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. Use prescribed respiratory protection corresponding with potential exposures during cleaning work before handing over the equipment into maintenance. Wear suitable gloves
PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities Material transfers [CS3].	Use dedicated equipment [E85]. Ensure material transfers are under containment or extract ventilation [E66]. Wear suitable gloves.

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PROC9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	Use semi-automated and predominantly enclosed filling lines [E41]. Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51] Wear suitable gloves.
PROC15: Use a laboratory reagent Laboratory activities [CS36].	Handle in a fume cupboard or under extract ventilation [E83].
Section 2.2	Control of environmental exposure
Product characteristics	Liquefied gas (distribution of anhydrous ammonia). Liquid (aqueous ammonia solutions).
Amounts used	3 829 950 tonnes/annum, regional 1 000 000 tonnes.
Frequency and duration of use	Continuous use/release.
Environmental factors not influenced by risk management	
	The default flow rate of sewage treatment plants (STP) is 20,000 m ³ /day.
Local freshwater	10-fold dilution by receiving waters. Local concentration with atmospheric deposition not yet taken into account.
Marine water	100-fold dilution by receiving waters.
Other Operational Conditions of use affecting environmental exposure	Process design: General exposures (closed systems) [CS15]. Effectiveness of containment: high integrity contained systems
Technical conditions and measures at process level (source) to prevent release	
Release to air	1.21 x 10 ⁵ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC.) Default Release to Air for ERC 1 = 5%
Release to wastewater	4.85 x 10 ⁴ kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC.) Default Release to Water for ERC 1 = 2%
Soil (direct only)Agricultural soil	NA (No direct loss to soil is expected for this ERC)
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	No special measures are necessary. In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed
Organisation measures to prevent/limit release from site	Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.
Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation
3.1. Health	The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity.

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	<p>In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere where there is a risk of contact. The system effects of ammonia – i.e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.</p> <p>The exposure estimates were made using ECETOC TRA assessment method. The data for exposure estimation and risk characterization are given in Tables 6, 7 and 8. The operating conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.</p> <p>Appendix for the assessment of exposure by inhalation: If the control measurements show that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the contrary, it may be due to the fact that this method is not able to include the forced extraction of the outdoors into the assessment.</p> <p>Appendix for the dermal exposure assessment: Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure that 100% of the dose is dermally absorbed.</p>
3.2. Environment	Assesment method: EUSES 2.1
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.(Processes associated with the manufacturing of anhydrous ammonia are unlikely to pose an unacceptable health risk to industrial workers when dermal and inhalation exposures are controlled using appropriate operational conditions (e.g. task duration, use of ventilation) and risk management measures (e.g. PPE and RPE) such that exposures do not exceed the specified DNEL values.) Where an adjustment measures for risk management / operational conditions, users must ensure that risks are managed at least equivalent levels.
4.2. Environment	It is not expected that the estimated exposure exceeds the PNEC, if implemented risk management / operational conditions described in Section 2

HEALTH – WORKERS ES3

Table 6: Quantitative risk characterisation of **dermal** exposures to **anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia** for industrial workers (ES 3 – Use as an intermediate)

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PROC code	Exposure assumptions		ES 3- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d	
					Risk characterisation ratio	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	No gloves worn	Gloves worn (90% reduction)
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14	0.20	0.02
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.07	0.01	0.01	<0.01
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01

Notes: PROC process category code
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, gloves), under which the estimated dermal exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that when transferring the substance, including its filling into small containers, mixing and other processes with more exposure possibilities without the use of gloves in a space with emissions, where there is no device for local forced extract ventilation, one is in danger of ammonia toxic effects after its penetration through the skin into the body.

Table 7: Quantitative risk characterisation of **inhalation** exposure concentrations of **anhydrous ammonia** in industrial workers (ES 3 – Use as an intermediate)

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PROC code	Exposure assumptions		ES 3-exposure concentration s (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05
		Indoors without LEV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 4	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8b	>4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	3.19	0.16	0.07	0.00	0.09	<0.01	0.23	0.01
	1-4 hrs	Outdoors	44.63	2.23	0.94	0.05	1.24	0.06	3.19	0.16
		Indoors without LEV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with LEV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without LEV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with LEV	14.17	0.71	0.30	0.01	0.39	0.02	1.01	0.05
	1-4 hrs	Outdoors	59.50	2.98	1.25	0.06	1.65	0.08	4.25	0.21
		Indoors without LEV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with LEV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
PROC 15	>4 hrs	Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without LEV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

Notes: PROC process category code
RPE Respiratory Protect. Equipment
LEV Local exhaust ventilation

RCR	Risk Characterisation Ratio
DNEL	derived exposure level with no adverse effects (Derived No Effect Level)
NA	not available
Adverse effects on health:	
acute	immediate effect after contact with the substance
chronic	effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local	effect at the point of contact with the substance
system	effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

Table 8: Quantitative risk characterisation of **inhalation** exposure concentrations of **aqueous ammonia (in preparations of 5-25 % w/w)** for industrial workers (ES 3 – Use as an intermediate)

PROC code	Exposure assumptions		ES 3- exposure concentrations (EC) mg/m ³		Acute /long-term systemic effects DNEL = 47.6 mg/m ³		Acute – local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07
		Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
	1-4 hrs	Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
PROC 4	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
	1-4 hrs	Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 8b	>4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	3.94	0.20	0.08	0.00	0.11	0.01	0.28	0.01
	1-4 hrs	Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
		Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without LEV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with LEV	17.50	0.88	0.37	0.02	0.49	0.02	1.25	0.06
	1-4 hrs	Outdoors	73.50	3.68	1.54	0.08	2.04	0.10	5.25	0.26
		Indoors without LEV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with LEV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
PROC 15	>4 hrs	Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01

Notes:	PROC	process category code
	RPE	Respiratory Protection Equipment
	LEV	Local exhaust ventilation
	RCR	Risk Characterisation Ratio
	DNEL	derived exposure level with no adverse effects (Derived No Effect Level)
	NA	not available
Adverse effects on health:		
	acute	immediate effect after contact with the substance
	chronic	effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
	local	effect at the point of contact with the substance
	system	effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

EXPOSURE SCENARIO 4: INDUSTRIAL END-USE – USE OF AMMONIA AS A PROCESSING AID, NON-PROCESSING AID AND AUXILIARY AGENT

Section 1	Exposure Scenario Title
Title	Industrial end-use - use of ammonia as a processing aid, non-processing aid and auxiliary agent
Use Descriptor	<p>Sector of Use: Industrial (SU4, SU5, SU6a, SU6b, SU7, SU8, SU11, SU12, SU13, SU15, SU16, SU 23, NACE C28.2.5)</p> <p>Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC10, PROC13, PROC19</p> <p>Environmental Release Categories: ERC4, ERC5, ERC6b, ERC7</p>
Processes, tasks, activities covered	<p>Ammonia and its aqueous solutions are used by a lot of industries in a wide variety of applications. This includes industrial use as reactive and non-reactive agents in continuous and batch processes, as auxiliary agents or substances in the closed systems. Examples of use as the process agent are water treatment, protective atmosphere for metal surface treatment, as the non-process agent in a closed system – coolant, as the reactive processing agent – removing nitrogen and sulfur oxides from fuel combustion emissions, extraction agent, neutralization agent, and as the auxiliary agent – production of semiconductors.</p> <p>Operating conditions differ considerably in various industry sectors as well as in various applications.</p>
Section 2	Operational conditions and risk management measures
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquefied gas (anhydrous ammonia). Liquid (aqueous ammonia solutions).
Concentration of substance in product	>99,5 % (anhydrous ammonia) 5-25% (aqueous ammonia solutions)
Amounts used	Not applicable
Frequency and duration of use	Differ considerably. It is a case of continuous as well as batch processes. Covers daily exposures up to 8 hours (unless stated differently) [G2].
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting worker exposure	Assumes use at a temperature exceeding the ambient one by max. 20 °C (unless stated differently) [G17]. Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135]. PROC 1 PROC 2 PROC 3 PROC 4 PROC 5 PROC 7 PROC 8a PROC 8b PROC 9	<p>Provide extract ventilation to points where emissions occur [E54].</p> <p>Ensure material transfers are under containment or extract ventilation [E66].</p> <p>Enter all the production areas having a protective mask with a filter effective against ammonia at the standby position.</p> <p>Use chemically resistant gloves. Use suitable eye protection [PPE26]. Wear suitable coveralls to prevent exposure to the skin [PPE27]. Wear appropriate footwear.</p> <p>Conduct operator vocational as well as safety training.</p>

PROC 10 PROC 13 PROC 15 PROC 19	
PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems) [CS15]. Continuous process [CS54].	Handle substance within a closed system [E47].
PROC2: Use in closed, continuous process with occasional controlled exposure (for instance sampling) General exposures (closed systems) [CS15]. Continuous process [CS54]. With sample collection [CS56]	Handle substance within a closed system [E47]. Ensure samples are obtained under containment or extract ventilation [E76]. When sampling wear suitable gloves.
PROC3: Use in closed batch process (synthesis or formulation) General exposures (closed systems) [CS15]. Use in contained batch processes [CS37]. With sample collection [CS56]	Handle substance within a closed system [E47]. Handle substance within a predominantly closed system provided with extract ventilation [E49]. Ensure samples are obtained under containment or extract ventilation [E76].
PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises Batch process [CS55]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves
PROC5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) Mixing operations (closed systems) [CS29]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves
PROC7: Spraying in industrial settings and applications Spraying [CS10].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves.
PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. Use prescribed respiratory protection corresponding with potential exposures during cleaning work before handing over the equipment into maintenance. Wear suitable gloves.
PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities Material transfers [CS3].	Use dedicated equipment [E85]. Ensure material transfers are under containment or extract ventilation [E66].
PROC9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	Use semi-automated and predominantly enclosed filling lines.[E41] Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51]. Wear suitable gloves.
PROC10: Roller application or brushing of adhesive and other coating Rolling, Brushing [CS51].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves. Wear suitable gloves.

PROC13: Treatment of articles by dipping and pouring Treatment by dipping and pouring [CS35].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves.
PROC15: Use a laboratory reagent Laboratory activities [CS36].	Handle in a fume cupboard or under extract ventilation [E83].
PROC19: Hand-mixing with intimate contact and only PPE available Mixing (open systems)[CS30]. Manual [CS34].	Wear suitable personal protective equipment to prevent contact with the substance
Section 2.2	Control of environmental exposure
Product characteristics	Liquefied gas (anhydrous ammonia). Liquid (aqueous ammonia solutions).
Amounts used	354 631 tonnes/annum, regional 25000 tonnes
Frequency and duration of use	Continuous use/release. Batch processes
Environmental factors not influenced by risk management	
	The default flow rate of sewage treatment plants (STP) is 20,000 m ³ /day.
Local freshwater	10-fold dilution by receiving waters. Local concentration with atmospheric deposition not yet taken into account.
Marine water	100-fold dilution by receiving waters.
Other Operational Conditions of use affecting environmental exposure	Process design: General exposures (closed systems) [CS15]. Effectiveness of containment: high integrity contained systems
Technical conditions and measures at process level (source) to prevent release	
Release to air	7.15 x 10 ⁴ kg/day, 3.76 x 10 ⁴ kg/day, 75.2 kg/day, 3760 kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC) Default Release to Air for ERC4 95%, ERC5 50%, ERC6b 0.1%, ERC7 5%
Release to wastewater	7.52 x 10 ⁴ kg/day, 3.76 x 10 ⁴ kg/day, 3760 kg/day, 3760 kg/day (Predicted values are those calculated by EUSES using the tonnage data and defaults for ERC.) Default Release to Water for ERC4 100%, ERC5 50%, ERC6b 5%, ERC7 5%
Soil (direct only)Agricultural soil	NA (No direct loss to soil is expected for these ERC)
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed
Organisation measures to prevent/limit release from site	Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	No special measures are necessary. In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.

Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation
3.1. Health	<p>The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity. In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere where there is a risk of contact. The system effects of ammonia – i.e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.</p> <p>The exposure estimates were made using ECETOC TRA assessment method. The data for exposure estimation and risk characterization are given in Tables 9, 10 and 11. The operating conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.</p> <p>Appendix for the assessment of exposure by inhalation: If the control measurements show that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the contrary, it may be due to the fact that this method is not able to include the forced extraction of the outdoors into the assessment.</p> <p>Appendix for the dermal exposure assessment: Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure, that 100% of the dose is dermally absorbed.</p> <p>In the case of PROC 19 process (hand mixing) the mentioned conservative calculation results in exceeding the DNEL values for system health effects even when wearing gloves. When used in this case more realistic assumption for the evaluation that 10% of the dose is dermally absorbed, then the DNEL value will not be exceeded.</p>
3.2. Environment	Assessment method: EUSES 2.1
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<p>It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.</p> <p>The processes associated with the end industrial use of ammonia as a process, non-process or auxiliary agent do not pose an unacceptable risk to the industrial workers' health, if the dermal and inhalation exposures are controlled using suitable operating conditions (for instance task duration, use of ventilation) and risk management measures (for instance personal protective equipment) of such a type that the exposures do not exceed the DNEL values.</p> <p>Where the risk management measures / operating conditions have been modified, the users must ensure the risks to be managed on at least equivalent levels.</p>
4.2. Environment	It is not expected that the estimated exposure exceeds the PNEC, if implemented risk management/operational conditions described in Section 2

HEALTH – WORKERS ES4

Table 9: Quantitative risk characterisation of **dermal** exposures to **anhydrous or aqueous (in preparations of 5-25 % w/w) ammonia** for industrial workers (ES 4 – Industrial end-use)

PROC code	Exposure assumptions		ES 4- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d	
					RCR	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	No gloves worn	Gloves worn (90% reduction)
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14	0.20	0.02
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.07	0.01	0.01	<0.01
PROC 7	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	42.86	4.29	6.30	0.63
		Indoors with LEV	2.14	0.21	0.32	0.03
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	27.43	2.74	4.03	0.40
		Indoors with LEV	1.37	0.14	0.20	0.02
PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	141.73	14.14	20.80	2.08 *

*Adjusting for 10% dermal absorption gives a dermal exposure of 1.41 mg/kg bw/d assuming gloves affording 90% protection are worn and the RCR = 0.2

Notes.: PROC process category code
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, gloves), under which the estimated dermal exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that when transferring the substance, including its transfer into small containers, mixing, industrial spraying, roller application or brushing, dipping or pouring in and other processes with more exposure possibilities, without the use of gloves in a space with emissions, where there is no device for local forced extract

ventilation, one is in danger of ammonia toxic effects after its penetration through the skin into the body. This risk exists even for hand-mixing performed without gloves.

Table 10: Quantitative risk characterisation of **inhalation** exposure concentrations of **anhydrous ammonia** for industrial workers (ES 4 – Industrial end-use)

PROC code	Exposure assumptions		ES 4- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
							RCR		RCR	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE 95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05
		Indoors without LEV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 4	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8b	>4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	3.19	0.16	0.07	0.00	0.09	<0.01	0.23	0.01
	1-4 hrs	Outdoors	44.63	2.23	0.94	0.05	1.24	0.06	3.19	0.16
		Indoors without LEV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with LEV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without LEV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with LEV	14.17	0.71	0.30	0.01	0.39	0.02	1.01	0.05
	1-4 hrs	Outdoors	59.50	2.98	1.25	0.06	1.65	0.08	4.25	0.21
		Indoors without LEV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with LEV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03

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PROC code	Exposure assumptions		ES 4- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	RCR		RCR		RCR		RCR		RCR	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 13	>4 hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 15	>4 hrs	Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without LEV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

Notes: PROC process category code
RPE Respiratory Protection Equipment
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
NA not available

Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary

- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 13 /treatment of articles by dipping and pouring/ may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Dodatek 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Dodatek 2 Where there is a system of control measurements, showing that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but the same duty as in "Warning 2" holds – i.e., always have your protective mask at the standby position.

Table 11: Quantitative risk characterisation of inhalation exposure concentrations of aqueous ammonia (in preparations of 5-25% w/w) in industrial workers (ES 4 – Industrial end-use)

PROC code	Exposure assumptions		ES 4-exposure concentration s (EC) mg/m ³		Acute /long-term systemic effects DNEL = 47.6 mg/m ³		Acute – local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE (95% reduction)	No RPE	RPE - 95% reduction	No RPE	RPE - 95% reduction	No RPE	RPE - 95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07
		Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
	1-4 hrs	Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
PROC 4	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
	1-4 hrs	Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02

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PROC code	Exposure assumptions		ES 4-exposure concentration s (EC) mg/m ³		Acute /long-term systemic effects DNEL = 47.6 mg/m ³		Acute – local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE (95% reduction)	No RPE	RPE - 95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 7	>4hrs	Outdoors	306.25	15.31	6.43	0.32	8.51	0.43	21.88	1.09
		Indoors without LEV	437.5	21.88	9.19	0.46	12.15	0.61	31.25	1.56
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	183.75	9.19	3.86	0.19	5.10	0.26	13.13	0.66
		Indoors without LEV	262.5	13.13	5.51	0.28	7.29	0.36	18.75	0.94
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 8b	>4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	3.94	0.20	0.08	0.00	0.11	0.01	0.28	0.01
	1-4 hrs	Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
		Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without LEV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with LEV	17.50	0.88	0.37	0.02	0.49	0.02	1.25	0.06
	1-4 hrs	Outdoors	73.50	3.68	1.54	0.08	2.04	0.10	5.25	0.26
		Indoors without LEV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with LEV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
PROC 10	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 13	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 15	>4 hrs	Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
PROC 19	>4 hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47

Notes:	PROC	process category code
	RPE	Respiratory Protection Equipment
	LEV	Local exhaust ventilation
	RCR	Risk Characterisation Ratio
	DNEL	derived exposure level with no adverse effects (Derived No Effect Level)
	NA	not available
Adverse effects on health:		
	acute	immediate effect after contact with the substance
	chronic	effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
	local	effect at the point of contact with the substance
	system	effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 7 /spraying in industrial settings and applications / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 10 /roller application or brushing of adhesive and other coating / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 13 /treatment of articles by dipping and pouring/ may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 19 /hand-mixing with intimate contact and only PPE available / must never be performed without respiratory protection



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SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006 (REACH), as amended

Valid Issue: 2/1/2021 – version 8(4)

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Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

EXPOSURE SCENARIO 5: WIDE DISPERSIVE END-USE: PROFESSIONAL USES OF ANHYDROUS AND AQUEOUS AMMONIA

Section 1	Exposure Scenario Title
Title	Wide dispersive end-use: Professional uses of anhydrous and aqueous ammonia
Use Descriptor	Sector of Use: Industrial (SU1, SU10, SU23) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC10, PROC11, PROC13, PROC18, PROC19 Environmental Release Categories: ERC8a, ERC8b, ERC8d, ERC8e, ERC8f, ERC9a, ERC9b, ERC11a
Processes, tasks, activities covered	Ammonia and its aqueous solutions are used by a lot of professionals in a wide variety of applications. The most common ones include professional use in chemical laboratories, as coolant in closed systems, water treatment chemicals, fertilizer, cleaning product, agent for product surface treatment, etc. Operating conditions vary considerably in different industry sectors and different applications. The exposure may often occur when operating equipment containing ammonia (for instance manipulating valves) or in application of ammonia-based products.
Section 2	Operational conditions and risk management measures
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquefied gas (anhydrous ammonia). Liquid (aqueous ammonia solutions).
Concentration of substance in product	>99,5 % (anhydrous ammonia) 5-25% (aqueous ammonia solutions)
Amounts used	Not applicable
Frequency and duration of use	Vary considerably at various applications.
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting worker exposure	Assumes use at a temperature exceeding the ambient one by max. 20 °C (unless stated differently) [G17]. Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135]. PROC 1 PROC 2 PROC 3 PROC 4 PROC 5 PROC 8a PROC 8b PROC 9 PROC 10	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Enter all the production areas having a protective mask with a filter effective against ammonia at the standby position. Use chemically resistant gloves. Wear chemically resistant gloves (tested to EN374) in combination with specific activity training [PPE17]. Use suitable eye protection [PPE26]. Wear suitable coveralls to prevent exposure to the skin [PPE27]. Wear appropriate footwear. Conduct operator vocational as well as safety training.

PROC 11 PROC 13 PROC 15 PROC 19 PROC 20	
PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems) [CS15]. Continuous process [CS54].	Handle substance within a closed system [E47].
PROC2: Use in closed, continuous process with occasional controlled exposure (for instance sampling) General exposures (closed systems) [CS15]. Continuous process [CS54]. With sample collection [CS56]	Handle substance within a closed system [E47]. Ensure samples are obtained under containment or extract ventilation [E76]. When sampling wear suitable gloves.
PROC3: Use in closed batch process (synthesis or formulation) General exposures (closed systems) [CS15]. Use in contained batch processes [CS37]. With sample collection [CS56]	Handle substance within a predominantly closed system provided with extract ventilation [E49]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76].
PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises Batch process [CS55]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) Mixing operations (closed systems) [CS29]. With sample collection [CS56]	Provide extract ventilation to points where emissions occur [E54]. Ensure material transfers are under containment or extract ventilation [E66]. Ensure samples are obtained under containment or extract ventilation [E76]. Wear suitable gloves.
PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. Use prescribed respiratory protection corresponding with potential exposures during cleaning work before handing over the equipment into maintenance. Wear suitable gloves
PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities Material transfers [CS3].	Use dedicated equipment [E85]. Ensure material transfers are under containment or extract ventilation [E66]. Wear suitable gloves
PROC9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	Use semi-automated and predominantly enclosed filling lines [E41]. Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51] Wear suitable gloves
PROC10: Roller application or brushing of adhesive and other coating Rolling, Brushing [CS51].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves.

AMMONIA

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PROC11: Spraying outside industrial settings and/or applications Spraying [CS10].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves.
PROC13: Treatment of articles by dipping and pouring Treatment by dipping and pouring [CS35].	Provide extract ventilation to points where emissions occur [E54]. Wear suitable gloves.
PROC15: Use a laboratory reagent Laboratory activities [CS36].	Handle in a fume cupboard or under extract ventilation [E83].
PROC19: Hand-mixing with intimate contact and only PPE available Mixing (open systems)[CS30]. Manual [CS34].	Wear suitable personal protective equipment to prevent contact with the substance
PROC20: Professional use of dispersed liquids for heat and pressure transfer in closed systems	Handle substance within a closed system [E47]. Ensure material transfers are under containment or extract ventilation [E66].
Section 2.2	Control of environmental exposure
Product characteristics	Liquefied gas (anhydrous ammonia). Liquid (aqueous ammonia solutions).
Amounts used	Not applicable. Qualitative assessment was made only.
Frequency and duration of use	Cannot be determined.
Environmental factors not influenced by risk management	The resulting environmental exposure is not expected to add significantly to already present background levels of ammonia in the environment.
Local freshwater	Not applicable. Qualitative assessment was made only.
Marine water	Not applicable. Qualitative assessment was made only.
Other Operational Conditions of use affecting environmental exposure	Not applicable. Qualitative assessment was made only.
Technical conditions and measures at process level (source) to prevent release	
Release to air	Not applicable. Qualitative assessment was made only.
Release to wastewater	Not applicable. Qualitative assessment was made only.
Soil (direct only)Agricultural soil	Not applicable. Qualitative assessment was made only.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed
Organisation measures to prevent/limit release from site	No special measures are necessary. Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.
Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation

3.1. Health

The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity. In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is **essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere where there is a risk of contact**. The system effects of ammonia – i. e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.

The exposure estimates were made using ECETOC TRA assessment method. The data for exposure estimation and risk characterization are given in Tables 12, 13 and 14. The operating conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.

Appendix for the assessment of exposure by inhalation:

If the control measurements show that DNEL values are not exceeded outdoors, even if the ECETOC TRA assessment results indicated the contrary, it may be due to the fact that this method is not able to include the forced extraction of the outdoors into the assessment.

Appendix for the dermal exposure assessment:

Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure, that 100% of the dose is dermally absorbed.

In the case of PROC 19 process (hand mixing) the mentioned conservative calculation results in exceeding the DNEL values for system health effects even when wearing gloves. When used in this case more realistic assumption for the evaluation that 10% of the dose is dermally absorbed, then the DNEL value will not be exceeded.

3.2. Environment

Most of the ammonia in the environment comes from the natural sources, predominantly from the organic material decomposition. Professional use of ammonia is rather wide and varied, but this activity is not expected to significantly increase the current level of ammonia, which is commonly found in the environment. It has not been made, therefore, a quantitative assessment of the environmental exposure.

Section 4

Guidance to check compliance with the Exposure Scenario

4.1. Health

It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.

The processes associated with the end industrial use of ammonia as a process, non-process or auxiliary agent do not pose an unacceptable risk to the industrial workers' health, if the dermal and inhalation exposures are controlled using suitable operating conditions (for instance task duration, use of ventilation) and risk management measures (for instance personal protective equipment) of such a type that the exposures do not exceed the DNEL values.

Where the risk management measures / operating conditions have been modified, the users must ensure the risks to be managed on at least equivalent levels.

Professional users are expected to evaluate the risks in their way of ammonia use so that they ensure at their work activities that the public is excluded of their operations, thus there is no risk of its accidental exposure.

4.2. Environment

A qualitative assessment has been made only, because the resulting exposure is not expected to be significantly increased against the current level of ammonia commonly found in the environment.

HEALTH – WORKERS ES5

Table 12: Quantitative risk characterisation of dermal exposures to anhydrous or aqueous (in preparations of 5- 25% w/w) ammonia for professional workers (ES 5)

PROC code	Exposure assumptions		ES 5- exposure concentrations (EC) mg/kg bw/d		Acute / long term systemic effects DNEL = 6.8 mg/kg bw/d Risk characterisation ratio	
	Duration	Use of ventilation	No gloves worn	Gloves worn (90% reduction)	No gloves worn	Gloves worn (90% reduction)
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	1.37	0.14	0.20	0.02
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.07	0.01	0.01	<0.01
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	27.43	2.74	4.03	0.40
		Indoors with LEV	1.37	0.14	0.20	0.02
PROC 11	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	107.14	10.71	15.76	1.58
		Indoors with LEV	2.14	0.21	0.32	0.03
PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	13.71	1.37	2.02	0.20
		Indoors with LEV	0.69	0.07	0.10	0.01
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	0.34	0.03	0.05	0.01
		Indoors with LEV	0.03	<0.01	0.01	<0.01
PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	141.73	14.14	20.80	2.08 *
PROC 20	1-4 hrs or >4 hrs	Outdoors / Indoors without LEV	1.71	0.17	0.25	0.03
		Indoors with LEV	0.14	0.01	0.02	<0.01

* For conservative calculation, an assumption of 100% dermal absorption is used. Adjusting it to a more realistic value of 10% dermal absorption (ammonia is poorly absorbed through the skin) one gets dermal exposure value 1.41 mg/kg bw/d for PROC 19 (hand mixing) which, on condition of using gloves providing 90% protection, results in risk characterisation ratio RCR = 0.2.

Notes: PROC process category code
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)

Adverse effects on health:

acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, gloves), under which the estimated dermal exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health**

of workers in the industry. It means in this particular case, that when transferring the substance, including its transfer into small containers, mixing, industrial spraying, roller application or brushing, dipping or pouring in and other processes with more exposure possibilities, without the use of gloves in a space with emissions, where there is no device for local forced extract ventilation, one is in danger of ammonia toxic effects after its penetration through the skin into the body. This risk exists even for hand-mixing performed without gloves.

Table 13: Quantitative risk characterisation of inhalation exposure concentrations of anhydrous ammonia for professional workers (ES 5)

PROC code	Exposure assumptions		ES 5-exposure concentration s (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m ³		Acute-local effects DNEL = 36 mg/m ³		Long-term local effects DNEL = 14 mg/m ³	
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without LEV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05
		Indoors without LEV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 4	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without LEV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with LEV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4 hrs	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11
		Indoors without LEV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with LEV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
PROC 8b	>4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27
		Indoors without LEV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with LEV	3.19	0.16	0.07	0.00	0.09	<0.01	0.23	0.01
	1-4 hrs	Outdoors	44.63	2.23	0.94	0.05	1.24	0.06	3.19	0.16
		Indoors without LEV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with LEV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without LEV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51

PROC code	Exposure assumptions		ES 5- exposure concentrations (EC) mg/m ³		Acute / long-term systemic effects DNEL = 47.6 mg/m3		Acute-local effects DNEL = 36 mg/m3		Long-term local effects DNEL = 14 mg/m3		
					RCR		RCR		RCR		
	Duration	Use of ventilation	No RPE	RPE -95% reduction	No RPE	RPE - 95% reduction	No RPE	RPE 95% reduction	No RPE	RPE -95% reduction	
		Indoors with LEV	14.17	0.71	0.30	0.01	0.39	0.02	1.01	0.05	
	1-4 hrs	Outdoors	59.50	2.98	1.25	0.06	1.65	0.08	4.25	0.21	
		Indoors without LEV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30	
		Indoors with LEV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03	
PROC 13	>4 hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44	
		Indoors without LEV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63	
		Indoors with LEV	17.71	0.89	0.37	0.02	0.49	0.02	1.26	0.06	
	1-4 hrs	Outdoors	74.38	3.72	1.56	0.08	2.07	0.10	5.31	0.27	
Indoors without LEV		106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38		
Indoors with LEV		10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04		
PROC 15	>4 hrs	Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13	
		Indoors with LEV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01	
		Indoors without LEV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08	
	1-4 hrs	Indoors with LEV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01	
PROC 20		>4 hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
			Indoors without LEV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
	Indoors with LEV		7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03	
	1-4 hrs	Outdoors	14.88	0.74	0.31	0.02	0.41	0.02	1.06	0.05	
Indoors without LEV		21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08		
Indoors with LEV		4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02		

Notes: PROC process category code
RPE Respiratory Protection Equipment
LEV Local exhaust ventilation
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
NA not available

Adverse effects on health:

acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i. e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection

PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary

- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 13 /treatment of articles by dipping and pouring/ may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 20 /professional use for heat and pressure transfer in closed systems / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

Table 14: Quantitative risk characterisation of **inhalation exposure concentrations of aqueous ammonia (in preparations of 5-25 % w/w)** for professional workers (ES 5)

PROC code	Exposure assumptions		ES 5- exposure concentration s (EC) mg/m ³		Acute /long- term systemic effects DNEL = 47.6 mg/m3		Acute – local effects DNEL = 36 mg/m3		Long-term local effects DNEL = 14 mg/m3	
	Duration	Use of ventilation	No RPE	RPE (95% reduction)	No RPE	RPE - 95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	NA	NA	NA	NA	NA	NA
		Indoors without LEV	0.01	NA	NA	NA	NA	NA	NA	NA
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without LEV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with LEV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07

PROC code	Exposure assumptions		ES 5-exposure concentration s (EC) mg/m ³		Acute /long-term systemic effects DNEL = 47.6 mg/m3		Acute – local effects DNEL = 36 mg/m3		Long-term local effects DNEL = 14 mg/m3	
	Duration	Use of ventilation	No RPE	RPE (95% reduction)	No RPE	RPE - 95% reduction	No RPE	RPE -95% reduction	No RPE	RPE -95% reduction
PROC 3	>4hrs	Indoors without LEV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with LEV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
		Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
	1-4 hrs	Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
PROC 4	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
	1-4 hrs	Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
		Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without LEV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
PROC 5	>4hrs	Indoors with LEV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
		Outdoors	36.75	1.84	0.77	0.04	1.02	0.05	2.63	0.13
		Indoors without LEV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with LEV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
	1-4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
		Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
PROC 8a	>4hrs	Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
	1-4 hrs	Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
PROC 8b	>4 hrs	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
		Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	3.94	0.20	0.08	0.00	0.11	0.01	0.28	0.01
		Outdoors	55.13	2.76	1.16	0.06	1.53	0.08	3.94	0.20
	1-4 hrs	Indoors without LEV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with LEV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
		Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without LEV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
PROC 9	>4hrs	Indoors with LEV	17.50	0.88	0.37	0.02	0.49	0.02	1.25	0.06
		Outdoors	73.50	3.68	1.54	0.08	2.04	0.10	5.25	0.26
		Indoors without LEV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with LEV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
PROC 10	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without LEV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with LEV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
		Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33
	1-4 hrs	Indoors without LEV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with LEV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
		Outdoors	613.20	30.66	12.88	0.64	17.03	0.85	43.80	2.19
		Indoors without LEV	876.00	43.80	18.40	0.92	24.33	1.22	62.57	3.13
PROC 11	>4hrs	Indoors with LEV	175.20	8.76	3.68	0.18	4.87	0.24	12.51	0.63
		Outdoors	367.92	18.40	7.73	0.39	10.22	0.51	26.28	1.31
		Indoors without LEV	525.60	26.28	11.04	0.55	14.60	0.73	37.54	1.88
		Indoors with LEV	105.12	5.26	2.21	0.11	2.92	0.15	7.51	0.38
PROC 13	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55

Notes:	PROC	process category code
	RPE	Respiratory Protection Equipment
	LEV	Local exhaust ventilation
	RCR	Risk Characterisation Ratio
	DNEL	derived exposure level with no adverse effects (Derived No Effect Level)
	NA	not available
Adverse effects on health:		
	acute	immediate effect after contact with the substance
	chronic	effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
	local	effect at the point of contact with the substance
	system	effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Operating conditions (duration, ventilation, respiratory protection), under which the estimated inhalation exposures exceed the DNEL values (i.e. RCR value ≥ 1), include insufficient measures for risk management. They are highlighted in the table by gray background and **pose an unacceptable risk to the health of workers in the industry**. It means in this particular case, that

- PROC 1 /use in closed process, no likelihood of exposure / may be always performed (even in areas without local forced extract ventilation) without respiratory protection
- PROC 2 /use in closed, continuous process with occasional controlled exposure, for instance sampling / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 3 /use in closed batch process (synthesis or formulation) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 4 /use in batch and other process (synthesis) where opportunity for exposure arises / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases a respiratory protection is necessary
- PROC 5 /mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 7 /spraying in industrial settings and applications / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8a /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 8b /transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities / may be performed without respiratory protection only in indoor areas equipped with local forced extract ventilation, in other cases respiratory protection is necessary
- PROC 9 /transfer of substance or preparation into small containers (dedicated filling line, including weighing) / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases a respiratory protection is necessary
- PROC 10 /roller application or brushing of adhesive and other coating / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary
- PROC 11 /spraying outside industrial settings and/or applications / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 13 /treatment of articles by dipping and pouring/ may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation for less than four hours only, in other cases respiratory protection is necessary

- PROC 15 /use a laboratory reagent / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary
- PROC 19 /hand-mixing with intimate contact and only PPE available / must never be performed without respiratory protection
- PROC 20 /professional use for heat and pressure transfer in closed systems / may be performed without respiratory protection in indoor areas equipped with local forced extract ventilation only, in other cases respiratory protection is necessary

Appendix 1 **In all the evaluated processes, including those for which the respiratory protection is not necessary according to the above table, the obligation is recommended to always have a protective mask at the standby position.**

Appendix 2 Where there is a system of control measurements, proving that DNEL values outdoors are not exceeded, even if the ECETOC TRA assessment results indicated the contrary (RCR value ≥ 1), it may be due to the fact that this method is not able to include the forced extract ventilation of the outdoors into the assessment. In such a case it is not necessary to use respiratory protection, but there is the same duty as in "Warning 2" i. e., always have your protective mask at the standby position.

EXPOSURE SCENARIO 6: WIDE-DISPERSIVE END-USE – CONSUMER USES OF AQUEOUS AMMONIA

Section 1	Exposure Scenario Title
Title	Wide-dispersive end-use - Consumer use of aqueous ammonia
Use Descriptor	Sector of Use: Industrial (SU1, SU10, SU23) Process Categories: PC9a, PC9b, PC9c, PC1, PC12, PC16, PC18, PC20, PC23, PC35, PC37, PC39 UCN CODE A40200 Environmental Release Categories: ERC8a, ERC8b, ERC8d, ERC8e, ERC8f, ERC9a, ERC9b, ERC11a
Processes, tasks, activities covered	Consumers may be exposed to aqueous ammonia solutions (containing up to 25 wt% of ammonia) using different products for the household (for instance fertilizers, paints, solvents, washing and cleaning products, personal hygiene products, cosmetics). 0.05 to 0.4 wt% of ammonia is usually contained in preparations; in concentrated cleaning products, which are usually diluted before use, 5 to 10 wt% of ammonia is usually contained. When using prevalent household products, the primary route of exposure is inhalation and also dermal local effects (irritability/causticity).
Section 2	Operational conditions and risk management measures
Section 2.1	Control of consumer exposure
Product characteristics	
Physical form of product	Liquid.
Concentration of substance in product	up to 25 wt% of ammonia
Amounts used	Not applicable
Frequency and duration of use	The frequency and duration very different depending on the particular application. Using generally infrequent (once a month or several times a week).
Human factors not influenced by risk management	Not applicable
Other Operational Conditions affecting consumer exposure	Limit the substance content in the product to 25% [OC18]. Assumes a good basic standard of occupational hygiene is implemented [G1]. Assumes activities are at ambient temperature (unless stated differently) [G17].
Contributing Scenarios	Risk Management Measures
General risk management measures applicable to all activities [CS135].	Use suitable eye protection and gloves [PPE14].) Follow the basic hygiene rules. Follow the instructions provided by the product supplier.
PC1: Adhesives, sealants	No other specific measures identified [EI20].
PC9a Coatings and paints, thinners, paint removers	No other specific measures identified [EI20]
PC9b Fillers, putties, plasters, modelling clay	No other specific measures identified [EI20].
PC9c: Finger paints	No other specific measures identified [EI20].
PC12: Fertilizers	No other specific measures identified [EI20].
PC16: Heat transfer fluids	No other specific measures identified [EI20].
PC18: Ink and toners	No other specific measures identified [EI20].

PC20: Products such as ph-regulators, flocculants, pre-cipitants, neutralization agents	No other specific measures identified [EI20].
PC23: Leather tanning, dye, finishing, impregnation and care products	No other specific measures identified [EI20].
PC35 Washing and cleaning products (including solvent based products)	No other specific measures identified [EI20].
PC39 Cosmetics, personal care products	No other specific measures identified [EI20].
UCN kód A40200: Chladicí prostředky	No other specific measures identified [EI20].
Section 2.2	Control of environmental exposure
Product characteristics	Liquid (aqueous ammonia solutions).
Amounts used	Not applicable. Qualitative assessment was made only.
Frequency and duration of use	Cannot be determined.
Environmental factors not influenced by risk management	The resulting environmental exposure is not expected to add significantly to already present background levels of ammonia in the environment.
Local freshwater	Not applicable. Qualitative assessment was made only.
Marine water	Not applicable. Qualitative assessment was made only.
Other Operational Conditions of use affecting environmental exposure	Not applicable. Qualitative assessment was made only.
Technical conditions and measures at process level (source) to prevent release	
Release to air	Not applicable. Qualitative assessment was made only.
Release to wastewater	Not applicable. Qualitative assessment was made only.
Soil (direct only)Agricultural soil	Not applicable. Qualitative assessment was made only.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed
Organisation measures to prevent/limit release from site	No special measures are necessary. Nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas.
Conditions and measures related to municipal sewage treatment plant	In reality removal of ammonia in sewage treatment plants is highly efficient. Complete consumption within the STP can be assumed.
Conditions and measures related to external treatment of waste for disposal	External treatment and disposal of waste should comply with applicable local and/or national regulations
Conditions and measures related to external recovery of waste	External recovery and recycling of waste should comply with applicable local and/or national regulations
Section 3	Exposure Estimation
3.1. Health	The most serious acute and chronic local harmful effect of ammonia inhalation is respiratory irritation; the system effect of ammonia inhalation is its toxicity. In the case of dermal exposure, the local damage definitely dominates – from irritation to skin and eyes burning, and so it is essential to wear appropriate protective equipment to prevent contact with skin and eyes everywhere

	<p>where there is a risk of contact. The system effects of ammonia – i.e. symptoms of its toxicity are improbable in the case of dermal exposure, because ammonia is poorly absorbed through the skin.</p> <p>The exposure estimates were made using ECETOC TRA, ConsExpo 4.1, RIVM Factsheet assessment method. The data for exposure estimation and risk characterization are given in Tables 15 and 16. The conditions under which the estimated dermal (by skin penetration) and inhalation (by inhaling) exposures exceed the DNEL values are highlighted by gray background.</p> <p>Appendix for the dermal exposure assessment:</p> <p>Despite the fact that ammonia is poorly absorbed through the skin, an assumption has been used for a conservative assessment of the dermal exposure, that 100% of the dose is dermally absorbed.</p> <p>In the case of PC 12 (fertilizer using) and PC39 (hair dyeing) processes the mentioned conservative calculation results in exceeding the DNEL values for system health effects even when wearing gloves. When used in this case more realistic assumption for the evaluation that 10% of the dose is dermally absorbed, then the DNEL value will not be exceeded.</p>
3.2. Environment	<p>Most of the ammonia in the environment comes from the natural sources, predominantly from the organic material decomposition. Consumer use of ammonia is rather wide and varied, but this activity is not expected to significantly increase the current level of ammonia, which is commonly found in the environment. It has not been made, therefore, a quantitative assessment of the environmental exposure.</p>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<p>It is not expected that the estimated exposure exceeds the DN(M)EL, if implemented risk management / operational conditions described in Section 2.</p> <p>Consumer use of common household products containing ammonia then do not pose an unacceptable health risk to human health.</p>
4.2. Environment	<p>A qualitative assessment has been made only, because the resulting exposure to the environment is not expected to be significantly increased against the current level of ammonia commonly found in the environment.</p>

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Table 15: Quantitative risk characterisation of dermal exposures to aqueous ammonia for using common household products (e.g. DIY, cleaning and cosmetic products)

Product category	Frequency of use	Acute system effects DNEL = 6.8 mg/kg bw/d				Chronic system effects DNEL = 6.8 mg/kg bw/d			
		100% absorption		10% absorption		100% absorption		10% absorption	
		Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR
PC9a Coatings and paints, thinners, paint removers (containing 0.05 wt% of ammonia)									
Application of water dilutable paints using brush and roller	once/month	0.03	4.4x 10 ⁻³	-	-	8.2x 10 ⁻⁵	1.2x 10 ⁻⁶	-	-

AMMONIA

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006 (REACH), as amended

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Product category	Frequency of use	Acute system effects DNEL = 6.8 mg/kg bw/d				Chronic system effects DNEL = 6.8 mg/kg bw/d			
		100% absorption		10% absorption		100% absorption		10% absorption	
		Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR	Exposure dose mg/kg bw/d]	Risk characterisation ratio RCR
Spraying paint from a can	once/month	0.03	1.9x 10 ⁻³	-	-	6.8x 10 ⁻⁵	1.0x 10 ⁻⁵	-	-
Application of paints generally	once/month	0.0021	3.1x 10 ⁻³	-	-	1.9x 10 ⁻⁶	1.6x 10 ⁻⁷	-	-
Application of paint removers	once/month	0.0042	6.2x 10 ⁻³	-	-	1.1x 10 ⁻⁵	1.6x 10 ⁻⁶	-	-
PC9b Fillers, putties, plasters, modelling clay, etc. (containing 0.05 wt% of ammonia)									
Filler application	once/month	4.2x 10 ⁻⁴	6.2x 10 ⁻⁵	-	-	3.4x 10 ⁻⁶	5x 10 ⁻⁷	-	-
PC35: Washing and cleaning products, including solvent based products (containing 0.125 wt% of ammonia)									
Application of multi-purpose liquid cleaning/washing products	104 times /month	0.41	0.06	-	-	0.12	0.02	-	-
PC39: Cosmetics, personal care products (containing 4 wt% of ammonia)									
Application of hair dyes	once/month	67	9.85*	6.7	0.99	2.203	0.324	0.220	0.032
PC12: Fertilizers: preparations for lawn and garden (containing up to 25 wt% of ammonia)									
Application of fertilizer	once/year	35.7	5.25*	3.57	0.53	0.2	0.03	0.02	0.003

* For conservative calculation, an assumption of 100% dermal absorption is used. Adjusting it to a more realistic value of 10% dermal absorption (ammonia is poorly absorbed through the skin) one gets values of risk characterization RCR <1 for PC39 (hair dyeing) and PC12 (fertilizing), which means that the DNEL values are not exceeded.

Notes: PC product category code
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)
Adverse effects on health:
acute immediate effect after contact with the substance
chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
local effect at the point of contact with the substance
system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: The conditions, under which the estimated dermal exposures exceed the DNEL permissible exposure values (i. e. RCR value ≥ 1), are highlighted in the table by gray background. In this particular case, it means that there is no risk of acute or chronic effects from dermal exposure, assuming the worst scenario of 100% dermal absorption, when applying paint by brush or roller, when spraying paints from a can, in general use of paints or paint removers, or when applying fillers or cleaning and washing products. When applying fertilizers or hair dyeing, assuming 100% of dermal absorption the exposures would exceed the DNEL values, but due to the fact that ammonia is poorly absorbed through the skin, there is more realistic assumption of 10% absorption at which the DNEL values are not exceeded.

Table 16: Quantitative risk characterisation of **inhalation exposures** to aqueous ammonia for using common household products (e.g. DIY, cleaning and cosmetic products)

Product category	Frequency of use	Acute local effects DNEL = 7.2 mg/m³		Chronic local effects DNEL = 2.8 mg/m³		Acute/chronic system effects DNEL = 23.8 mg/m³	
		100% absorption		100% absorption		100% absorption	
		Exposure dose mg/kg bw/dl	Risk characterisation ratio RCR	Exposure dose mg/kg bw/dl	Risk characterisation ratio RCR	Exposure dose mg/kg bw/dl	Risk characterisation ratio RCR
PC9a Coatings and paints, thinners, paint removers (containing 0.05 wt% of ammonia)							
Application of water dilutable paint using brush and roller	once/month	7	0.97	0.0018	6.4x 10 ⁻⁴	0.0018	7.6x 10 ⁻⁵
Spraying paint from a can	once/month	0.67	0.09	5.1x 10 ⁻⁵	1.8x 10 ⁻⁵	5.1x 10 ⁻⁵	2.1x 10 ⁻⁶
Application of paints generally	once/month	6.7	0.93	2.4x 10 ⁻⁴	8.6x 10 ⁻⁵	2.4x 10 ⁻⁴	1.0x 10 ⁻⁵
Application of paint removers	once/month	3.2	0.44	3.6x 10 ⁻⁴	1.3x 10 ⁻⁴	3.6x 10 ⁻⁴	1.5x 10 ⁻⁵
PC9b Fillers, putties, plasters, modelling clay, etc. (containing 0.05 wt% of ammonia)							
Filler application	once/month	0.37	0.05	5.1x 10 ⁻³	1.8x 10 ⁻³	5.1x 10 ⁻³	2.1x 10 ⁻⁶
PC35: Washing and cleaning products, including solvent based products (containing 0.125 wt% of ammonia)							
Application of multi-purpose liquid cleaning/ washing products	104 times /month	3.3	0.46	0.16	0.06	0.16	6.7x 10 ⁻³

Notes: PC product category code
RCR Risk Characterisation Ratio
DNEL derived exposure level with no adverse effects (Derived No Effect Level)

Adverse effects on health:

- acute immediate effect after contact with the substance
- chronic effect after a longer latency period (i. e. from the moment of the actual contact with the substance to the first damage/disease symptoms)
- local effect at the point of contact with the substance
- system effect at a point remote from the point of contact (for example liver, kidney damages, etc.)

Evaluation: Even in one of the evaluated use (applying paint by brush or roller, spraying paints from a can, general use of paints or paint removers, applying fillers or cleaning and washing products) the estimated inhalation exposures do not exceed the DNEL permissible exposure values (i. e. RCR value is always less than 1). Consumer use of common household products that contain ammonia, do not pose an unacceptable health risk to human health.