Revision date: 2026.02.06
Version number: 10.1
Revision number: 0
Modification date: 2025.02.12

SECTION 1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifier

Trade name: Ammonia, anhydrous
Chemical name: Ammonia, anhydrous
Index number in accordance with Regulation (EC) No. 1272/2008: 007-001-00-5
EC Number: 231-635-3
CAS Number: 7664-41-7
REACH Registration No.: 01-2119488876-14-xxxx

Other means of identification: None.

1.2. ReVIVant identified uses of the mixture and uses advised against

1.2.1. Uses:
Industrial use:
- 1) Industrial use [SU8, SU24, SU0 (C20.1.5)]: Production of anhydrous ammonia (PC not specified);
- 2) Industrial use [SU1, SU8, SU9, SU10, SU24]: Supply and formulation of anhydrous ammonia (PC not specified);
- 3) Industrial use [SU1, SU5, SU8, SU9, SU12, SU24]: Use of anhydrous ammonia as an intermediate in industry (PC not specified);
- 4) Industrial use [SU4, SU5, SU6a, SU6b, SU8, SU9, SU11, SU12, SU13, SU15, SU16, SU23, SU0: Other (B, C, C28.2, M71)]: Industrial final anhydrous ammonia and ammonia water as recyclable and unrecyclable auxiliary materials, reacting auxiliary materials and as auxiliary agents (PC not specified).

Professional use:
- 5) Professional use [SU1, SU4, SU5, SU6a, SU6b, SU9, SU10, SU11, SU12, SU15, SU16, SU17, SU23, SU8, SU9, SU24, SU0: Other: B, C, C28.2, M71]: Anhydrous ammonia and ammonia water professional widespread use(age) as recyclable and unrecyclable auxiliary materials, reacting auxiliary materials and as auxiliary agents (PC not specified).

Further consumer use: none.

1.2.2 Uses advised against: None.

1.3. Details of the supplier of the safety data sheet

Manufacturer: AB Achema
Address: Jonalaukio k., Ruklos sen., LT-55296
Country: Lithuania
Tel. Nr.: + 370 349 56736
Manufacturer's website: www.achema.lt
Person responsible for the Safety Data Sheet (with e-mail address): Stasys Stančika, e-mail: s.stancika@achema.com

1.4. Emergency telephone number

Please contact: Poison Information and Control Office in the Republic of Lithuania by phone +370 52362052, cell phone +370 687 53378, on site http://www.apsinuodijau.lt/information-in-english/ or by the Common emergency Center by 112.
Helpdesk services work: 24 hours a day, 365 days a year.
Other remarks (language in which assistance is provided): assistance is provided in Lithuanian.
Poison Control Centers in Europe are available on site http://www.who.int/pcs/poisons/centre/directory/euro/en/.
Telephone numbers of poison control centers in the European Economic Area: **IRELAND** (Dublin) +353 1 8379964; **AUSTRIA** (Vienna) +43 1 406 43 43; **BELGIUM** (Brussels) +32 70 245 245; **BULGARIA** (Sofia) +359 2 9154 409; **CZECH REPUBLIC** (Praha) +420 224 919 293; **DENMARK** (Copenhagen) 82 12 12 12; **ESTONIA** (Talinn) 112; **GREECE** (Athens) +30 10 779 3777; **ICELAND** (Reykjavik) +354 525 111, +354 543 2222; **ITALY** (Rome) +39 06 305 4343; **LATVIA** (Ryga) +371 704 2468; **MALTA** (Valletta) 2425 0000; **NORWAY** (Oslo) 22 591300; **NETHERLANDS** (Bilthoven) +31 30 274 88 88; **FRANCE** (Paris) +33 1 40 0548 48; **FINLAND** (Helsinki) +358 9 471 977; **SWEDEN** emergency cases 112; in less acute cases +46 040 456 6700; **HUNGARY** (Budapest) 06 80 20 11 99; **GERMANY** (Berlin) +49 30 19240.

SECTION 2. HAZARDS IDENTIFICATION

2.1 Classification of the substance

Classification under Regulation (EC) No. 1272/2008 [CLP]:

Flam. Gas 2, H221;
Press. Gas, H280;
Acut. Tox.3, H301, H311, H331;
Skin Corr. 1B, H314;
Aquatic Acute 1, H400.

2.2 Label elements

Labelling in accordance with Regulation (EC) No 1272/2008 [CLP]:

Hazard pictogram(s):

GHS06 **GHS05** **GHS04** **GHS09**

Signal world: DANGER

Hazard Statements:
H221 – Flammable gas.
H280 – Contains gas under pressure; may explode if heated.
H301 – Toxic if swallowed.

H311 – Toxic in contact with skin.
H314 – Causes severe skin burns and eye damage
H331 – Toxic if inhaled.
H400 – Very toxic to aquatic life.

Precautionary statements:
P210 – Keep away from heat/sparks/open flames/hot surfaces – No Smoking.
P260 – Do not breathe dust/fumes/gas/mist/vapours/sprays.
P270 – Do not eat, drink or smoke when using this product.
P280 – Wear protective gloves / protective clothing / eye protection / face protection.
P264+P363 – Wash hands thoroughly after handling. Wash contaminated clothing before reuse.
P301+310 – IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P303+P361+P352 – IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 – IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P405 – Store locked up.

2.3 Other hazards

PBT or vPvB criteria: According to Annex XIII of Regulation (EC) No 1907/2006, no PBT and vPvB assessment has been conducted.
This substance does not contain any components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 in concentrations of 0,1 % or more.
Ammonia vapor mixtures with air will explode within 16-25% volume.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

According to the REACH Regulation the product is a mono-constituent substance.

CAS Number	Index No. in accordance with Regulation (EB) No. 1272/2008	IUPAC Name	Mass fraction, %	EC Number
7664-41-7	007-001-00-5	Ammonia, anhydrous	99.9 %	231-235-3

SECTION 4. FIRST-AID MEASURES

4.1 Description of first aid measures

4.1.1 General information.
The material can get through: inhalation, contact with skin, contact with eyes, ingestion.
4.1.2 If inhaled: in case of accident by inhalation: remove victim to fresh air and keep at rest. Oxygen or

artificial respiration if needed. Victim to lie down in the recovery position, cover and keep him warm. Call a doctor immediately. Take victim immediately to hospital. If breathing difficult, assess the extent of the damage to the affected respiratory tract, indications that the patient could have started bronchitis and / or pneumonia.
4.1.3 If on skin: take off contaminated clothing and shoes immediately. Wash off with plenty of water, at least 15 minutes. Then wash thoroughly with soap and water. If skin irritation and pain persist, seek medical advice. When clinging to the skin, it must be well-drained and stooped before cleaning them.
4.1.4 If in eyes: immediate medical attention is required. Take victim immediately to hospital. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If eye irritation, pain, swelling, excessive tearing are felt, seek medical advice.
4.1.5 If swallowed: call a physician immediately. Take victim immediately to hospital. If victim is conscious: - If swallowed, rinse mouth with milk or water (only if the person is conscious). Do NOT INDUCE VOMITING. If victim is unconscious but breathing: oxygen or artificial respiration if needed.
4.1.6. Individual protection measures recommended for first-aiders: For the victim delivered from affected area the first aid should be given with hand protection (see section 8.2.2 of this SDS). In areas where there is a risk of ammonia, providing first aid, the person must use eye and face protection, skin protection, respiratory protection (see section 8.2.2 of this SDL for requirements).

4.2 Most important symptoms and effects (acute and delayed)

Ammonia is toxic by inhalation, ingestion, in contact with skin. May cause burns. After inhalation, depending on duration and concentration, may cause ammonia vapors to irritate the upper respiratory tract and lungs, causing severe lung burns, which can be fatal.
Inhalation: quenching, cough attacks, dizziness, stomach pain, nausea. At high concentrations excites the central nervous system and causes convulsions. Pulmonary edema may develop within 48 hours of inhalation.
After skin contact: liquid ammonia drops can cause chemical and cold burns. Ammonia vapor irritates the damp skin surface. Ammonia has a weaker effect on the skin than other alkalis, but can cause severe pain, redness and blistering for longer.
After contact with the eyes: liquid ammonia drops can cause irreversible eye damage, the consequences of which may occur after a few days. In the eyes, ammonia can dazzle because it quickly penetrates into the eyes. Ammonia vapor irritates the eye mucosa and causes tearing, eye pain.
If swallowed: liquid ammonia causes severe gastrointestinal burns.

4.3 Indication of any immediate medical attention and special treatment needed

Keep under medical surveillance if inhaled: pulmonary oedema may occur within 48 hours.
Keep under medical surveillance in case of eye contact: eye damage effects may occur within a few days.

SECTION 5. FIRE-FIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media:
- If the fire is small – dry chemical, carbon dioxide.
- If the fire is large – water spray/mist, foam.
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Unsuitable extinguishing media: water. Only to be used in a closed container with ammonia for cooling and fogging, in order to precipitate ammonia vapors.

5.2 Special hazards arising from the substance or mixture

The release of ammonia vapor in enclosed spaces can lead to a burst of explosive mixtures. Closed liquid ammonia can explode from warming. Ammonia vapor clouds can limit visibility. Do not spray water into liquid

ammonia and inside its containers, this can cause heat dissipation, increase evaporation and spray hazards. Contaminated water is very dangerous to the environment.

5.3 Advice for fire-fighters

When burning ammonia gas, the best way to quench ammonia is by stopping the ammonia gas leakage and only then starting to quench it. Wear personal protective work clothing, safety boots, protective gloves, eye, face protection, respiratory protection according to LST EN 469. If there is a risk of inhalation of ammonia vapors, use self-contained breathing apparatus in accordance with LST EN 402. If there is a risk of ammonia in contact with skin, use a full-body chemical protective suit and boots in accordance with LST EN 943-1. If it is possible and safe to do this, remove ammonia containers from the fire. The outer walls of containers with ammonia, which went into the fire, cool down by a water jet until the flame disappeares. If the ammonia tank is exposed to open fire, people have to keep a long distance from them because of the risk of an explosion of ammonia containers. Avoid contact with contaminated water. Reach from the front side. Sweep gaseous ammonia, steam, fog by water spraying. Cover the surface with foam to reduce evaporation. Insulate the area until gas is scattered. Prevent the entry of ammonia or contaminated water into water bodies. After the fire, rinse the equipment exposed to smoke to prevent damage.

5.4 Other information

Prevent the entry of ammonia or contaminated water into water sources.

SECTION 6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

6.1.1 For personnel not involved in emergency situations: use recommended type K respiratory protection according LST EN 14387. Approach from upwind it it‘s safe. If unsafe to evacuate, stay indoors, close windows, turn off ventilation and electrical equipment, remove potential sources of ignition. If necessary, wear wet towels or other clothes on the face. If available, use self-contained breathing apparatus according to LST EN 402.

6.1.2 For the personnel involved in emergency situations: wear personal protective work clothing, safety boots, protective gloves, eye, face protection, respiratory protection (see requirements in section 8.2.2. of this SDS). If there is a risk of inhalation of ammonia vapors, use self-contained breathing apparatus in accordance with LST EN 402. If there is a risk of ammonia in contact with skin, use a full-body chemical protective suit and boots in accordance with LST EN 943-1. If possible, stop the flow of ammonia. According to the size and nature of the contaminated site, it is important to assess whether extraneous people have to evacuate or evacuate unsafe ones and they must remain in the rooms to close windows, turn off ventilation and electrical equipment, and remove potential sources of ignition. Isolate the accident area. Be on the side of the accident area so that the wind will carry harmful vapors away from you. Do not be in the dumps Locate poured ammonia, ventilate the area. Closed rooms are avoided before they enter. Ammonia vapor may be precipitated by water spraying. Avoid contact with contaminated water. Remove ammonia-free materials (see section 10).

6.2 Environmental precautions

Do not allow product to spread into the environment. Do not discharge into drains and / or rivers. In case of accidental plumbing or sewage system pollution, inform the systems supervising institutions.

6.3 Methods and material for containment and cleaning up

6.3.1 Containment: if possible, stop the leek of ammonia. According to the size and nature of the contaminated site evaluate if the bystanders have to evacuate or if evacuation is unsafe and they must remain indoors, close

windows, shut off ventilation and electrical devices, remove potential sources of ignition. Contain the accident area. Be on the side of the accident area from which the wind carries harmful vapors away from you. Do not be in hollow gound.
6.3.2 Cleaning: For a gas leak, increase ventilation. Ventilate closed spaces before entering. For gas leaks, use fire hoses equipped with fog nozzles to disperse gas down-wind.
6.3.3 Other information: none.

6.4 Reference to other sections
Collect spilled ammonia and its aqueous solution according to the requirements of section 13. Use personal protective equipment when handling spilled ammonia and its aqueous solution in accordance with section 8.

SECTION 7. HANDLING AND STORAGE

7.1 Precaution for safe handling. Protective measures
Protective measures: use local extraction ventilation at workplaces, constantly monitor indoor air ammonia concentrations. If handling ammonia or working in territory which contains ammonia, use appropriate personal protective equipment. Skin protection measures must be worn when there is exposure of ammonia through liquid, fog, vapors.
Fire prevention measures: while indoors do not use open flame, a potential source of ignition. Use only explosion-proof electrical equipment and measures to protect against discharge of electric charge.
Aerosol and dust prevention measures: use respiratory protective and body protective equipment where there is a risk of spillage or splashes.
Environmental precautions: do not tamper with the container, prevent the release of ammonia into the environment. Small leaks into the environment can be found through litmus paper.
Recommendations concerning good general hygiene practices at the work place: do not eat, drink, smoke at workplace. Wash hands after work and before eating. Remove contaminated clothing and remove contaminated protective equipment before entering eating.

7.2 Condition for safe storage, including any incompatibilities
Technical measures and storage conditions: store in special containers in cool and well ventilated areas. Protect from heat, exposure to sunlight, sources of ignition, contacts with incompatible materials (see section 10).
Requirements for storage places and containers: use only explosion-proof electrical equipment and measures for protection against electric charge discharge in warehouses.
It is allowed to store up to 49 tons of ammonia at a time in a warehouse. Larger amounts of ammonia can be stored in facilities which according to the 17.08.2004. resolution of the Government of the Republic of Lithuania No. 966 “On the approval of list and attribution criteria description for industrial accident prevention, liquidation and investigation regulations and of hazardous material within objects, mixtures or preparations classified as hazardous” (the Official Gazette, 2004, No. 130-4649) including all subsequent amendments and supplements or regulation No. 2012/18/EU fulfilling the requirements for hazardous objects.
When storing the product in Lithuania in stationary containers with a volume of more than 50 m^3, these containers must be registered with the state register management institution in accordance with the Chief State Labor Inspector of the Republic of Lithuania order No. 1-178 of 1st of August 2006 “On the Approval of the List-Classification of Potentially Dangerous Equipment to be Registered in the State Register, Indicating Their Parameters”. When storing the product in other countries, the storage requirements in force in those countries must be complied with.
Additional information on storage conditions: none.

7.3 ReVIVant identified uses

Industrial use:
Used as an intermediate substance in the manufacture of nitric acid, alkali, colourants, medicines, cosmetics, vitamins, synthetic fibers and plastics, as recyclable or non-recyclable auxiliary material, for example in photochemical processes, cooling systems, insulating works, inks and toners, coatings, solvent and device for paint cleaning as an auxiliary material in the chemical industry, for example an extraction measure for the removal of NO_x, SO_x, auxiliary measure for food production, neutralizing measures, textile dyes, washing and cleaning measures, processing of textile products. It is also used in pulp and paper processing, leather processing, wood and metal surface processing, rubber and latex processing, semiconductor and electronics manufacturing.

Professional use:
Used as a laboratory measure, as a cooling measure in cooling systems, as a water processing chemical, as a fertilizer, as a coating and paint solvent or device for cleaning, as a photo chemical. It is also used as a cleaning measure for leather products or other surface precessing measure, a pH adjustment or neutralizing measure, an auxiliary agent in the food industry.

Further consumer use:
Use in coating, paint diluent and device for cleaning, fillings, putty and plasters, washing and cleaning products, as well as cosmetics and body care products.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

The limit value of the component of the chemical substance and the preparation in the ambient air:
Long-term exposure limit (IPRD): 14 mg / m^3 or 20 ppm according to hygiene norm HN 23 in Lithuania.
Short-term exposure limit (TPRD): 36 mg / m^3 or 50 ppm according to hygiene norm HN 23 in Lithuania.
Limit value (NRD) according to HN 23: not applicable according to hygiene norm HN 23 in Lithuania.

Non-limiting value (s) (DNEL)
Ammonia was subjected to a quantitative effect assessment. The DNEL values for SDS sub-section 1.2.1, are given for the product use methods in which exposure scenarios are included in SDS.
Ammonia, anhydrous 99,9%

DNEL/DMEL			Exposure route	Exposure frequency	Critical component	Remark
Worker		Consumer				
Industry	Professional					
No threshold VIVel	No threshold VIVel	No threshold VIVel	oral	short term (acute)		
No threshold VIVel	No threshold VIVel	No threshold VIVel		long term (repeated)		
6.8 mg/kg NH_3	6.8 mg/kg NH_3	No threshold VIVel	dermal	short term (acute)		
No threshold VIVel	No threshold VIVel	No threshold VIVel		long term (repeated)		
47.6 mg/m^3 NH_3	23.8 mg/m^3 NH_3	No threshold VIVel	inhalation	short term (acute)		
No threshold VIVel	No threshold VIVel	No threshold VIVel		long term (repeated)		

Exposure scenario (1): production of anhydrous ammonia.
Exposure via skin quantitative risk assessment of ammonia for industrial workers: Acute / long term systemic effects DNEL = 6.8 mg / kg ps / d.

Exposure via inhalation concentration is calculated using the ECETOC TRA model: Acute / long-term systemic effects DNEL = 47.6 mg / m^3; long-term – local effects DNEL = 14 mg / m^3.

Exposure scenario (2): supply and formulation of anhydrous ammonia.

These RVR values have been obtained from the ECETOC TRA model and related DNELs.

Exposure via skin quantitative risk assessment of ammonia or ammonia water (mixtures 5-25% s / s) for industrial workers: Acute / long-term systemic effects DNEL = 6.8 mg / kg ps /d.

Exposure via inhalation quantitative risk assessment of anhydrous ammonia for industrial workers: 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.

Exposure scenario (3): supply and formulation of anhydrous ammonia.

These RVR values have been obtained from the ECETOC TRA model and related DNELs.

Exposure via skin quantitative risk assessment of ammonia or ammonia water (mixtures 5-25% s / s) for industrial workers: Acute / long-term systemic effects DNEL = 6.8 mg / kg ps /d.

Exposure via inhalation quantitative risk assessment of anhydrous ammonia for industrial workers: 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.

Exposure scenario (4): the final industrial use of anhydrous ammonia and ammonia as recyclable and unrecyclable auxiliary substance, reacting auxiliary material and as auxiliary agent.

These RVR values have been obtained from the ECETOC TRA model and related DNELs.
Exposure via skin quantitative risk assessment of anhydrous or aquatic (mixtures 5-25% s / s) ammonia for industrial workers: Acute / long-term systemic effects DNEL = 6.8 mg / kg ps / day.
Exposure via inhalation quantitative risk assessment of anhydrous ammonia for industrial workers: 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.
Exposure via inhalation quantitative risk assessment of ammonia water (mixtures 5-25% s / s) for industrial workers: 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.

Exposure scenario (5): the professional widespread use of anhydrous ammonia and ammonia water as recyclable and recyclable auxiliary materials and as auxiliary agent.

Quantitative risk assessment of anhydrous or aquatic (in mixtures 5-25% s / s) ammonia dermal exposure for professional workers: Acute / long-term systemic effects DNEL = 6.8 mg / kg ps / d.
Quantitative risk assessment of anhydrous ammonia inhalation exposure for professional workers: 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.
Quantitative risk assessment of ammonia water (mixtures 5-25% s / s) inhalation exposure for professional workers: 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.

The physico-chemical properties of DNEL ammonia which could have the greatest negative effect are presented.

Workers exposure

Exposure method	Exposure type	Hazardousness	Physicochemical property that could have the greatest negative effect
Dermal	Systemic effect - acute	DNEL: 6,8 mg/kg bw/d	Specific toxicity for a specific organ repeated effect
Inhalation	Systemic effect - acute	DNEL: 47,6 mg/m³	Specific toxicity for a specific organ repeated effect
Dermal	Local effect - acute	Ammonia is a corrosive material. DNEL values are not available.	Corrosion / irritation (eye and skin)
Inhalation	Local effect - acute	DNEL: 36 mg/m³	Respiratory tract irritation
Dermal	Systemic effect - long lasting	6,8 mg/kg bw/d	Specific toxicity for a specific organ repeated effect
Inhalation	Systemic effect - long lasting	DNEL: 47,6 mg/m³	Specific toxicity for a specific organ repeated effect
Dermal	Local effect – long lasting	Ammonia is a corrosive material. DNEL values are not available.	Corrosion / irritation (eye and skin)
Inhalation	Local effect – long lasting	DNEL: 14 mg/m³	Respiratory tract irritation

Predicted inactive concentration(s) PNEC:

Task in the field of environmental protection	PNEC value, mg/l
Fresh water	0,0011 mg/l
Fresh water sediment	Ammonia is highly soluble in water and does not accumulate in sediments therefore it is not demanded to determine a PNEC of sediment.
Sea water	0,0011 mg/l
Sea water sediment	Ammonia is highly soluble in water and does not accumulate in sediments therefore it is not demanded to obtain a sediment PNEC.
Food chain	There is no data that ammonia has bioaccumulation properties. Because its log Kow value is 0.23 which is less than 3, it is not demanded to determine a PNEC of food chain.
Microorganisms in sewage treatment system	Ammonia is fragmented by bacteria as a nutrient. It is also an intermediate product for bacteria decomposing other nitrogen compounds. Accordingly it is not demanded to determine a PNEC for it.
Soil (agricultural)	Ammonia, directly inserted in the soil, rapidly converts into other compounds in the nitrate cycle, and therefore its effects on the macro-organisms of soil are not noticeable.
Air	Not specified.

Ammonia odor threshold in the range 0.6-53 ppm, average 17 ppm.
If an odor of ammonia is detected, measurements shall be made during manufacture, storage or use of the product so that the concentration of ammonia in the workplace does not exceed:

- long-term exposure limit (IPRD): 14 mg / m^3 or 20 ppm (applicable in Lithuania according to hygiene norm HN 23).
- short-term exposure limit (TPRD): 36 mg / m^3 or 50 ppm (applicable in Lithuania according to hygiene norm HN 23).

The product must be manufactured and used in a professional manner by the Minister of Social Security and Labor of the Republic of Lithuania and the Minister of Health of 2001 of 24 of July Order No. 97/406 „On approval of Regulations for the Protection of Workers from Chemical Agents at Work and for the Protection of Workers against the Exposure to Carcinogens and Mutagens at Work“ (Official Gazette, 2001, No. 65-2396), with all the subsequent amendments and additions.

8.2 Exposure controls

8.2.1. Appropriate engineering controls: Supply-exhaust ventilation according to STR 2.09.02, continuous monitoring of ammonia vapor concentration in ambient air, and explosive environmental equipment. Ammonia treated areas should have full-body and eye-wash showers. Engineering controls must be used to ensure that the amount of ammonia in the environment does not exceed the limit values.

Organizational measures to avoid exposure of the product:
8.2.2. Individual protection measures, such as personal protective equipment: personal protective equipment must be used in accordance with good work-hygiene practices and must be used together with other control measures, including technical controls, ventilation and isolation.
8.2.2.1 Eye and (or) face protection: chemical protective safety goggles or face protective shield according to LST EN ISO 16321-1 and LST EN ISO 16321-3. Face shielding remedies are recommended.
8.2.2.2 Skin protection:
Hand protection: adequate protection gloves according to LST EN 420, LST EN ISO 21420 due to chemical protection, EN 388 due to mechanical protection, LST EN 511 due to freezing protection. Protective gloves must be made of one of the materials listed in the table, at least as specified, for penetration of thickness and resistance.

Glove material	Glove thickness, mm	Penetration time, min*
Butyl rubber	0.70	480
Fluorescent rubber	1.50	480
Fluorocarbon rubber	n.m. 0.40	120
Polychloroprene	n.m. 0.50	60

* - Time of penetration of glove material is the time that the product in contact with the glove penetrates through it completely. The shorter the penetration time, the glove material is less resistant to the product.

The suitability and durability of gloves depend on the frequency and duration of contact with the product, the material used to manufacture gloves, chemical resistance, gloves, functional use. It is recommended to use glove material with a penetration time of less than 480 minutes when working with the product continuously. When working with the product, gloves may not be used for longer than the penetration time.
Gloves made of natural rubber / natural latex, nitrile / nitrile latex, polyvinyl chloride are not suitable for work with the product.
Skin protection creams do not adequately protect the product.
Please note that the penetration time of the glove material in this section has been set at 22 ° C and using pure ammonium nitrate. When using calcium ammonium nitrate consisting of a mixture of ammonium nitrate and dolomite, the time of penetration of the glove material should be similar in size. When working at a higher temperature, the resistance of the glove material may be considerably lower, and in such cases, the permitted life of the glove must be shortened. We recommend that when you start using a new type or other manufacturer's gloves, make sure that they are chemically and mechanically resistant to working conditions. If you have any questions about the suitability of the gloves, please contact the manufacturers / suppliers of gloves.
The inside of the gloves should not contain powders which can cause hand skin allergies.
Before using the gloves, please always make sure there are no tears, cracks, or other defects. When the work is finished, the gloves must be cleaned and washed thoroughly before they are dry. After work, care must be taken to the hand skin.
Other protection: chemical resistant workwear in accordance with LST EN ISO 13688, LST EN 1149-5 on antistatic properties, LST EN ISO 11612 on protection against heat and flame and ammonia-resistant rubber boots according to LST EN ISO 20345.
8.2.2.3 Respiratory protection: Suitable respiratory protection in the presence of low vapor or aerosol concentrations of the product (slightly exceeding the permitted occupational exposure limits HN 23), is a filter with a “K” filter according to LST EN 14387. In case of prolonged use in the environment, use gas hoses, compressed air breathing apparatus according to LST EN 402.
8.2.2.4 Thermal protection: Chemically resistant gloves according to LST EN 511, winter footwear protection – felt with rubber calio, felt shoes with rubber padding or rubberized shoes according LST EN 20345.
8.2.3 Environmental exposure controls: conduct regular / constant control of the pH of discharged sewage water, do not allow to enter drains and the environment.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Physical state: gas, while in 20 ºC and pressure of 1013 hPa.
b) Color: colourless.
c) Odour: very pungent. Odour threshold: 0.6 – 53 ppm threshold, with geometric mean of 17 ppm.
d) Melting and solidifying temperature: -77.7°C (source – Merck Index).
e) Boiling point or initial boiling point and boiling range: 240 K or –33.4 °C at 1013 hPa. Validation: According to the REACH documentation for ammonia registration, in the literature source – Handbook of

Compressed Gases a boiling point of –33 °C is indicated and in the literature source – CRC Handbook 2006 it is indicated of –33.33 °C.
f) Flammability: flammable gas.
g) Upper and lower explosion limits: the lower explosion limit of ammonia is 16% by volume and the upper limit is 25% by volume.
h) Flash point: according to REACH Regulation Annex VII column 2 it is not clarified, using an explanation: it was not identified because the product is an inorganic material.
i) Auto-ignition temperature: 924 K or 651 °C at 1013 hPa. Validation: The result of the registration for ammonia according to REACH dossier was calculated on the basis of the source – Fire Protection Guide.
j) Decomposition temperature: 450 °C.
k) pH: 11.7 (1% concentration aqueous solution).
l) Kinematic viscosity: n.a. since it is a gas. The literature source – CRC Handbook – estimates the ammonia anhydrous viscosity values: 0.475, 0.317, 0.276 and 0.255 cp at a temperature of –69, –50, –40 and –33.5 °C.
m) Solubility: highly soluble in water, approximately 482 000 mg / l at 25 °C. Validation: according to REACH documentation for ammonia, the solubility of water in various literature sources is 48200 – 53100 mg/l.
n) Partition coefficient: n-octanol/water (logarithmic value): Log Kow (Pow) is equal to 0.23 at 20 °C. Validation: according to REACH regulation annex VII column 2, could be unexplained because the material is inorganic. The value is based on the literature source – UK Environment Agency report.
o) Vapour pressure: 8611 hPa at 20 °C. Validation: Registration of ammonia according to the literature sources given in REACH dossier – Handbook of Compressed Gases.
p) Density and / or relative density: 0.717 g / l at normal temperature and pressure; 0.769 g / l at standard temperature and pressure. Validation: refers to ammonia REACH registration.
q) Relative vapor density: 0,7714 g/l, at 0 ºC and pressure 101,3 kPa.
r) Fraction properties: Not applicable as the product is a gas.

9.2 Other information
None.

SECTION 10. STABILITY AND REACTIVITY

10.1 Reactivity
Stable under normal conditions. See section 10.3 for more details.

10.2 Chemical stability
Stable under appropriate conditions. Not Polymerize. See section 10.3 for more details.

10.3 Possibility of hazardous reactions
Can form unstable or explosive compounds with halogens, strong oxides, nitric acid, fluorine, nitrogen oxides, hypochlorites, silver, mercury, lead. Tightly reacts with strong acids, nitrogen oxides. Ammonia forms explosive mixtures with air and hydrocarbons, ethanol, silver nitrate, chlorine. Contains explosive products in response to silver chloride, silver oxide, bromine, iodine, gold, mercury, and telomerur halite. Ammonia is incompatible, which may lead to dangerous reactions, with silver, acetylaldehyde, halogens, perchlorates, hydrochloric acid, chlorine monoxide, chlorite, nitrogen tetroxide, tin and sulfur.
When heated above 454 °C, it decomposes in the presence of hydrogen. In the case of certain metals, such as nickel, the dehumidification temperature may drop to 300 °C. At 690 °C and in the case of electrical sparking, ammonia decomposes into nitrogen and hydrogen, which can form combustible mixtures with air.

10.4 Conditions to avoid
Heating, mechanical damage to the container.

10.5 Incompatible materials
Halogens, nitric acid, hypochlorites, silver, mercury, lead, strong acids and nitrogen oxides. Destroys copper, gold, zinc, aluminum, cadmium and their compounds. For the possibility of hazardous reactions see section 10.3.

10.6 Hazardous decomposition products
Hydrogen, nitrogen oxides.

SECTION 11. TOXICOLOGICAL INFORMATION

11.1 Information on hazard classes as defined in Regulation (EC) No 1272/2008
Acute toxicity: toxic by inhalation. Based on available data in accordance with Regulation (EC) No. 1272/2008 it is classified as acute toxicity Cat.3.

	Effect dose	Species	Method	Remark
Acute oral toxicity	LD50 350 mg/kg bw	Wistar male rats	Acute Oral Toxicity	Probit Analysis
Acute dermal toxicity	Not determined due to ammonia is corrosive to the skin			
Acute inhalative toxicity	LC50 28130 – 9850 mg/m^3	Wistar male and female rats	Assessment of acute inhalation toxicity in the rat following various exposure periods.	Results are the range from 10 minutes exposure to 60 minutes exposure.

Long term toxicity

	Effect dose	Value	Exposure time period	Species	Method	Evaluation	Remark
Sub-acute oral	68 mg/kg bw/d	NOAEL	35 days	CD male and female rats	Combined Repeated dose Toxicity Study with the Reproduction/Developmental Toxicity Study	No marked toxicity	
Sub-chronic inhalative	35 or 63 mg/m^3	NOAEC	50 days	Wistar rats, male	Subchronic inhalative toxicity of ammonia in the rat.	No systemic toxicity, however, the primary effect is local irritation of the respiratory tract.	

Skin irritation or/and sensitization: corrosive. Based on available data in accordance with Regulation (EC) No. 1272/2008 it is classified as skin corrosion / irritation Cat. 1B.

	Exposure time	Species	Evaluation	Method	Remark
Primary irritation to the skin	n/a	Human	Corrosive	n/a	Skin pH was determined to be 10
Irritation to eyes	n/a	n/a	Highly irritating	n/a	No study conducted, however, based on the results of the skin irritation, it can be assumed that eye irritation will occur.

Serious eye damage/irritation: highly irritates the eyes. In accordance with Regulation (EC) No. 1272/2008 it is classified as skin corrosion / irritation. Cat. 1B. Refered to REACH dossier data for registration of ammonia.
Sensitizing of the airways or skin: severely irritating to the eyes. In accordance with Regulation (EC) No. 1272/2008 it is classified as skin corrosion / irritation Cat. 1B. Referred to the registration of ammonia in accordance with REACH dossier data.
Respiratory or dermal sensitization: irritating to the respiratory system. In accordance with Regulation (EC) No. 1272/2008 it is classified as skin corrosion / irritation Cat. 1B. Referred to the registration of ammonia in accordance with REACH dossier data.
Mutagenicity: Based on available data does not meet the criteria for classification in accordance with Regulation (EC) No. 1272/2008. Validation: There is no indication of mutagenicity while testing *in vitro* for bacterial inverse mutation and *in vivo* micronucleus test. The Ames test, performed with ammonia, is negative (with and without the metabolic activation). Referred to registration of ammonia in accordance with REACH dossier data.
Carcinogenicity: Based on available data does not meet with the classification criteria in accordance with Regulation (EC) No. 1272/2008. Validation: Studies conducted with ammonium sulphate showed no signs of carcinogenicity. An ammonia exposure study has shown that long-term exposure via drinking water which has ammonia in it can lead to gastritis that stimulates stomach carcinogenesis. However, there is no evidence that ammonia is carcinogenic. Referred to registration of ammonia in accordance with REACH dossier data.
Reproductive toxicity: Based on available data does not meet the classification criteria in accordance with Regulation (EC) No. 1272/2008. Validation: Ammonia registration in the REACH dossier states that no evidence of reproductive toxicity has been identified in ammonium salts studies. Based on the physiological role of ammonia, it was concluded that ammonia is not able to cause reproductive toxicity.
Specific target organ toxicity (STOT) (single exposure): Based on available data does not meet the classification criteria in accordance with Regulation (EC) No. 1272/2008. Referred to registration of ammonia in accordance with REACH dossier.
Specific target organ toxicity (STOT) (repeated effects): Based on available data does not meet the classification criteria in accordance with Regulation (EC) No. 1272/2008. Referred to registration of ammonia in accordance with REACH dossier for registration of ammonia.
Aspiration hazard: Based on available data does not meet the classification criteria in accordance with Regulation (EC) No. 1272/2008.

11.2. Information on the other hazards

11.2.1. Endocrine disrupting properties: This substance does not contain any components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 in concentrations of 0,1 % or more.

11.2.2. Other information: None.

SECTION 12. ECOLOGICAL INFORMATION

12.1 Toxicity

According to the available data, the product is classified as hazardous to the aquatic environment category 1 in accordance with Regulation (EC) No 1272/2008.

Hazardous to the aquatic environment: toxic to aquatic organisms. Based on available data, the classification criteria as toxic to aquatic organisms Cat. 1 are met in accordance with Regulation (EC) No. 1272/2008.

Aquatic toxicity	Effect dose	Exposure time	Species	Method	Evaluation	Remark
Acute fish toxicity	LC50	96 h	*Onchorynchus mykiss*		0.89 mg/L unionised ammonia.	Result is pH and temperature adjusted.
Acute daphnia toxicity	EC50	48 h	*Daphnia magna*	Freshwater static, equivalent to ASTM E729-80.	101 mg/L	Results based on mortality.
Acute algae toxicity	EC50	18 days	*Chlorella vulgaris*	Freshwater, static	7200 mg/L	Result based on cell number
Chronic fish toxicity	LOEC	73 days	*Onchorynchus mykiss*		0.022 mg/L	Result based on mortality
Chronic daphnia toxicity	NOEC	96 h	*Daphnia magna*	Freshwater flow-through equivalent or similar to EPA OPPTS 850.1300 (Daphnid Chronic Toxicity Test)	0.79 mg/L unionised ammonia	Result based on mortality.

12.2 Persistence and degradability

Not considered to be persistent and is rapidly biodegradable in aquatic systems. In abiotic environments, ammonia is assimilated by aquatic algae and macrophytes for use as a nitrogen source.
The registration of ammonia in the REACH documentation states that ammonia dissipates relatively quickly in ambient air and rapidly returns to the soil via combination with sulfate ions or washout by rainfall. Ammonia strongly adsorbs to soil, sediment particles and colloids in water under aerobic conditions. Biodegradation of ammonia to nitrate occurs in water under aerobic conditions resulting in a biological oxygen demand (BOD).

12.3 Bioaccumulative potential

The accumulation of ammonia in biota is not considered of importance in the environment as it does not accumulate in lipid-rich tissues in the same manner as organic chemicals. Ammonia is ubiquitous in the aquatic environment due to the breakdown of plant and animal material and due to animal excretory processes. Based on the chemical nature of ammonia and the fact that it is a product of animal metabolism, ammonia registration in the REACH documentation states that bioaccumulation of ammonia is unlikely.

12.4 Mobility in soil

There is limited mobility in soil expected due to the strong adsorption of ammonium ions to clay minerals and the bacterial oxidation to nitrate. Ammonia in soil is in dynamic equilibrium with nitrate and other substrates in the nitrate cycle.

12.5 Results of PBT and vPvB assessment

This substance is not identified as a PBT substance.

12.6 Endocrine disrupting properties:

This substance does not contain any components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 in concentrations of 0,1 % or more.

12.7 Other side effects:

Undetermined.

SECTION 13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

13.1.1 Product / package disposal:

Waste from residues – ammonia waste in accordance with Regulation (EU) 1357/2014 is classified as hazardous waste by **HP 3** „Flammable“ hazard statement code H221 „Flammable gas“; **HP 6** „Acute toxicity“ hazard statement H301 „Toxic if swallowed“, H311 „Toxic in contact with skin“, H331 „Toxic if inhaled“; **HP 8** „Corrosive“ hazard statement H314 „Causes severe skin burns and eye damage“; **HP 14** „Ecotoxicity“ hazard statement H400 „Very toxic to aquatic life“; **HP 15** „Wastes that may show any of the previous hazardous properties which primary waste does not directly possess“ hazard statement H280 „Contains gas under pressure; may explode if heated“.

Ammonia packaging waste – ammonia packaging waste in accordance with Regulation (EU) 1357/2014 is classified as hazardous waste by **HP 3** „Flammable“ hazard statement code H221 „Flammable gas“; **HP 6** „Acute Toxicity“ hazard statement H301 „Toxic if swallowed“, H311 „Toxic in contact with skin“, H331 „Toxic if inhaled“; **HP 8** „Corrosive“ hazard statement H314 „Causes severe skin burns and eye damage“; **HP 14** „Ecotoxic“ hazard statement H400 „Very toxic to aquatic life“; **HP 15** „Wastes capable of exhibiting a hazardous property listed above not directly displayed by the original waste” hazard statement H280 „Contains gas under pressure; may explode if heated“.

13.1.2 Information related to waste disposal:

Waste management method – waste of ammonia and its mixtures is hazardous waste as the production, mixing and use of alkaline solutions is carried out with the waste code 06 02 03* and must be handled in accordance with the Law on Waste Management and regional and local laws of the Republic of Lithuania. Wastes of ammonia and its mixtures may be temporarily stored in appropriate, closed, well-labbeled containers before the transfer to the company managing the registered waste in accordance with the „Waste Management Act“. The final product waste code is assigned by the waste manager / holder.

Disposal of packaging – empty containers can contain ammonia vapours, that when mixed with air may form explosive mixtures, therefore do not drill cut, grind or weld empty containers. The used packaging is dangerous and must be handled in accordance with the Republic of Lithuania „Packaging and packaging waste management law“ as well as regional and local laws. The used packaging may be temporarily stored, properly marked, until the transfer to the company registered in he „Waste Management Act“ to manage the waste. The final product waste code is assigned by the waste manager / holder.

13.1.3 Related information about the disposal of sewage: ammonia is toxic to aquatic life. It is forbidden to release water contaminated by the product into the environment or into the water drain. Wastes of ammonia and its mixtures may be temporarily stored in appropriate, closed, well-marked containers until the transfer to the company registered in he „Waste Management Act“ to manage the waste.

13.1.4. Other disposal recommendations: none.

SECTION 14. TRANSPORT INFORMATION

14.1 UN number or ID number

UN No. 1005.

14.2 UN proper shipping name
Ammonia, Anhydrous.

14.3 Transport hazard class (es)
Hazard class 2. Labbeling according to ADR: 2.3 + 8.

14.4 Packing group
Not applicable.

14.5 Environmental hazards
Environmentally hazardous substance.

14.6 Special precautions for user
Not applicable.

14.7 Carriage of bulk cargoes by sea in accordance with IMO measures
Not applicable.

SECTION 15. REGULATORY INFORMATION

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

EU legislation:
- Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC;

- Commission Regulation No. (EU) 2020/878 amending Regulation of the European Parliament and of the Council Annex II to Regulation (EC) No. 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) (published in Official Journal of the European Union L 203 of 26 June 2020);

- Commission Regulation (EC) No. 552/2009 of 22 June 2009 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards Annex XVII;

- Regulation (EC) No. 1272/2008 2006 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006;

- Commission Regulation (EU) No. 1357/2014 of 18 December 2014 replacing Annex III to Directive 2008/98/EC of the European Parliament and of the Council on waste and repealing certain Directives;

- Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (published in the Official Journal of the European Union L197, 27 of July 2012);

- Regulation (EU) 2019/1148 of the European Parliament and of the Council 20th of June 2019 on trade in and use of

explosives precursors and amending Regulation (EC) No. 1907/2006 and repealing Regulation (EU) No. 98/2013 (published in the Official Journal of the European Union L 186/1, 2019) as subsequently amended and supplemented;

- European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR);
- The International Rule for Transport of Dangerous Substances by Railway (RID);
- The International Maritime Dangerous Goods (IMDG);
- International Convention for the Prevention of Pollution from Ships (MARPOL 73/78);
- The International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code) (the IBC Code).

National legislation (Lithuania):
- Applicable Law on Waste Disposal of the Republic of Lithuania;
- Applicable Law on Package and Package Waste Handling of the Republic of Lithuania;
- HN23 Maximum Allowable Concentrations of Hazardous Chemical Substances and Preparations in Working Environment. General Requirements;
- HN36 Banned and Restricted Substances;
- Applicable Regulations for Workers ”Protection against the Impact of Chemical Factors” and Regulations for Workers „Protection against Carcinogenous and Mutagenous Impacts”;
- Applicable Procedure of Safety Data Sheet Requirements and Supply thereof to Professional Users;
- Applicable Rules on Labeling of Items (Products) to be Sold in Lithuania and Referring Price thereof;
- Applicable Rules on Waste Disposal;

- Law on the Supervision of Toxic Substances of the Republic of Lithuania (No IX-456 of 12 July 2001) (Official Gazette 2001, No 64-2330; TAR identification code 1011010ISTA00IX-456) including all subsequent amendments and supplements;

- Minister of Health of the Republic of Lithuania, 2002 June 26 Order No. 302 “On the Approval of the Rules for Issuing Permits for the Acquisition, Sale or Other Transfer of Toxic Substances” (Official Gazette, 2002, No. 70-2932, TAR identification code 1022250ISAK00000302) including all subsequent supplements and amendments;

- 17 of August 2004 Governments of the LR resolution No. 966 „On Prevention, Response and Investigation of dangerous objects and substances, mixtures or preparations classified as hazardous materials, and a list of criteria for designation of the Approval” subsequently amended and supplemented. (Official Gazette, 2004, No. 130-4649; 2005 No. 131-4731, 2008, No. 109-4159; 2009 No. 90-3855; 2010, No. 59-2894; 2012 No. 61-3078), as amended and supplemented;

- Minister of Social Security and Labor of the Republic of Lithuania and Minister of Health of 2001 July 24 order No. 97/406 “On Approval of Provisions for the Protection of Workers from Chemical Agents at Work and the Protection of Workers from the Effects of Carcinogens and Mutagens at Work” (Official Gazette, 2001, No. 65-2396, TAR identification code 1012230ISAK0097 / 406), including all subsequent amendments and supplements;

- Minister of Agriculture of the Republic of Lithuania 2013 December 9 th order No. 3D-825 “On Approval of Rules for Technological Design of Warehouses for Mineral Fertilizers and Plant Protection Products in the UAA TPT 10: 2013” (Official Gazette, 2013, No. 128-6540, TAR identification code 1132330ISAK003D-825), including all subsequent amendments and supplements;

- Chief State Labor Inspector of the Republic of Lithuania in 2006 August 1 Order No. 1-178 “On the Approval of the List-Classification of Potentially Dangerous Equipment to be Registered in the State Register, Indicating Their Parameters”;

- LST EN 388 “Protective gloves against mechanical hazards”;

- LST EN 402 “Respiratory protective devices. Lung-controlled self-contained open-circuit compressed air breathing apparatus with full face mask or mouthpiece assembly. Requirements, testing, marking”.

- LST EN 420 “Protective gloves. General requirements and testing methods”;

- LST EN 469 “Protective clothing for firefighters. Performance requirements for firefighting protective clothing”;

- LST EN 511 “Protective gloves from freezing”;

- LST EN ISO 780 „Packaging. Distribution packages. Graphic symbols for packaging handling and storage (ISO 780:2015)“;

- LST EN 943-1 “Protective clothing against solid, liquid and gaseous chemicals, including liquid and particulate aerosols Part 1. Performance requirements for Type 1 (gas tight) chemical suit”;

- LST EN 1149-5 “Protective clothing. Electrostatic properties. Part 5. Material Characteristics and Design Requirements”;

- LST EN ISO 11612 “Protective clothing. Clothing for protection against heat and flame. Minimum performance requirements (ISO 11612: 2015)”;

- LST EN ISO 13688 “Protective clothing. General requirements (ISO 13688:2013)”;

- LST EN 14387 “Respiratory protective devices. Gas filters and composite filters. Requirements, testing, marking”;

- LST EN ISO 16321-1 „Eye and face protection equipment for work”. Part 1. General requirements (ISO 16321-1:2021)“;

- LST EN ISO 16321-3 „Eye and face protection equipment for work”. Part 3. Additional requirements for mesh guards (ISO 16321-3:2021)“;

- LST EN ISO 20345 „Personal protective equipment. Safe footwear (ISO 20345: 2011)”;

- LST EN ISO 21420 „Protective gloves. General requirements and test methods“.

Additional information on the reVIVant Community provisions on safety, health and the environment for the product:
The product is a toxic substance according to the Law on the Supervision of Toxic Substances of the Republic of Lithuania. Pursuant to the Law on the Supervision of Toxic Substances of the Republic of Lithuania, only competent persons who comply with the requirements of this Law and have a permit referred to in Article 9 (1) of this Law to perform activities related to toxic substances (hereinafter - permit) public health center. Permits are revoked in accordance with the 2002 Decree of the Minister of Health of the Republic of Lithuania. June 26 order no. 302 “On the Approval of the Rules for Issuing Permits for the Acquisition, Sale or Other Transfer of Toxic Substances” with all subsequent amendments and additions.

The product is a dangerous substance, which is subject to the Government of the Republic Regulation No. 18.08.2004. 966 „On the Approval of the Description and List of Criteria for the List of Substances, Mixtures or Preparations Substances of Hazardous Substances in Hazardous Substances“ (Official Gazette, 2004, No. 130-4649) with all subsequent amendments and supplements And listed in Part 2 of Annex I to Directive 2012/18 / EU.
Restrictions on the product as regards Regulation (EU) No. 2019/1148: not applicable.

15.2 Chemical safety assessment
A chemical safety assessment has been conducted. See annex.

SECTION 16. OTHER INFORMATION

Revision date: 2026.02.06
Version: 10.1
Revision No. 0
Issuing date: 2025.02.12

(i) A clear evidence of added, deleted or modified information:
The following changes were made to the safety data sheet as compared to the previous version:
- Headline of SDS: Revision date, version number and issuing date of this safety data sheet has been changed;
- sub-section 2.3: information on product components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100, or Commission Regulation (EU) 2018/605, at concentrations of 0.1% or more has been included;
- sub-section 11.2.1: information on product components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100, or Commission Regulation (EU) 2018/605, at concentrations of 0.1% or more has been included;
- sub-section 12.6: information on product components considered to have endocrine disrupting properties in accordance with Article 59(1) of REACH, Commission Delegated Regulation (EU) 2017/2100, or Commission Regulation (EU) 2018/605, at concentrations of 0.1% or more has been included;
- section 16: revision date, version number and issuing date of this safety data sheet has been changed.

(ii) List of abbreviations and acronyms used throughout the Safety Data Sheet:
Acute Tox.3 – Acute toxicity Category 3;
ADR – European Agreement on Dangerous Goods by Road;
ATE – Acute toxicity estimates;
Aquatic Acute 1 – Dangerous for the aquatic environment category 1;
C&L – Classification and labeling;
CLP – Classification, Labeling and Packaging regulation; Regulation (EC) No. 1272/2008;
CAS – Chemical Abstracts Service;
CSR – Chemical Safety Report;
DNEL – Derived No-Effect Limit;
DMEL – Derived minimum impact value;
EC – European Commission;
ECHA – European Chemicals Agency;
EC_{50} – Effective concentration in 50% of the target population;
EC No. – EINECS and ELINCS numbers;
EFMA – European Fertilizers Manufactures Association.
EINECS – European Inventory of Existing Commercial Chemical Substances.
ELINCS – European List of New Chemicals.
EN – European norm;
EU – European Union;
Flam Gas 2 – Flammable gas category 2;
GHS – Generally Harmonized System;
HN – Hygiene norm;
IBC Code – The International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk;
IMDG – International Maritime Dangerous Goods Code;
IMSBC – International Bulk Cargo Code;
IPRD – Long-term Exposure Limit;
IUCLID – International Database of General Information on Chemicals;
IUPAC – International Union of Pure and Applied Chemistry;
UN – United Nations;
Kow – octanol-water partition coefficient;
LC_{50} – Median lethal concentration in 50% of the population under study;
LD_{50} – Median lethal doze in 50% of the population under study;
LOEC – Minimum observed effect concentration;

LT – Lithuanian;
MARPOL 73/78 – International Convention for the Prevention of Pollution from Ships;
NOAEC – Concentration of non-observation negative effect;
NOEC – Concentration of non-observation effect;
OJ – Official Journal;
PBT – Persistent bioaccumulative toxicity;
PEC – Predicted environmental concentration;
PNEC – Predicted no effect concentration;
PPE – Personal protective equipment;
Press Gas – Pressurized gas;
REACH – Registration, Evaluation, Authorization and Restrictions;
RID – Regulations Concerning the International Carriage of Dangerous Goods by Rail;
RV - Limit value in working environment;
RMP - Risk Management Tools;
SCBA – Self-contained breathing apparatus;
Skin Corr 1B – Skin corrosion / irritation Category 1B;
SDS – Safety Data Sheet;
SIEF – Chemical Substance Information Exchange Forum;
STOT – Specific target organ toxicity;
(STOT) RE – Repeated exposure;
(STOT) SE – One-time effects;
SVHC – Severely critical substance;
TPRD – Short-term exposure limit;
UN – United Nations;
(Q) SAR – (Quantitative) structure and property relationship;
vPvB – Very persistent, very bioaccumulative.

Explanation of Utilization Sector (S):
SU1 – Agriculture, Forestry, Fisheries;
SU4 – Food industry;
SU5 – Manufacture of textiles, leather, fur;
SU6a – Manufacture of wood and wood products;
SU6b – Manufacture of pulp, paper and paper products;
SU8 – Production of large-scale chemical products (including petroleum products);
SU9 – Manufacture of purified chemicals;
SU10 – Preparation or repackaging;
SU11 – Manufacture of rubber products;
SU12 – Manufacture of plastics, including blending and recycling;
SU13 – Manufacture of other non-metallic mineral products, such as gypsum, cement;
SU15 – Manufacture of products of metal components, except machinery and equipment;
SU16 – Manufacture of computer, electronic and optical products, electrical equipment;
SU17 – Generic production, eg machinery, equipment, vehicles, other transport equipment;
SU23 – Electricity, steam, gas, water supply and sewage treatment;
SU0 – Other (C20.1.5);
SU0 – Other (B, C, C28.2, M71).

(iii) Bibliography:
1) http://gestis-en.itrust.de/nxt/gateway.dll?f=templates&fn=default.htm&vid=gestiseng:sdbeng
2) Ammonia registration dossier under REACH, available on the website of the European Chemicals Agency

(data taken on 28-02-2021);

(iv) Applicable classification and procedures used to determine the classification of mixtures in accordance with Regulation (EC) No. 1272/2008 [CLP Regulation]: does not apply to solids.

(v) Hazard and precautionary statements:
H221 – Flammable gas.
H280 – Contains gas under pressure; may explode if heated.
H301 – Toxic if swallowed.
H311 – Toxic in contact with skin.
H314 – Causes severe skin burns and eye damage.
H331 – Toxic if inhaled.
H400 – Very toxic to aquatic life.
P210 – Keep away from heat/sparks/open flames/hot surfaces – No Smoking.
P260 – Do not breathe dust/fumes/gas/mist/vapours/sprays.
P270 – Do not eat, drink or smoke when using this product.
P280 – Wear protective gloves / protective clothing / eye protection / face protection.
P264+P363 – Wash hands thoroughly after handling. Wash contaminated clothing before reuse.
P301+310 – IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P303+P361+P352 – IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 – IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P405 – Store locked up.

Additional information presented on the package (container) label of chemical substance: visual sign No. 6 „Protect from rain“ in compliance with LST EN ISO 780.

(vi) Training Advice:
To ensure the protection of people and the environment, people who manufacture, handle and use this product must be trained to work with hazardous substances, hazardous materials, have adequate hygiene skills, first aid principles and information on emergency procedures. This safety data sheet must be made available to those working with the product. Persons must be instructed before working with the product.

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

Release info: This version replaces all previous documents.

Annex of extended Safety Data Sheet (eSDS):

Exposure Scenarios:
1. Manufacture of ammonia;
2. Distribution and formulation of ammonia;
3. Industrial use of anhydrous ammonia as an intermediate;
4. Industrial end-use of anhydrous and aqueous ammonia as processing aids, non-processing aids and auxiliary agents;
5. Wide-dispersive professional use of anhydrous and aqueous ammonia.

Exposure Scenario 1: Manufacture of ammonia

1	**Exposure Scenario 1**

Manufacturie of anhydrous ammonia
Processes Covered:
Environmental Releases
ERC1: Manufacture of substances
Worker Processes
PROC01: Use in closed process, no likelihood of exposure.
PROC02: Use in closed, continuous process with occasional controlled exposure.
PROC08a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.
PROC08b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
Anhydrous ammonia (>99.5 % wt) is manufactured by high temperature and pressure synthesis in large facilities. A typical ammonia-producing industrial plant first coverts natural gas (e.g. methane), liquefied petroleum gas (e.g. propane and butane) or petroleum naphtha into gaseous hydrogen. The method for producing hydrogen from hydrocarbons is referred to as “steam reforming”. Several processes are involved in producing hydrogen from a natural gas feedstock including sulphur and carbon dioxide removal and methanation to remove any small residual amounts of carbon dioxide or carbon monoxide. Catalytic shift conversion is used to convert CH_4 to CO_2 and hydrogen. Hydrogen is then catalytically reacted with nitrogen (derived from air) in the ratio 3:1 by volume and compressed to around 200 times atmospheric pressure (up to 1000 atm or 100 megapascals) at high temperatures of around 700ºC to form anhydrous liquid ammonia. This step is known as the ammonia synthesis loop (e.g. the Haber-Bosch process).

Contributing Environmental Scenario: Environmental exposure arising from the manufacture of anhydrous ammonia.

Contributing Worker Scenarios: Worker exposure arising due to day to day use in closed processes with no likelihood of exposure, day to day use in closed continuous processes with occasional exposure (such as sampling) and Transfer of substance to and from vessels and containers**.**

2.1	**Contributing scenario 1 controlling environmental exposure for ES 1**

Environmental exposure arising due manufacture of anhydrous ammonia.

Section 2.1 describes the environmental releases that may occur during the manufacture of Ammonia. These releases may occur due to emission to wastewater or through emission to the atmosphere. If emission to wastewater occurs on-site treatment in an industrial waste water treatment plant will be required in order to

remove downstream emissions to the environment. In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. It is considered that if there processes are employed complete removal from the wastewater stream will occur. Emissions to the atmosphere should not exceed concentrations of 40 mg/m^3.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.
Amounts used
Production sites may manufacture up to a largest individual site value of 950,000 tonnes per annum, with approximately 6.5 million tonnes produced per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use
Frequency of use is estimated to be 220 days per year, with a standard 8 hour working day.
Environmental factors influenced by risk management
Flow rate of receiving water at least 18,000 m^3 per day. Dilution of STP emissions at least 10 fold.
Other operational conditions affecting environmental exposure
Production takes place in a highly specialized indoor facility with emissions to air being controlled. Reactions are performed under closed conditions, with transfer pipelines are either fully or partially closed systems. Emission via wastewater is prevented by on-site WWTP processes. Manufacturing processes may be indoor or outdoor.
Technical conditions and measures at process VIVel (source) to prevent release
Manufacture is carried out indoors or outdoors in dedicated facilities. Losses to surface water or the municipal STP should be prevented by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. With regards to environmental emissions the loss of aqueous ammonia is most reVIVant as once the anhydrous ammonia reacts with wastewater or atmospheric moisture aqueous ammonia will be formed.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Waste water should be emitted to the on-site WWTP for specialized removal. Emissions to air from manufacturing or from the onsite WWTP should not exceed a concentration of 40 mg/m^3 of air. This is approximately equivalent to a total loss to air of 140,000 kg/day. Sludge from the on-site WWTP should not be spread to soil. Any solid waste must be sent to a landfill for burying, incineration or recycling.
Organizational measures to prevent/limit releases from site
Workers are fully trained in order to prevent accidental release and exposures may be monitored to ensure airborne concentrations are within acceptable VIVels.
Conditions and measures related to municipal STP
Direct emissions to the municipal STP should not be made.
Conditions and measures related to external treatment of waste for disposal
Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the manufacturing process. Sludge from the onsite WWTP should be recycled, incinerated or sent to landfill.
Conditions and measures related to external recovery of waste
There is no envisaged external recovery of waste. Waste sludge is reduced and then incinerated and emissions to air are not collected.

2.2	**Contributing scenario 2 controlling worker exposure day to day use in closed processes with no likelihood of exposure**

Worker exposure arising due to day to day use in closed processes with no likelihood of exposure during the manufacturing process.

Section 2.2 describes the potential exposure to workers during the manufacture of anhydrous ammonia from operation of closed systems with occasional potential for exposure during tasks such as sampling, maintenance and cleaning. The potential exposure arises from the operation of the reactor and its associated machinery.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. 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). During tasks such as cleaning and sampling, suitable protective clothing and equipment is available.

Product characteristics

The produced substance is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.

Amounts used

Production sites may produce up to 950,000 tonnes per annum, with approximately 6.5 million tonnes produced per year in the European Union.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential for exposure during manufacture is generally considered to be of short duration, with limited potential for exposure. Tasks such as maintenance are carried out only rarely.
Exposure to workers was assessed taking into account different operational conditions that may be associated with the manufacturing of anhydrous ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90 % protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

During the manufacture of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not required.

Technical conditions and measures at process VIVel (source) to prevent release

If being carried out indoors the transfer of the substance from the reactor vessel and the operation of the reactor vessel itself takes place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required.

All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the reactor and associated machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.3	**Contributing scenario 3 controlling worker exposure due to day to day use in closed continuous processes with occasional exposure (such as sampling)**

Worker exposure arising due to day to day use in closed continuous processes with occasional exposure (such as sampling).
Section 2.3 describes the potential exposure to workers during the manufacture of anhydrous ammonia from operation of closed systems with occasional potential for exposure during tasks such as sampling, maintenance and cleaning. The potential exposure arises from the operation of the reactor and its associated machinery. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. 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). During tasks such as cleaning and sampling suitable protective clothing and equipment is available.
Product characteristics
The produced substance is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.
Amounts used

Production sites may manufacture up to 950,000 tonnes per annum, with approximately 6.5 million tonnes produced per year in the European Union.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential for exposure during manufacture is generally considered to be of short duration, with limited potential for exposure. Tasks such as maintenance are carried out only rarely. Exposure to workers was assessed taking into account different operational conditions that may be associated with the manufacturing of anhydrous ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90 % protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the manufacture of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not required.
Technical conditions and measures at process VIVel (source) to prevent release
If being carried out indoors the transfer of the substance from the reactor vessel and the operation of the reactor vessel itself takes place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the reactor and associated machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust

ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.
VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills, normal loading and unloading operations, cleaning and maintenance. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.4	**Contributing scenario 4 controlling worker exposure for transfer of produced ammonia to and from vessels and containers**

Worker exposure arising due to transfer of produced ammonia to and from vessels and containers.

Section 2.4 describes the potential exposure to workers during the transfer of manufactured of anhydrous ammonia. The potential exposure arises from the transfer of the substance from the reactor to storage areas or vessels. Workers involved in this transfer of the substance will be exposed in the manual handling of the substance to storage vessels and potentially during the loading of road and rail tankers.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. 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).

Product characteristics

The transferred substance is a colourless gas (or a liquid at high pressure) at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.

Amounts used

Production sites may manufacture up to 950,000 tonnes per annum, with approximately 6.5 million tonnes produced per year in the European Union. It is expected that all produced amounts will be transferred to vessels or tanks at some point.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Transfer of ammonia may be carried out for periods from 1 to 4 hours or greater than 4 hours with limited potential for exposure due to the nature of the associated systems.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

When the transfer of ammonia from the reactor vessel is carried out indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the transfer processes are carried out outdoors VIV is not required.
Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur.
Anhydrous ammonia is stored in closed containers and tanks and is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal

protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions and measures at process VIVel (source) to prevent release
If being carried out indoors the transfer of the substance from the reactor vessel to storage tanks or areas takes place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not always required.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations. All transfer pipelines should be sealed to prevent leaks.
Organizational measures to prevent/limit release
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
During transfer of produced ammonia workers may potentially be exposed to ammonia when operating equipment (e.g. valves, pumps or filling tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.

3	**Exposure estimation and reference to its source**

The assessment of worker exposure to anhydrous ammonia during manufacturing (ES 1) was carried out for processes reVIVant to this scenario as identified by PROC codes reflecting: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), maintenance and clean-down (PROC 8a) and transfer (PROC 8b). A screening-VIVel (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m^3) associated with each process defined by PROC codes.
Exposure to workers was assessed taking into account different operational conditions that may be associated with the manufacturing of anhydrous ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90 % protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.
For environmental emissions complete removal in the on-site WWTP was considered during derivation of the values below.

Information for contributing scenario 1 (environmental exposure):
The following PEC values were calculated using EUSES 2.1

PEC	Values
PEC in sewage effluent	0 (due to complete removal)
PEC in aquatic compartment (mg/L): Freshwater Marine Water	 3.48×10^{-3} 7.61×10^{-4}
PEC in sediments (mg/kg): Freshwater sediments Marine water sediments	 3.76×10^{-3} 8.24×10^{-4}
PEC in soil and groundwater:	Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.
PEC in air: annual average (mg/M^3)	36.1

The following RCR values were obtained:

Compartments	PEC	PNEC	PEC/PNEC	Discussion
Freshwater (Tier 2)	3.48×10^{-3} mg/L (Total	0.0011 mg/l	0.121	Conversion from Total Ammonia to Free Ammonia based on a

	Ammonia) 1.33×10^{-4} mg/L (Free Ammonia)	(Free Ammonia)		fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
Marine water (Tier 2)	8.24×10^{-4} mg/L (Total Ammonia) 3.15×10^{-5} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.029	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)

The following values were obtained using ECETOC TRA for worker exposure
Dermal exposures to anhydrous ammonia predicted using the ECETOC TRA model for industrial workers during manufacturing

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: storage (closed or bulk container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14
			Indoors with VIV	0.14	0.01
Information for contributing scenario 4:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
			Indoors with VIV	0.14	0.01

Transfer (charging/discharging) from or to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
			Indoors with VIV	0.69	0.07

Inhalation exposure concentrations for anhydrous ammonia predicted using the ECETOC TRA model for industrial workers during manufacturing

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Inhalation Exposure Concentration mg/m3**	
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA
			Indoors without VIV	0.01	NA
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24
			Indoors without VIV	35.42	1.77
			Indoors with VIV	3.54	0.18
		1-4 hrs	Outdoors	14.88	0.74
			Indoors without VIV	22.25	1.06
			Indoors with VIV	2.13	0.11
Information for contributing scenario 4:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	>4hrs	Outdoors	123.96	6.20
			Indoors without VIV	177.08	8.85
			Indoors with VIV	17.71	0.89
		1-4 hrs	Outdoors	74.38	3.72
			Indoors without VIV	106.25	5.31
			Indoors with VIV	10.63	0.53
Transfer (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72
			Indoors without VIV	106.25	5.31
			Indoors with VIV	3.19	0.16
		1-4 hrs	Outdoors	44.63	2.23

			Indoors without VIV	63.75	3.19
			Indoors with VIV	1.91	0.10

The following RCR values were obtained using ECETOC TRA and the reVIVant DNELs
Quantitative risk characterisation of dermal exposures to anhydrous ammonia for industrial workers

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)**
Information for contributing scenario 2:						
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
Information for contributing scenario 3:						
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14	0.20	0.02
		Indoors with VIV	0.14	0.01	0.02	<0.01
Information for contributing scenario 4:						
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01

Quantitative risk characterisation of inhalation exposure concentrations of anhydrous ammonia for workers

PROC code	**Exposure assumptions**	**ES 1- exposure concentrations (EC) mg/m³**	**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
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.001	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.001	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	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 VIV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 4:										
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with VIV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01

4	Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environmental releases:
In order to work within the boundaries of the ES the following conditions should be met:

- Local emission to air less than 40 mg/M^3
- When the on-site WWTP is used the WWTP sludge should not be spread to soil
- Emissions from the waste-water stream should be completely removed
- Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the manufacturing process.
- Measured emissions should be ensured to lead to concentrations in the environment which are less than the reVIVant PNEC

Worker exposure:
In order to work within the boundaries of the ES the following conditions should be met:

- VIV should be in place in indoor facilities at times when natural ventilation is not sufficient.
- Where the potential for dermal exposure exists, gloves with a minimum efficiency of 90% and RPE with 95% efficiency should be worn.
- Health monitoring should be conducted regularly to ascertain the potential VIVels of exposure.
- Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise.
- All technological devices should have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
- Workers should be fully trained.
  Any measured worker exposure VIVels should be confirmed to be below the reVIVant DNEL as presented in section 3 above.

Exposure Scenario 2: Distribution and formulation of anhydrous ammonia

1	Exposure Scenario 2

Distribution and formulation of anhydrous ammonia
Processes Covered:
Environmental Releases
ERC2: Formulation of preparations
Worker Processes
PROC01: Use in closed process, no likelihood of exposure.
PROC02: Use in closed, continuous process with occasional controlled exposure.
PROC03: Use in closed batch processes
PROC04: Use in batch and other processes where the potential for exposure occurs
PROC05: Mixing and blending
PROC08a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.
PROC08b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
PROC09: Transfer of formulations to small containers.
PROC15: Laboratory use
Manufactured anhydrous liquid ammonia (>99.5 % wt) is distributed widely to many industrial and municipality users. Anhydrous liquid ammonia is transported to chemical formulation facilities which produce aqueous solutions of ammonia. Aqueous ammonia products are then distributed to a wide range of industrial end-users and is also used to produce products for professional and consumer users.
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 VIVel of an anhydrous ammonia tank is 85%. Anhydrous liquid ammonia may also be distributed to end-user industries via pipeline systems.
Anhydrous liquid ammonia is used to produce aqueous ammonia solutions (5-25% w/w). The anhydrous liquid ammonia product is transported to chemical manufacturing facilities by rail or road where it is blended with deionised water to produce solutions of aqueous ammonia that are used for a broad range of applications. Aqueous ammonia solution products are distributed to a wide range of industrial users by road or rail in various quantities (e.g. tanks or 1, 5, 15 and 50 gallon containers). Distributors of anhydrous and aqueous ammonia can operate on a regional or national VIVel.

Contributing Environmental Scenario: Environmental exposure arising due to distribution and formulation of anhydrous ammonia.

Contributing Worker Scenarios: Worker exposure arising due to day to day use in closed processes with no likelihood of exposure, day to day use in closed continuous processes with occasional exposure (such as sampling), day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance), mixing and blending, transfer to small containers, transfer of substance to and from large vessels and containers and laboratory use.

2.1	Contributing scenario 1 controlling environmental exposure for ES 2

Environmental exposure arising from the distribution and formulation of anhydrous ammonia.

Section 2.1 describes the environmental releases that may occur during the distribution and formulation

of anhydrous ammonia.. These releases may occur due to emission to wastewater or through emission to the atmosphere. If emission to wastewater occurs on-site treatment in an industrial waste water treatment plant will be required in order to remove downstream emissions to the environment. In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. It is considered that if there processes are employed complete removal from the wastewater stream will occur. Emissions to the atmosphere should not exceed concentrations of 21.1 mg/m^3.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Formulation of ammonia is generally a short duration task, with limited potential for exposure.
Environmental factors influenced by risk management
Flow rate of receiving water at least 18,000 m^3 per day. Dilution of STP emissions at least 10 fold.
Other operational conditions affecting environmental exposure
Workers are fully trained in safe use and the use of appropriate systems in order to prevent accidental release. Closed systems are employed in order to prevent un-intended emissions.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed sealed. On site WWTPs should be available at industrial sites in order to eliminate emissions to the environment via contaminated wastewater.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Waste water should be emitted to the on-site WWTP for specialized removal. Emissions to air from formulation and distribution or from the onsite WWTP should not exceed a concentration of 21.1 mg/m^3 of air. This is approximately equivalent to a total loss to air of 74,000 kg/day. Sludge from the on-site WWTP should not be spread to soil. Any solid waste will be sent as waste for landfill, incineration or recycling.
Organizational measures to prevent/limit releases from site
Workers are fully trained in order to prevent accidental release and exposures may be monitored to ensure airborne concentrations are within acceptable VIVels.
Conditions and measures related to municipal STP
Direct emissions to the municipal STP should not be made.
Conditions and measures related to external treatment of waste for disposal
Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the formulation process. Sludge from the onsite WWTP should be recycled, incinerated or buried in a landfill.
Conditions and measures related to external recovery of waste

There is no envisaged external recovery of waste. Waste sludge is reduced and then incinerated and emissions to air are not collected. .	
2.2	**Contributing scenario 2 controlling worker exposure day to day use in closed processes with no likelihood of exposure.**
Worker exposure arising due to day to day use in closed processes with no likelihood of exposure during the distribution and formulation processes.	
Section 2.2 describes the potential exposure to workers during the formulation of preparations of ammonia from operation of closed systems. The potential exposure arises from the operation of formulation equipment and its associated machinery. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated solutions are 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).	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Formulation of ammonia is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
During the formulation and mixing of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required.	
Technical conditions and measures at process VIVel (source) to prevent release	
If formulation is being carried out indoors the process should take place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.	
Organizational measures to prevent/limit release	

Workers are fully trained in safe use of the transfer and formulation and machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating distribution and formulation equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.3	**Contributing scenario 3 controlling worker exposure due to day to day use in closed continuous processes with occasional exposure (such as sampling)**

Worker exposure arising due to day to day use in closed continuous processes with occasional exposure (such as sampling).
Section 2.3 describes the potential exposure to workers during the distribution and formulation of preparations of ammonia from operation of closed systems with the potential for occasional exposure during tasks such as sampling, cleaning and maintenance. The potential exposure arises from the operation of formulation equipment and its associated machinery and during routine sampling, cleaning and occasional maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in these tasks. Formulated solutions are 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).
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Tasks

such as sampling, cleaning and routine maintenance of ammonia distribution and formulation machinery are generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the formulation and mixing of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
If formulation is being carried out indoors the process should take place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the transfer and formulation and machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating distribution and formulation equipment (e.g. valves, pumps or tanks etc) or when carrying out specific tasks such as sampling, cleaning and maintenance. All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.4	**Contributing scenario 4 controlling worker exposure for day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance)**
Worker exposure arising due to day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance).	

Section 2.4 describes the potential exposure to workers during day to day use of formulation and distribution machinery, pipelines and storage vessels. Potential exposure may occur during the day to day use however it is more likely to occur during tasks associated with the batch or other processes such as sampling of formulated solutions, cleaning and routine maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. formulated 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).
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Tasks such as sampling, cleaning and routine maintenance of ammonia distribution and formulation machinery are generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the formulation and mixing of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
If formulation is being carried out indoors the process should take place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the transfer and formulation and machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.

Workers may potentially be exposed to ammonia when operating distribution and formulation equipment (e.g. valves, pumps or tanks etc) or when carrying out specific tasks such as sampling, cleaning and maintenance. All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment.
Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.
VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.5	**Contributing scenario 5 controlling worker exposure for mixing and blending**

Worker exposure arising due to mixing and blending in batch processes during formulation of preparations

Section 2.5 describes the potential exposure to workers during mixing and blending of ammonia formulations Potential exposure may occur during the day to day use of machinery and technologies associated with the blending and mixing process.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. formulated 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).

Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.
During mixing and blending of the formulations the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.

Amounts used

Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Tasks such as mixing and blending and use of formulation machinery generally have limited potential for exposure due to the specialized nature of the technologies involved.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure
During the blending and mixing of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
If mixing and blending is being carried out indoors the process should take place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of mixing and blending machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating mixing and blending equipment (e.g. valves, pumps or tanks etc). Operations are generally performed in a closed system. Pipelines and tanks are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.6	Contributing scenario 6 controlling worker exposure for transfer to small containers

Worker exposure arising due to transfer to small containers in a dedicated filling line.

Section 2.6 describes the potential exposure to workers during the filling of small containers in dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers themselves.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the small sized containers.

Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable.
During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.

Amounts used

Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. Though it is unlikely that all this tonnage will be filled into small containers this amount has nonetheless been considered for the exposure assessment. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

During the filling of small containers indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required. RPE is provided when required.

Technical conditions and measures at process VIVel (source) to prevent release

If formulation is being carried out indoors the process should take place in a fully closed system, VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a closed system is still employed however specific VIV is not required.
All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.

Technical conditions to control dispersion from source towards worker

VIV should be in place during indoor operations when natural ventilation is not sufficient. Pipelines and container filling equipment should be closed and sealed systems where possible.

Organizational measures to prevent/limit release

Workers are fully trained in safe use of the transfer and container filling machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating filling lines and during the filling of the small containers.. Pipelines and vessels are sealed and insulated where possible. Extract ventilation is provided at openings and points were emissions may occur. The filled ammonia is stored in the closed small containers. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.7	**Contributing scenario 7 controlling worker exposure for transfer to and from large containers and vessels**

Worker exposure arising due transfer of ammonia to and from large containers and vessels
Section 2.7 describes the potential exposure to workers during the filling and loading to/from large containers and vessels in dedicated and non-dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the large sized containers.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During formulation the formation of solutions of aqueous ammonia in the 5 – 25% concentrations range is expected. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.
Amounts used
Formulation sites may use up to a largest individual site tonnage of 1,000,000 tonnes per annum, with approximately 3.8 million tonnes formulated per year in the European Union. Though it is unlikely that all this tonnage will be filled into large vessels and containers this amount has nonetheless been considered for the exposure assessment. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year.
Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the filling and transfer of ammonia to/from large vessels and containers indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. When the processes are carried out outdoors VIV is not generally required. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
If transfer to or from the large vessels or containers is being carried out indoors a VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). When carried out outdoors a specialized system is still employed however specific VIV is not required. The filling may be at dedicated or non-dedicated facilities however the transfer machinery will still be highly specialized and controlled. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Pipelines and container filling equipment should be closed and sealed systems where possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the transfer and container filling machinery and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating filling lines and during the filling of the large containers and vessels. Pipelines and vessels are generally sealed and insulated where possible. Extract ventilation is provided at openings and points were emissions may occur. The filled ammonia is stored in the closed small containers. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.8	**Contributing scenario 7 controlling worker exposure for laboratory use**
Worker exposure arising due to laboratory use of ammonia (small scale non-industrial laboratories).	
Section 2.8 describes the potential exposure to workers during laboratory use especially during the filling and loading of small flasks and vessels using non-dedicated filling lines or small scale transfer methods. Potential exposure is most likely to occur during tasks associated with the actual transfer or mixing of the ammonia solutions. For dedicated small scale laboratories appropriate PPE and onsite control parameters are in place to limit the risk	

of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During laboratory use of ammonia solutions of aqueous ammonia in the 5 – 25% concentrations range are most liklety to be encountered. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.
Amounts used
Amounts use in a non-industrial setting are likely to be small with less than 1 litre or 1 kilogram present on site. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330 however actual emission of ammonia is likely to be much less frequent in practice.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Again use of ammonia is not likely to be this frequent in practice.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the laboratory use of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
During laboratory use VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). All technological devices should have a proper quality certification, and should be regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not considered sufficient or in enclosed areas.
Organizational measures to prevent/limit release
Laboratory workers are fully trained in safe use of chemicals in general and in the use of appropriate PPE in order to prevent accidental release or exposure.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia during laboratory use when filling containers and vessels or during transfer. Extract ventilation is provided at openings and points were emissions may occur. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.

VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

3	**Exposure estimation and reference to its source**

The assessment of worker exposure to aqueous ammonia during formulation or to anhydrous and aqueous forms of ammonia during distribution (ES 2) was carried out for processes reVIVant to this scenario as identified by PROC codes reflecting: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), maintenance and clean-down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9) and analysis of samples (PROC 15). A screening-VIVel (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m^3) associated with each process defined by PROC codes.
Exposure to workers was assessed taking into account different operational conditions that may be associated with the formulation of aqueous ammonia solutions and the distribution of anhydrous and aqueous ammonia products and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.
The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposures where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35 $g.mol^{-1}$ and 17 $g.mol^{-1}$ for aqueous and anhydrous forms respectively and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6×10^5 Pa at 20°C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5×10^3 Pa to 4×10^4 Pa at 20°C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.
For environmental emissions complete removal in the on-site WWTP was considered during derivation of the values below. Emission values and environmental concentrations were calculated using the EUSES 2.1 model.
Information for contributing scenario 1 (environmental exposure):
The following PEC values were calculated using EUSES 2.1

PEC	**Values**
PEC in sewage effluent	0 (due to complete removal)
PEC in aquatic compartment (mg/L):	
Freshwater	1.3×10^{-3}
Marine Water	3.14×10^{-4}

PEC in sediments (mg/kg): Freshwater sediments Marine water sediments	 1.41×10^{-3} 3.40×10^{-4}
PEC in soil and groundwater:	Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.
PEC in air: annual average (mg/M^3)	19

The following RCR values were obtained:

Compartments	PEC	PNEC	PEC/PNEC	Discussion
Freshwater (Tier 2)	1.30×10^{-3} mg/L (Total Ammonia) 4.97×10^{-5} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.045	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
Marine water (Tier 2)	3.14×10^{-4} mg/L (Total Ammonia) 1.20×10^{-5} mg/L	0.0011 mg/l (Free Ammonia)	0.011	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-

	(Free Ammonia)			600/3-79-091)

The following values were obtained using ECETOC TRA for worker exposure

Dermal exposures predicted using the ECETOC TRA model

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: storage (closed or bulk container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14
			Indoors with VIV	0.14	0.01
Information for contributing scenario 4:					
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 5:					
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with VIV	0.07	0.01
Information for contributing scenario 6:					
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69

		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 7:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
			Indoors with VIV	0.14	0.01
Transfer (charging/discharging) from or to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
			Indoors with VIV	0.69	0.07
Information for contributing scenario 8:					
Laboratory use : Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01

Inhalation exposure concentrations predicted using the ECETOC TRA model

				Anhydrous ammonia		**Aqueous ammonia (5-25% w/w)**	
Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/m3**			
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Information for contributing scenario 2:							
Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	NA
		1-4 hrs or >4 hrs	Indoors without VIV	0.01	NA	0.01	NA
Information for contributing scenario 3:							
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.53	0.18	4.38	0.22

		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without VIV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 4:							
Use in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Information for contributing scenario 5:							
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 6:							
Maintenance, clean down	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with	17.71	0.89	21.88	1.09

			VIV				
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with VIV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without VIV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with VIV	1.91	0.1	2.36	0.12
Information for contributing scenario 7:							
Transfer into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without VIV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with VIV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without VIV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with VIV	8.5	0.43	10.50	0.53
Information for contributing scenario 8:							
Quality control in a laboratory	PROC 15	>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without VIV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13

The following RCR values were obtained using ECETOC TRA and the reVIVant DNELs

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)	Acute / long term systemic effects

			mg/kg bw/d		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)
Information for contributing scenario 2:						
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
Information for contributing scenario 3:						
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14	0.20	0.02
		Indoors with VIV	0.14	0.01	0.02	<0.01
Information for contributing scenario 4:						
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 5:						
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.07	0.01	0.01	<0.01
Information for contributing scenario 6:						
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 7:						
PROC 9	1-4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10

	or >4 hrs	Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 8:						
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01

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/m³**		**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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	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 VIV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	7.08	0.35	0.15	0.01	0.20	0.01	0.51	0.03
	1-4	Outdoors	29.75	1.49	0.63	0.03	0.83	0.04	2.13	0.11

	hrs	Indoors without VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	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 VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with VIV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
Information for contributing scenario 7:										
PROC 9	>4	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35

	hrs	Indoors without VIV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with VIV	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 VIV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with VIV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
Information for contributing scenario 8:										
PROC 15	>4 hrs	Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without VIV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

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

PROC code	**Exposure assumptions**		**ES 2-exposure concentrations (EC) mg/m³**		**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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.0001	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4	Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07

	hrs	Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	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 VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	21.88	1.09	0.46	0.02	0.61	0.03	1.56	0.08
	1-4	Outdoors	91.88	4.59	1.93	0.10	2.55	0.13	6.56	0.33

	hrs	Indoors without VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with VIV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
Information for contributing scenario 7:										
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without VIV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with VIV	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 VIV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with VIV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
Information for contributing scenario 8:										
PROC 15	>4 hrs	Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01

4	**Guidance to DU to evaluate whether he works inside the boundaries set by the ES**

Environmental releases:
In order to work within the boundaries of the ES the following conditions should be met:

- Local emission to air less than 21.1 mg/M^3
- When the on-site WWTP is used the WWTP sludge should not be spread to soil
- Emissions from the waste-water stream should be completely removed
- Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the formulation process.
- Measured emissions should be ensured to lead to concentrations in the environment which are less than

the reVIVant PNEC

- Emissions to wastewater from laboratory use should not be to the municipal STP

Worker exposure:

In order to work within the boundaries of the ES the following conditions should be met:

- VIV should be in place in indoor facilities at times when natural ventilation is not sufficient.
- Where the potential for dermal exposure exists, gloves with a minimum efficiency of 90% and RPE with 95% efficiency should be worn.
- Health monitoring should be conducted regularly to ascertain the potential VIVels of exposure.
- Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise.
- All technological devices should have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
- Workers should be fully trained.
  Any measured worker exposure VIVels should be confirmed to be below the reVIVant DNEL as presented in section 3 above.

Exposure Scenario 3: Industrial uses of anhydrous ammonia as an intermediate

1	Exposure Scenario 3

Industrial uses of anhydrous ammonia as an intermediate
Processes Covered:
Environmental Releases
ERC6a: Industrial use of intermediates
Worker Processes
PROC01: Use in closed process, no likelihood of exposure.
PROC02: Use in closed, continuous process with occasional controlled exposure.
PROC03: Use in closed batch processes
PROC04: Use in batch and other processes where the potential for exposure occurs
PROC05: Mixing and blending
PROC08a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.
PROC08b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
PROC09: Transfer of formulations to small containers.
PROC15: Laboratory use
Ammonia is used by the chemicals industry to manufacture a range other substances including: nitric acid, alkalis, dyes, pharmaceuticals, cosmetics, vitamins, synthetic textile fibres and plastics.
Ammonia is used as an intermediate in the synthesis of a number of chemicals. It is used in the manufacture of nitric acid (HNO_3) which is used in making explosives such as TNT (2,4,6-trinitrotoluene); nitro-glycerine (which is also used as a vasodilator) and PETN (pentaerythritol nitrate). Ammonia is also used in the synthesis of alkakis: sodium hydrogen carbonate (sodium bicarbonate; $NaHCO_3$), soda ash (sodium carbonate, Na_2CO_3), hydrogen cyanide (hydrocyanic acid; HCN) and hydrazine (N_2H_4) used in rocket propulsion systems.
Ammonia is used to manufacture explosives such as ammonium nitrate (NH_4NO_3). It is also used as an intermediate in the synthesis of dyes, and synthetic 'man-made' fibres such as nylon, rayon and acrylics. It is also used in the manufacture of plastics such as phenolics and polyurethanes.
Ammonia is used in the manufacture of drugs such as sulphonamide which inhibit the growth and multiplication of bacteria that require *p*-aminobenzoic acid (PABA) and for the biosynthesis of folic acids, antimalarials and vitamins (e.g. B vitamins: nicotinamide and thiamine).
Ammonia is also used in the production of ammonium and nitrate salts used in fertilisers.

Contributing Environmental Scenario: Environmental exposure arising due to Industrial uses of anhydrous ammonia as an intermediate.

Contributing Worker Scenarios: Worker exposure arising due to day to day use in closed processes with no likelihood of exposure, day to day use in closed continuous processes with occasional exposure (such as sampling), day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance), mixing and blending, transfer to small containers, transfer of substance to and from large vessels and containers and laboratory use.

2.1	Contributing scenario 1 controlling environmental exposure for ES 3

Environmental exposure arising due to industrial uses of anhydrous ammonia as an intermediate.

Section 2.1 describes the environmental releases that may occur during the industrial uses of anhydrous ammonia as an intermediate. These releases may occur due to emission to wastewater or through emission to the atmosphere. If emission to wastewater occurs on-site treatment in an industrial waste water treatment plant will be

required in order to remove downstream emissions to the environment. In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to nitrate followed by denitrification resulting in the release of nitrogen gas. It is considered that if there processes are employed complete removal from the wastewater stream will occur. Emissions to the atmosphere should not exceed concentrations of 30.5 mg/m^3.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.
Environmental factors influenced by risk management
Flow rate of receiving water at least 18,000 m^3 per day. Dilution of STP emissions at least 10 fold.
Other operational conditions affecting environmental exposure
Workers are fully trained in safe use and the use of appropriate systems in order to prevent accidental release. Closed systems are employed in order to prevent un-intended emissions.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed sealed. On site WWTPs should be available at industrial sites in order to eliminate emissions to the environment via contaminated wastewater.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Waste water should be emitted to the on-site WWTP for specialized removal. Emissions to air from the industrial processes or from the onsite WWTP should not exceed a concentration of 30.5 mg/m^3 of air. This is approximately equivalent to a total loss to air of 106,000 kg/day. Sludge from the on-site WWTP should not be spread to soil. Any solid waste must be sent to a dump for burying, incineration or recycling.
Organizational measures to prevent/limit releases from site
Workers are fully trained in order to prevent accidental release and exposures may be monitored to ensure airborne concentrations are within acceptable VIVels.
Conditions and measures related to municipal STP
Direct emissions to the municipal STP should not be made.
Conditions and measures related to external treatment of waste for disposal
Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the industrial process. Sludge from the onsite WWTP should be recycled, incinerated or buried at a dump.
Conditions and measures related to external recovery of waste
There is no envisaged external recovery of waste. Waste sludge is reduced and then incinerated and emissions to

air are not collected.	
2.2	**Contributing scenario 2 controlling worker exposure day to day use in closed processes with no likelihood of exposure**
Worker exposure arising due to day to day use in closed processes with no likelihood of exposure during the industrial use processes.	
Section 2.2 describes the potential exposure to workers during the industrial use of ammonia as an intermediate from operation of closed systems. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Conditions and measures related to personal protection, hygiene and health.	
Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and	

sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment.
Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.
VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.3	**Contributing scenario 3 controlling worker exposure due to day to day use in closed continuous processes with occasional exposure (such as sampling)**

Worker exposure arising due to day to day use in closed continuous processes with occasional exposure (such as sampling).

Section 2.3 describes the potential exposure to workers during the industrial use of preparations of ammonia from the operation of closed systems with the potential for occasional exposure during tasks such as sampling, cleaning and maintenance. The potential exposure arises from the operation of industrial intermediate use equipment and its associated machinery and during routine sampling, cleaning and occasional maintenance.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in these tasks. Formulated solutions are 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).

Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.

Amounts used

Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.

Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.4	**Contributing scenario 4 controlling worker exposure for day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance)**
Worker exposure arising due to day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance).	
Section 2.4 describes the potential exposure to workers during day to day use of industrial machinery, pipelines and storage vessels. Potential exposure may occur during the day to day use however it is more likely to occur during tasks associated with the batch or other processes themselves such as sampling of produced intermediates, cleaning and routine maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Solutions of ammonia are 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). This contributing considers the potential exposures from batch and other processes (such as one off exposures) and though there is some potential for exposure generally systems are in place to control and losses or unintended emissions of ammonia at the industrial facility.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very	

soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use during batch and other processes is generally a short duration task, with limited potential for exposure occurring in reality.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.5	Contributing scenario 5 controlling worker exposure for mixing and blending

Worker exposure arising due to mixing and blending in batch processes during use as an intermediate

Section 2.5 describes the potential exposure to workers during mixing and blending of ammonia formulations Potential exposure may occur during the day to day use of machinery and technologies associated with the blending and mixing process as part of the overall industrial use of ammonia as an intermediate.
Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Stock 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).

Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.

Amounts used

Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.

Technical conditions and measures at process VIVel (source) to prevent release

Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.

Technical conditions to control dispersion from source towards worker

VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.

Organizational measures to prevent/limit release

Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.

Conditions and measures related to personal protection, hygiene and health.

Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or blending tanks etc). All operations are performed in a closed system. Pipelines, blending apparatuses and vessels

are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.6	**Contributing scenario 6 controlling worker exposure for transfer to small containers**

Worker exposure arising due to transfer to small containers in a dedicated filling line.
Section 2.6 describes the potential exposure to workers during the filling of small containers in dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the small sized containers.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however

system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.7	**Contributing scenario 7 controlling worker exposure for transfer to and from large containers and vessels**

Worker exposure arising due transfer of ammonia to and from large containers and vessels
Section 2.7 describes the potential exposure to workers during the filling and loading to/from large vessels and containers in dedicated and non-dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers and vessels themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the small sized containers.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 800,000 tonnes per annum, with up to 3.8 million tonnes consumed per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia when operating industrial use equipment (e.g. valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emissions may occur. Ammonia is stored in closed containers and tanks and transferred under containment. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.8	**Contributing scenario 8 controlling worker exposure for laboratory use**
Worker exposure arising due to laboratory use of ammonia (small scale non-industrial laboratories).	
Section 2.8 describes the potential exposure to workers during laboratory use of ammonia as an intermediate especially during the filling and loading of small flasks and vessels using non-dedicated filling lines or small scale transfer methods. Potential exposure is most likely to occur during tasks associated with the actual transfer or mixing of the ammonia solutions. For dedicated small scale laboratories appropriate PPE and onsite control parameters are in place to limit the risk	

of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During laboratory use of ammonia solutions of aqueous ammonia in the 5 – 25% concentrations range are most liklety to be encountered. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.
Amounts used
Amounts use in a non-industrial setting are likely to be small with less than 1 litre or 1 kilogram present on site. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330 however actual emission of ammonia is likely to be much less frequent in practice.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Again use of ammonia is not likely to be this frequent in practice.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (according to ECETOC).
Other given operational conditions affecting worker exposure
During the laboratory use of ammonia as an intermediate indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
During laboratory use VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). All technological devices should have a proper quality certification, and should be regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not considered sufficient or in enclosed areas.
Organizational measures to prevent/limit release
Laboratory workers are fully trained in safe use of chemicals in general and in the use of appropriate PPE in order to prevent accidental release or exposure.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia during laboratory use when filling containers and vessels or during transfer. Extract ventilation is provided at openings and points were emissions may occur. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in these procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise.

VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

3	**Exposure estimation and reference to its source**

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

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

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

For environmental emissions complete removal in the on-site WWTP was considered during derivation of the values below. Emission values and environmental concentrations were calculated using the EUSES 2.1 model.

Information for contributing scenario 1 (environmental exposure):

The following PEC values were calculated using EUSES 2.1

PEC	**Values**
PEC in sewage effluent	0 (due to complete removal)
PEC in aquatic compartment (mg/L): Freshwater Marine Water	 2.19×10^{-3} 5.37×10^{-4}

PEC in sediments (mg/kg): Freshwater sediments Marine water sediments	 2.37 x 10^{-3} 5.82 x 10^{-4}
PEC in soil and groundwater:	Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.
PEC in air: annual average (mg/M^3)	30.5

The following RCR values were obtained:

Compartments	**PEC**	**PNEC**	**PEC/PNEC**	**Discussion**
ERC 6a Freshwater (Tier 2)	2.19 x 10^{-3} mg/L (Total Ammonia) 8.37 x 10^{-5}mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.076	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 6a Marine water (Tier 2)	5.37 x 10^{-4} mg/L (Total Ammonia) 2.05 x 10^{-5} mg/L	0.0011 mg/l (Free Ammonia)	0.019	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-

	(Free Ammonia)			600/3-79-091)

The following values were obtained using ECETOC TRA for worker exposure

Dermal exposures predicted using the ECETOC TRA model

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: storage (closed or bulk container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14
			Indoors with VIV	0.14	0.01
Information for contributing scenario 4:					
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 5:					
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with VIV	0.07	0.01
Information for contributing scenario 6:					
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69

		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 7:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
			Indoors with VIV	0.14	0.01
Transfer (charging/discharging) from or to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
			Indoors with VIV	0.69	0.07
Information for contributing scenario 8:					
Laboratory use : Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01

Inhalation exposure concentrations predicted using the ECETOC TRA model

				Anhydrous ammonia		**Aqueous ammonia (5-25% w/w)**	
Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/m3**			
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Information for contributing scenario 2:							
Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	NA
		1-4 hrs or >4 hrs	Indoors without VIV	0.01	NA	0.01	NA
Information for contributing scenario 3:							
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.53	0.18	4.38	0.22

		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without VIV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 4:							
Use in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Information for contributing scenario 5:							
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 6:							
Maintenance, clean down	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with	17.71	0.89	21.88	1.09

			VIV				
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with VIV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without VIV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with VIV	1.91	0.1	2.36	0.12
Information for contributing scenario 7:							
Transfer into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without VIV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with VIV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without VIV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with VIV	8.5	0.43	10.50	0.53
Information for contributing scenario 8:							
Quality control in a laboratory	PROC 15	>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without VIV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13

The following RCR values were obtained using ECETOC TRA and the reVIVant DNELs

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)

PROC	Exposure assumptions	ES 2- exposure	Acute / long term

code			concentrations (EC) mg/kg bw/d		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)
Information for contributing scenario 2:						
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
Information for contributing scenario 3:						
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14	0.20	0.02
		Indoors with VIV	0.14	0.01	0.02	<0.01
Information for contributing scenario 4:						
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 5:						
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.07	0.01	0.01	<0.01
Information for contributing scenario 6:						
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 7:						

PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 8:						
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01

Quantitative risk characterisation of inhalation exposure concentrations of anhydrous ammonia for industrial workers (ES 2 – industrial use)

PROC code	**Exposure assumptions**		**ES 2- exposure concentrations (EC) mg/m³**		**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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	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 VIV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25

		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	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 VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with VIV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
Information for contributing scenario 7:										

PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without VIV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with VIV	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 VIV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with VIV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
Information for contributing scenario 8:										
PROC 15	>4 hrs	Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without VIV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

Quantitative risk characterisation of inhalation exposure concentrations of aqueous ammonia (in preparations of 5-25 % w/w) in workers (ES 2 – industrial use)

PROC code	**Exposure assumptions**		**ES 2-exposure concentrations (EC) mg/m³**		**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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.0001	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16

		Indoors with VIV	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 VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	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 VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78

		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with VIV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
Information for contributing scenario 7:										
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without VIV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with VIV	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 VIV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with VIV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
Information for contributing scenario 8:										
PROC 15	>4 hrs	Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01

4 Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Environmental releases:
In order to work within the boundaries of the ES the following conditions should be met:

- Local emission to air less than 30.5 mg/M^3
- When the on-site WWTP is used the WWTP sludge should not be spread to soil
- Emissions from the waste-water stream should be completely removed
- Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the

industrial process.

- Measured emissions should be ensured to lead to concentrations in the environment which are less than the reVIVant PNEC
- Emissions to wastewater from laboratory use should not be to the municipal STP

Worker exposure:

In order to work within the boundaries of the ES the following conditions should be met:

- VIV should be in place in indoor facilities at times when natural ventilation is not sufficient.
- Where the potential for dermal exposure exists, gloves with a minimum efficiency of 90% and RPE with 95% efficiency should be worn.
- Health monitoring should be conducted regularly to ascertain the potential VIVels of exposure.
- Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise.
- All technological devices should have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
- Workers should be fully trained.
  Any measured worker exposure VIVels should be confirmed to be below the reVIVant DNEL as presented in section 3 above.

Exposure Scenario 4: Industrial End-use of anhydrous and aqueous Ammonia as processing aids, non-processing aids and auxiliary agents

1	Exposure Scenario 4

Industrial end uses of anhydrous and aqueous Ammonia as processing aids, non –processing aids and auxiliary agents.
Processes Covered:
Environmental Releases
ERC4: Industrial uses of processing aids
ERC5: Industrial end use resulting in inclusion into or onto a matrix
ERC6b: Industrial end use of reactive processing aids
ERC 7: Industrial end use of substances in closed systems
Worker Processes
PROC01: Use in closed process, no likelihood of exposure.
PROC02: Use in closed, continuous process with occasional controlled exposure.
PROC03: Use in closed batch processes
PROC04: Use in batch and other processes where the potential for exposure occurs
PROC05: Mixing and blending
PROC07: Industrial spraying
PROC08a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.
PROC08b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
PROC09: Transfer of formulations to small containers.
PROC10: Roller application or brushing of coatings
PROC13: Treatment of articles by dipping and pouring
PROC15: Laboratory use
PROC19: Low energy hand mixing
Anhydrous liquid and aqueous solutions of ammonia are used by a range of industry sectors in a broad number of applications. These include industrial end use as a reactive or non-reactive processing aid in continuous or batch processes, as an auxiliary agent or as substance in a closed system. Common industrial end-uses of ammonia are shown below.

Common industrial end-uses of ammonia

Industrial end-use	Type of use					Description of use
	Processing aid	Non-processing aid	Reactive processing aid	Auxiliary agent	Use in closed system	
Use as developing agent in photochemical processes	X					Ammonia is used as a developing agent in photochemical processes such as white printing, blue printing and in the diazo duplication press.

Use of refrigerant systems		X			X	Anhydrous liquid ammonia is used as a refrigerant in household, commercial and industrial systems due to its high heat of vaporisation and relative ease of liquefaction.
Insulation products		X				
Inks and toners	X	X				Ammonia vapours are used as a reagent in treating writing or ink marks
Coatings, thinners, paint removers	X	X				
Processing aid in chemicals industry			X			
Use as an extraction agent			X			Ammonia is used as an extraction agent in the mining industry to extract metals like copper, nickel and molybdenum from their ores.
Treatment of gas (NOx and SOx reduction)			X		X	Ammonia is used in stack emission control systems to neutralise sulphur oxides from combustion of sulphur-containing fuels, as a method of NOx control in both catalytic and non-catalytic applications and to enhance the efficiency of electrostatic precipitators for particulate control.
Processing aid in nutrition			X		X	The food and beverage industry use ammonia as a source of nitrogen required for yeast and micro-organism
Use as neutralising agent			X		X	Ammonia is used by the petrochemical industry in neutralizing the acid constituents of crude oil and in the protection of equipment from corrosion
Textile dyes			X			
Treatment of water	X		X			Aqueous ammonia is used in water and waste-water treatment areas to control pH, to regenerate weak anion exchange resins and as an oxygen scavenger in boiled water treatment. In water disinfection, aqueous ammonia is added to water containing free chlorine to produce a chloramines disinfectant.
Use as washing and cleaning products	X		X			Weak ammonia solutions are used extensively within industry, by professionals and consumers as commercial and household cleaners and detergents cleaning products. Commercial ammonia cleaning products contain up to 30% ammonia whereas household products contain 5-10% ammonia
Treatment of textiles		X	X			Liquid ammonia is used to increase the quality of textiles
Treatment of pulp and		X	X			Ammonia is used in the pulp and paper industry

paper						to pulp wood and as a casein dispersant to coat paper.
Treatment of leather		X	X			The leather industry utilises ammonia as a curing agent, as a slime and mould preservative in tanning liquors and as a protective agent for leather and furs in storage
Treatment of wood	X		X			Anhydrous ammonia fumes are used to darken wood in a process called “ammonia fuming”
Treatment of metal surfaces	X		X			Ammonia is used in metal treatment processes such as nitriding, carbonitriding, bright annealing, furnace brazing, sintering, sodium hydride descaling, atomic hydrogen welding and other application where protective atmospheres are required.
Treatment of rubber/latex		X	X			Concentrated aqueous ammonia is used in the rubber industry as a preservative for natural and synthetic latex due to its antibacterial and alkaline properties and as a stabiliser to prevent pre-mature coagulation (e.g. “ammoniation” of natural rubber latex.)
Manufacture of semiconductors/electronics				X		Ammonia is used in the electronics industry in the manufacturing of semiconductor chips.
Adhesives, sealants	X			X		
Polymer preparations	X			X		
Aircare products					X	
Preservatives		X				Ammonia is uses as a preservative for the storage of high moisture corn

Contributing Environmental Scenario: Environmental exposure arising due to Industrial end uses of anhydrous and aqueous ammonia.

Contributing Worker Scenarios: Worker exposure arising due to day to day use in closed processes with no likelihood of exposure, day to day use in closed continuous processes with occasional exposure (such as sampling), day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance), mixing and blending, transfer to small containers, transfer of substance to and from large vessels and containers, roller and brushing application of coatings, treatment of articles by dipping and pouring, laboratory use, hand mixing and industrial spraying.

2.1 Contributing scenario 1 controlling environmental exposure for ES 4

Environmental exposure arising due to industrial end uses of anhydrous and aqueous ammonia.

Section 2.1 describes the environmental releases that may occur during the industrial end uses of anhydrous and aqueous ammonia. These releases may occur due to emission to wastewater or through emission to the atmosphere. If emission to wastewater occurs on-site treatment in an industrial waste water treatment plant will be required in order to remove downstream emissions to the environment.
In reality removal of ammonia in sewage treatment plants is highly efficient being removed first by nitrification to

nitrate followed by denitrification resulting in the release of nitrogen gas. It is considered that if there processes are employed complete removal from the wastewater stream will occur. Emissions to the atmosphere should not exceed concentrations of 30.5 mg/m^3.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Possible exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.
Environmental factors influenced by risk management
Flow rate of receiving water at least 18,000 m^3 per day. Dilution of any STP emissions at least 10 fold.
Other operational conditions affecting environmental exposure
Workers are fully trained in safe use and the use of appropriate systems in order to prevent accidental release. Closed systems are employed in order to prevent un-intended emissions.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed sealed. On site WWTPs should be available at industrial sites in order to eliminate emissions to the environment via contaminated wastewater.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Waste water should be emitted to the on-site industrial WWTP for specialized removal. Emissions to air from the industrial processes or from the onsite WWTP should not exceed a total concentration of 19.9 mg/m^3 of air. This is approximately equivalent to a total loss to air of 70,000 kg/day. Sludge from the on-site WWTP should not be spread to soil. Any solid waste must be sent to a dump for burying, incineration or recycling.
Organizational measures to prevent/limit releases from site
Workers are fully trained in order to prevent accidental release and exposures may be monitored to ensure airborne concentrations are within acceptable VIVels.
Conditions and measures related to municipal STP
Direct emissions to the municipal STP should not be made.
Conditions and measures related to external treatment of waste for disposal
Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the industrial process. Sludge from the onsite WWTP should be recycled, incinerated or sent to landfill.
Conditions and measures related to external recovery of waste
There is no envisaged external recovery of waste. Waste sludge is reduced and then incinerated and emissions to air are not collected.

2.2	**Contributing scenario 2 controlling worker exposure day to day use in closed processes with**

	no likelihood of exposure
Worker exposure arising due to day to day use in closed processes with no likelihood of exposure during the industrial end use processes.	
Section 2.2 describes the potential exposure to workers during the industrial end use of ammonia as an intermediate from operation of closed systems. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Conditions and measures related to personal protection, hygiene and health.	
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room.	

Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.3	**Contributing scenario 3 controlling worker exposure due to day to day use in closed continuous processes with occasional exposure (such as sampling)**

Worker exposure arising due to day to day use in closed continuous processes with occasional exposure (such as sampling).
Section 2.3 describes the potential exposure to workers during the industrial end use of preparations of ammonia from the operation of closed systems with the potential for occasional exposure during tasks such as sampling, cleaning and maintenance. The potential exposure arises from the operation of industrial end use equipment and its associated machinery and during routine sampling, cleaning and occasional maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in these tasks. Formulated solutions are 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).
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.

Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.4	**Contributing scenario 4 controlling worker exposure for day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance)**

Worker exposure arising due to day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance).
Section 2.4 describes the potential exposure to workers during day to day use of industrial machinery, pipelines and storage vessels. Potential exposure may occur during the day to day use however it is more likely to occur during tasks associated with the batch or other processes themselves such as sampling of produced intermediates, cleaning and routine maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Solutions of ammonia are 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). This contributing considers the potential exposures from batch and other processes (such as one off exposures) and though there is some potential for exposure generally systems are in place to control and losses or unintended emissions of ammonia at the industrial facility.
Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial end use sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use during batch and other processes is generally a short duration task, with limited potential for exposure occurring in reality.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.

Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.	
2.5	**Contributing scenario 5 controlling worker exposure for mixing and blending**
Worker exposure arising due to mixing and blending in batch processes during industrial end use	
Section 2.5 describes the potential exposure to workers during mixing and blending of ammonia formulations. Potential exposure may occur during the day to day use of machinery and technologies associated with the blending and mixing process as part of the overall industrial end use of ammonia. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Stock 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).	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.	

Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.6	**Contributing scenario 6 controlling worker exposure for transfer to small containers**

Worker exposure arising due to transfer to small containers in a dedicated filling line.
Section 2.6 describes the potential exposure to workers during the filling of small containers in dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the small sized containers.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure

Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.7	**Contributing scenario 7 controlling worker exposure for transfer to and from large containers and vessels**

Worker exposure arising due transfer of ammonia to and from large containers and vessels
Section 2.7 describes the potential exposure to workers during the filling and loading to/from large vessels and containers in dedicated and non-dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers and vessels themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Formulated liquid ammonia is then stored and transported as a liquid in the small sized containers.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily

biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of anhydrous and aqueous forms of ammonia involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.8	**Contributing scenario 8 controlling worker exposure for roller and brushing applications of coatings**
Worker exposure arising due to roller and brushing applications of coatings	
Section 2.8 describes the potential exposure to workers during the industrial end use of ammonia during roller and brushing applications to surfaces of coatings of ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial brushing and roller applications is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place. Workers should not be directly exposed to the application solutions.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.	
Conditions and measures related to personal protection, hygiene and health.	
Industrial end-uses of surface applied ammonia during roller and brushing applications involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room.	

Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.9	**Contributing scenario 9 controlling worker exposure for treatment of articles by dipping and pouring**

Worker exposure arising due to treatment of articles by dipping and pouring.
Section 2.9 describes the potential exposure to workers during the industrial end use of ammonia during dipping and pouring treatment of articles using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial treatment of articles by dipping and pouring is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place. Workers should not be directly exposed to the article treatment solutions.
Technical conditions to control dispersion from source towards worker

VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of surface applied ammonia during roller and brushing applications involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). All operations are performed in a closed system. Pipelines and vessels are sealed and insulated and sampling is carried out with a closed sample loop. Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.10	**Contributing scenario 10 controlling worker exposure for laboratory use**

Worker exposure arising due to laboratory use of ammonia (small scale non-industrial laboratories).
Section 2.10 describes the potential exposure to workers during laboratory use of ammonia especially during the filling and loading of small flasks and vessels using non-dedicated filling lines or small scale transfer methods. Potential exposure is most likely to occur during tasks associated with the actual transfer or mixing of the ammonia solutions. For dedicated small scale laboratories appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During laboratory use of ammonia solutions of aqueous ammonia in the 5 – 25% concentrations range are most liklety to be encountered. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.
Amounts used

Amounts use in a non-industrial setting are likely to be small with less than 1 litre or 1 kilogram present on site. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330 however actual emission of ammonia is likely to be much less frequent in practice.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Again use of ammonia is not likely to be this frequent in practice.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the laboratory end use of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
During laboratory use VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). All technological devices should have a proper quality certification, and should be regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not considered sufficient or in enclosed areas.
Organizational measures to prevent/limit release
Laboratory workers are fully trained in safe use of chemicals in general and in the use of appropriate PPE in order to prevent accidental release or exposure.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia during laboratory use when filling containers and vessels or during transfer. Extract ventilation is provided at openings and points were emissions may occur. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in the required procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.11	**Contributing scenario 11 controlling worker exposure for hand mixing with intimate contact and PPE only**
Worker exposure arising due to hand mixing with intimate contact and PPE only.	
Section 2.11 describes the potential exposure to workers during the industrial end use of ammonia during hand mixing of formulations (with intimate contact and PPE only) using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	

Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia hand mixing in this case considered intimate contact and suitable PPE only.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Workers should not be directly exposed to the mixing solutions without PPE in place. VIV is generally not required.
Technical conditions to control dispersion from source towards worker
No specific measures aside from good industrial practice is required.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of mixing equipment and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial hand mixing of ammonia would generally be carried out indoors using low energy methods and in vessels which should reduce the potential for un-intended loss. The potential for industrial workers to be exposed to ammonia during these processes is therefore negligible since PPE and low emission methods are used. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the hand mixing of ammonia or ammonia solutions are well-trained in the required procedures and use of appropriate protective equipment.

2.12	**Contributing scenario 12 controlling worker exposure for industrial spraying**

Worker exposure arising due to industrial spraying and air dispersive techniques
Section 2.12 describes the potential exposure to workers during the industrial end use of ammonia for spray aplications using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.

Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Industrial sites may use up to a largest individual site tonnage of 25,000 tonnes per annum, with up to 354,000 tonnes used per year in the European Union. According to the guidance for this tonnage band, the default REACH number of emission days per year are 330.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during industrial spraying is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects is conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place. Workers should not be directly exposed to the article treatment solutions.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with industrial intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects is conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Industrial end-uses of sprayed ammonia during air dispersive applications involve special equipment and high integrity specialized systems. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps or tanks etc). Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the industrial end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

3	**Exposure estimation and reference to its source**

The assessment of worker exposure to anhydrous and aqueous forms of ammonia in industrial end-use applications (ES 4) was carried out for processes reVIVant to this scenario as identified by PROC codes reflecting: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), industrial spraying (PROC 7), maintenance and clean down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9), brush and roller applications (PROC 10), treatment of articles by dipping and pouring (PROC 13), and analysis of samples (PROC 15) and hand-mixing (PROC 19).
A screening-VIVel (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m3) associated with each process defined by PROC codes.
Exposure to workers was assessed taking into account different operational conditions that may be associated with the industrial end-use of ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposure concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.
The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposure where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35 $g.mol^{-1}$ and 17 $g.mol^{-1}$ for aqueous and anhydrous forms respectively) and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6 x 10^5 Pa at 20°C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5 x 10^3 Pa to 4 x10^4 Pa at 20°C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.
For environmental emissions complete removal in the on-site WWTP was considered during derivation of the values below. Emission values and environmental concentrations were calculated using the EUSES 2.1 model.

Information for contributing scenario 1 (environmental exposure):

The following PEC values were calculated using EUSES 2.1

ERC	PEC	Values
ERCs 4, 5, 6b and 7	PEC in sewage effluent	0 (due to complete removal)
ERCs 4, 5, 6b and 7	PEC in aquatic compartment (mg/L): Freshwater	ERC 4: 2.82 x 10^{-3} ERC 5: 1.46 x 10^{-3} ERC 6b: 4.54 x 10^{-5} ERC 7: 1.46x 10^{-4}
	Marine Water	ERC 4: 6.06 x 10^{-4} ERC 5: 3.17 x 10^{-4} ERC 6b: 5.19 x 10^{-6}

		ERC 7: 3.17 x 10^{-5}
ERCs 4, 5, 6b and 7	PEC in sediments (mg/kg): Freshwater sediments Marine water sediments	 ERC 4: 3.05 x 10^{-3} ERC 5: 1.58 x 10^{-3} ERC 6b: 4.91 x 10^{-5} ERC 7: 1.58 x 10^{-4} ERC 4: 6.56 x 10^{-4} ERC 5: 3.43 x 10^{-4} ERC 6b: 5.62 x 10^{-6} ERC 7: 3.43 x 10^{-5}
ERCs 4, 5, 6b and 7	PEC in soil and groundwater:	Upon contact with soil, ammonia will be rapidly converted by a variety of bacteria, actinomycetes and fungi to ammonium (NH_4^+) by the process of ammonification or mineralization. Ammonium is then rapidly converted to nitrate. Nitrate is subsequently taken up and utilised by plants or returned to the atmosphere following denitrification; the metabolic reduction of nitrate into nitrogen or nitrous oxide (N2O) gas. The most likely fate of ammonium ions in soils is conversion to nitrates by nitrification. Therefore accumulation of concentrations of ammonia in soil and groundwater will not be expected.
ERCs 4, 5, 6b and 7	PEC in air: annual average (mg/M^3)	ERC 4: 18 ERC 5: 9.45 ERC 6b: 0.0189 ERC 7: 0.945

The following RCR values were obtained:

Compartments	PEC	PNEC	PEC/PNEC	Discussion
ERC 4 Freshwater (Tier 2)	2.82×10^{-3} mg/L (Total Ammonia) 1.08×10^{-4} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.098	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 4 Marine water (Tier 2)	6.06×10^{-4} mg/L (Total Ammonia) 2.31×10^{-5} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.021	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 5 Freshwater (Tier 2)	1.46×10^{-3} mg/L (Total Ammonia) 5.58×10^{-5} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.051	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 5 Marine water (Tier 2)	3.17×10^{-4} mg/L (Total Ammonia) 1.21×10^{-5} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	0.011	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 6b Freshwater (Tier 2)	4.54×10^{-5} mg/L (Total Ammonia) 1.73×10^{-6} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	1.58×10^{-3}	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 6b Marine water (Tier 2)	5.19×10^{-6} mg/L (Total Ammonia) 1.98×10^{-7} mg/L	0.0011 mg/l (Free Ammonia)	1.80×10^{-4}	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA

	(Free Ammonia)			document EPA-600/3-79-091)
ERC 7 Freshwater (Tier 2)	1.46×10^{-4} mg/L (Total Ammonia) 5.58×10^{-6} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	5.07×10^{-3}	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)
ERC 7 Marine water (Tier 2)	3.17×10^{-5} mg/L (Total Ammonia) 1.21×10^{-6} mg/L (Free Ammonia)	0.0011 mg/l (Free Ammonia)	1.10×10^{-3}	Conversion from Total Ammonia to Free Ammonia based on a fraction of 3.82% given for pH 8 and 25C. (Ref data tabulated in EPA document EPA-600/3-79-091)

The following values were obtained using ECETOC TRA for worker exposure
Dermal exposures predicted using the ECETOC TRA model

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: storage (closed or bulk container)	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14
			Indoors with VIV	0.14	0.01
Information for contributing scenario 4:					
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01

Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 5:					
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with VIV	0.07	0.01
Information for contributing scenario 6:					
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 7:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
			Indoors with VIV	0.14	0.01
Transfer (charging/discharging) from or to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
			Indoors with VIV	0.69	0.07
Information for contributing scenario 8:					
Roller application or brushing	PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	27.43	0.14
		1-4 hrs or >4 hrs	Indoors with VIV	1.37	10.71
Information for contributing scenario 9:					
Treatment of articles by dipping and pouring	PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Information for contributing scenario 10:					
Laboratory use : Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01

Information for contributing scenario 11:					
Hand-mixing with intimate contact and PPE only	PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	141.73	14.13
Information for contributing scenario 12:					
Industrial spraying	PROC 7	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	42.86	4.29
		1-4 hrs or >4 hrs	Indoors with VIV	2.14	0.21

Inhalation exposure concentrations predicted using the ECETOC TRA model

				Anhydrous ammonia		**Aqueous ammonia (5-25% w/w)**	
Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/m3**			
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Information for contributing scenario 2:							
Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	NA
		1-4 hrs or >4 hrs	Indoors without VIV	0.01	NA	0.01	NA
Information for contributing scenario 3:							
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.53	0.18	4.38	0.22
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without VIV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 4:							
Use in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors	70.83	3.54	87.5	4.38

			without VIV				
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Information for contributing scenario 5:							
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 6:							
Maintenance, clean down	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging)	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59

from/to vessels or large containers at dedicated facilities		>4hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with VIV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without VIV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with VIV	1.91	0.1	2.36	0.12
Information for contributing scenario 7:							
Transfer into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without VIV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with VIV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without VIV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with VIV	8.5	0.43	10.50	0.53
Information for contributing scenario 8:							
Roller application or brushing	PROC 10	>4hrs	Outdoors	NA	NA	153.13	7.66
		>4hrs	Indoors without VIV	NA	NA	218.75	10.94
		>4hrs	Indoors with VIV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without VIV	NA	NA	131.25	6.56
		>4hrs	Outdoors	NA	NA	13.13	0.66
Information for contributing scenario 9:							
Treatment of articles by dipping and pouring	PROC 13	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 10:							
Quality control in a	PROC	>4hrs	Indoors	35.42	1.77	43.75	2.19

laboratory	15		without VIV				
		>4hrs	Indoors with VIV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without VIV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 11:							
Hand-mixing with intimate contact and PPE only	PROC 19	<4 hrs	Outdoors	NA	NA	153.13	7.66
		<4 hrs	Indoors without VIV	NA	NA	218.75	10.94
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without VIV	NA	NA	131.25	6.56
Information for contributing scenario 12:							
Industrial spraying	PROC 7	>4hrs	Outdoors	NA	NA	306.25	15.31
		>4hrs	Indoors without VIV	NA	NA	437.5	21.88
		>4hrs	Indoors with VIV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	183.75	9.19
		1-4 hrs	Indoors without VIV	NA	NA	262.5	13.13
		1-4 hrs	Indoors with VIV	NA	NA	13.13	0.66

The following RCR values were obtained using ECETOC TRA and the reVIVant DNELs
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**	
					Risk characterisation ratio	
	Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:						
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
Information for contributing scenario 3:						

PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14	0.20	0.02
		Indoors with VIV	0.14	0.01	0.02	<0.01
Information for contributing scenario 4:						
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 5:						
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.07	0.01	0.01	<0.01
Information for contributing scenario 6:						
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with LEV	0.69	0.07	0.10	0.01
Information for contributing scenario 7:						
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 8:						
PROC 10	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	27.43	2.74	4.03	0.40
		Indoors with VIV	1.37	0.14	0.20	0.02
Information for contributing scenario 9:						
PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 10:						

PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
Information for contributing scenario 11:						
PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	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						
Information for contributing scenario 12:						
PROC 7	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	42.86	4.29	6.30	0.63
		Indoors with VIV	2.14	0.21	0.32	0.03

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/m³**		**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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13

		Indoors with VIV	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 VIV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	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 VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	63.75	3.19	1.34	0.07	1.77	0.09	4.55	0.23
		Indoors with VIV	1.91	0.10	0.04	0.00	0.05	<0.01	0.14	0.01
Information for contributing scenario 7:										
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without VIV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with VIV	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 VIV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with VIV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
Information for contributing scenario 9:										
PROC 13	>4 hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 10:										
PROC 15	>4 hrs	Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without VIV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08

		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01

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 concentrations (EC) mg/m³		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
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	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 VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02

		VIV								
PROC 4	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02
Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28

		Indoors with VIV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
Information for contributing scenario 7:										
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without VIV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with VIV	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 VIV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with VIV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
Information for contributing scenario 8:										
PROC 10	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 9:										
PROC 13	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 10:										
PROC 15	>4 hrs	Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02

		VIV								
	1-4 hrs	Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 11:										
PROC 19	>4 hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
Information for contributing scenario 12:										
PROC 7	>4hrs	Outdoors	306.25	15.31	6.43	0.32	8.51	0.43	21.88	1.09
		Indoors without VIV	437.5	21.88	9.19	0.46	12.15	0.61	31.25	1.56
		Indoors with VIV	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 VIV	262.5	13.13	5.51	0.28	7.29	0.36	18.75	0.94
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05

4	**Guidance to DU to evaluate whether he works inside the boundaries set by the ES**

Environmental releases:
In order to work within the boundaries of the ES the following conditions should be met:

- Local emission to air less than 70,000 kg/day
- When the on-site WWTP is used the WWTP sludge should not be spread to soil
- Emissions from the waste-water stream should be completely removed
- Residues may be sent to external waste treatment, on-site effluent treatment or recycled back into the manufacturing process.
- Measured emissions should be ensured to lead to concentrations in the environment which are less than the reVIVant PNEC
- Emissions to wastewater from laboratory use should not be to the municipal STP

Worker exposure:
In order to work within the boundaries of the ES the following conditions should be met:

- VIV should be in place in indoor facilities at times when natural ventilation is not sufficient.
- Where the potential for dermal exposure exists, gloves with a minimum efficiency of 90% and RPE with 95% efficiency should be worn.
- Health monitoring should be conducted regularly to ascertain the potential VIVels of exposure.

- Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise.
- All technological devices should have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
- Workers should be fully trained.
  Any measured worker exposure VIVels should be confirmed to be below the reVIVant DNEL as presented in section 3 above.

Exposure Scenario 5: Wide-dispersive professional use of anhydrous and aqueous ammonia

1	Exposure Scenario 5

Wide dispersive professional uses of anhydrous and aqueous Ammonia as processing aids, non –processing aids and auxiliary agents.
Processes Covered:
Environmental Releases
ERC 8a: Wide dispersive indoor use of processing aids in open systems
ERC8b: Wide dispersive indoor use of reactive substances in open systems
ERC8d: Wide dispersive outdoor use of processing aids in open systems
ERC 8e: Wide dispersive outdoor use of reactive substances in open systems
ERC 9a: Wide dispersive indoor use of substances in closed systems
ERC 9b: Wide dispersive outdoor use of substances in closed systems
ERC11a: Wide dispersive indoor use of long-life articles and materials with low release
Worker Processes
PROC01: Use in closed process, no likelihood of exposure.
PROC02: Use in closed, continuous process with occasional controlled exposure.
PROC03: Use in closed batch processes
PROC04: Use in batch and other processes where the potential for exposure occurs
PROC05: Mixing and blending
PROC08a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.
PROC08b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
PROC09: Transfer of formulations to small containers.
PROC10: Roller application or brushing of coatings
PROC11: Non-professional spraying
PROC13: Treatment of articles by dipping and pouring
PROC15: Laboratory use
PROC19: Low energy hand mixing
PROC20: Heat and pressure transfer fluids
Anhydrous liquid ammonia (>99.5 % wt) and aqueous ammonia solution (5-25% wt) are used by professional workers in a broad number of applications. Common applications include: use as a laboratory chemical, a refrigerant in cooling systems, a water treatment chemical, a fertiliser, a coating, paint thinner or paint remover, a photochemical, a cleaning product, a leather or other surface treatment product, a pH regulator or neutralisation agent and a process aid for nutrition.
Typical activities associated with the professional uses of ammonia where exposures can arise include operating equipment containing ammonia (e.g. opening and closing valves), transferring ammonia from storage containers using pipe or hoses, maintaining equipment and applying ammonia-based products (e.g. fertiliser, cleaning or surface treatment products).
Operational conditions pertaining to the broad range of professional end-use scenarios involving anhydrous and aqueous forms of ammonia vary considerably across applications. A full characterisation of the frequency and duration of tasks is therefore beyond the scope of this exposure scenario. For the purposes of worker exposure estimation, operational conditions have been represented generically based

on the assumption that tasks may be either 1-4 hours or >4 hours in duration and that processes may be carried out either outdoors, indoors without VIV or indoors with VIV. These assumptions cover the broad range of tasks

associated with professional uses of ammonia.
Contributing Environmental Scenario: Environmental exposure arising due to Wide dispersive professional uses of anhydrous and aqueous ammonia.
Contributing Worker Scenarios: Worker exposure arising due to day to day use in closed processes with no likelihood of exposure, day to day use in closed continuous processes with occasional exposure (such as sampling), day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance), mixing and blending, transfer to small containers, transfer of substance to and from large vessels and containers, roller and brushing application of coatings, treatment of articles by dipping and pouring, laboratory use, use in heat and pressure transfer fluids, hand mixing and non-professional spraying.

2.1	**Contributing scenario 1 controlling environmental exposure for ES 5**

Environmental exposure arising due to wide dispersive professional uses of anhydrous and aqueous ammonia.
Section 2.1 describes the environmental releases that may occur during the wide dispersive professional uses of anhydrous and aqueous ammonia. These releases may occur due to emission to wastewater or through emission to the atmosphere. Due to the wide dispersive nature these uses local source emissions are expected to be very small and significant concentrations in the environment are not expected. Low VIVel emission may be outdoor or indoor with emission directed to air or to the STP. In reality removal of ammonia in sewage treatment plants is highly efficient as ammonia solutions are readily biodegradable. The majority of ammonia in the environment originates from natural sources, predominantly decaying organic matter. Wide dispersive professional uses of ammonia are diverse and widespread. The resulting environmental exposure is not expected to add significantly to already present background VIVels of ammonia in the environment. An additional assessment for environmental exposure for wide dispersive uses has therefore not been presented in section 3 below.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Professional use is expected to see very small amounts used on a local scale with use widespread throughout the EU.
Frequency and duration of use
Variable low VIVel use.
Environmental factors influenced by risk management
Large regional dilution and wide dispersive use pattern.
Other operational conditions affecting environmental exposure
Professional workers should be informed in order to prevent accidental release. Closed systems are employed in articles 9such as fridges) in order to prevent un-intended emissions.
Technical conditions and measures at process VIVel (source) to prevent release
Closed articles for long-life use.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

None-specifically required beyond standard good practice for professional workers.
Organizational measures to prevent/limit releases from site
Workers are trained in order to prevent accidental releases.
Conditions and measures related to municipal STP
Small low VIVel local emissions may be released to the STP where removal is expected to be efficient due to the readily biodegradable nature of low concentration ammonia solutions.
Conditions and measures related to external treatment of waste for disposal
Any residual waste (such as empty bottles or old fridges and cooling systems) must be sent to dump or for specialized disposal.
Conditions and measures related to external recovery of waste
There is no envisaged external recovery of ammonia waste.

2.2	**Contributing scenario 2 controlling worker exposure day to day use in closed processes with no likelihood of exposure.**

Worker exposure arising due to day to day use in closed processes with no likelihood of exposure during the professional end use processes.
Section 2.2 describes the potential exposure to workers during the professional end use of ammonia as an intermediate from operation of closed systems. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.

Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.3	**Contributing scenario 3 controlling worker exposure due to day to day use in closed continuous processes with occasional exposure (such as sampling)**

Worker exposure arising due to day to day use in closed continuous processes with occasional exposure (such as sampling).
Section 2.3 describes the potential exposure to workers during the professional end use of preparations of ammonia from the operation of closed systems with the potential for occasional exposure during tasks such as sampling, cleaning and maintenance. The potential exposure arises from the operation of professional end use equipment and its associated machinery and during routine sampling, cleaning and occasional maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in these tasks. Formulated solutions are 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).
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.

Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.4	**Contributing scenario 4 controlling worker exposure for day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance)**

Worker exposure arising due to day to day use in batch or other processes with some potential for exposure (such as sampling, cleaning, maintenance).
Section 2.4 describes the potential exposure to workers during day to day use of professional machinery, pipelines

and storage vessels. Potential exposure may occur during the day to day use however it is more likely to occur during tasks associated with the batch or other processes themselves such as cleaning and routine maintenance. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Solutions of ammonia are 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). This contributing considers the potential exposures from batch and other processes (such as one off exposures) and though there is some potential for exposure generally systems are in place to control and losses or unintended emissions of ammonia at the professional facility.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use during batch and other processes is generally a short duration task, with limited potential for exposure occurring in reality.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible.

Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.5	**Contributing scenario 5 controlling worker exposure for mixing and blending**

Worker exposure arising due to mixing and blending in batch processes during professional end use
Section 2.5 describes the potential exposure to workers during mixing and blending of ammonia formulations. Potential exposure may occur during the day to day use of machinery and technologies associated with the blending and mixing process as part of the overall professional end use of ammonia. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task. Stock 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).
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.
Technical conditions to control dispersion from source towards worker

VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.6	**Contributing scenario 6 controlling worker exposure for transfer to small containers**

Worker exposure arising due to transfer to small containers in a dedicated filling line.
Section 2.6 describes the potential exposure to workers during the filling of small containers in dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use is generally a short duration task, with limited potential for exposure.

Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.7	**Contributing scenario 7 controlling worker exposure for transfer to and from large containers and vessels**

Worker exposure arising due transfer of ammonia to and from large containers and vessels
Section 2.7 describes the potential exposure to workers during the filling and loading to/from large vessels and containers in dedicated and non-dedicated filling lines. Potential exposure is most likely to occur during tasks associated with the actual filling of the containers and vessels themselves. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional end use is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional end use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of anhydrous and aqueous forms of ammonia are diverse and should generally be carried out using specialized contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential fpr professionals to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room whenever possible. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps, tanks or during mixing etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for

professional worker exposure. Workers involved in the wide dispersive professional uses of ammonia are well-trained in the required procedures and use of appropriate protective equipment.	
2.8	**Contributing scenario 8 controlling worker exposure for roller and brushing applications of coatings**
Worker exposure arising due to roller and brushing applications of coatings	
Section 2.8 describes the potential exposure to workers during the professional end use of ammonia during roller and brushing applications to surfaces of coatings of ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional brushing and roller applications is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible. Workers should not be directly exposed to the application solutions.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with professional intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.	
Conditions and measures related to personal protection, hygiene and health.	
Professional end-uses of surface applied ammonia during roller and brushing applications involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical	

processing units The potential for professional workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room.
Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, brushing equipment, pumps or tanks etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise.
All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the professional end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.9	**Contributing scenario 9 controlling worker exposure for treatment of articles by dipping and pouring**

Worker exposure arising due to treatment of articles by dipping and pouring.

Section 2.9 describes the potential exposure to workers during the professional end use of ammonia during dipping and pouring treatment of articles using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.

Product characteristics

Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.

Amounts used

Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.

Frequency and duration of use exposure

Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional treatment of articles by dipping and pouring is generally a short duration task, with limited potential for exposure.

Human factors not influence by risk management

Respiration volume under conditions of use: 10 m^3/d
Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).

Other given operational conditions affecting worker exposure

Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.

Technical conditions and measures at process VIVel (source) to prevent release

Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible. Workers should not be directly exposed to the article treatment solutions.

Technical conditions to control dispersion from source towards worker

VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of surface applied ammonia during roller and brushing applications involve special equipment and high integrity contained systems with little or no potential for worker exposure. Facilities may be housed outdoors, with workers being segregated in separate control rooms with no direct contact with chemical processing units The potential for professional workers to be exposed to ammonia during these processes is therefore negligible since they are located in a separate control room. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, pumps or tanks etc). Extract ventilation is provided at openings and points were emission may occur. Anhydrous ammonia is stored in closed containers and tanks. Ammonia is transferred under containment. A good standard of general or controlled ventilation is applied when maintenance activities are carried out. Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the professional end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.10	**Contributing scenario 10 controlling worker exposure for laboratory use**

Worker exposure arising due to laboratory use of ammonia (small scale non-professional laboratories).
Section 2.10 describes the potential exposure to workers during laboratory use of ammonia especially during the filling and loading of small flasks and vessels using non-dedicated filling lines or small scale transfer methods. Potential exposure is most likely to occur during tasks associated with the actual transfer or mixing of the ammonia solutions. For dedicated small scale laboratories appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.
Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. During laboratory use of ammonia solutions of aqueous ammonia in the 5 – 25% concentrations range are most liklety to be encountered. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable. It is this aqueous ammonia that is most likely to cause potential exposure for this contributing scenario.
Amounts used

Amounts use in a professional setting are likely to be small with less than 1 litre or 1 kilogram present on site. According to the guidance for this tonnage band, the default REACH number of emission days per year are 365 for wide dispersive uses however actual emission of ammonia is likely to be much less frequent in practice.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Again use of ammonia is not likely to be this frequent in practice.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
During the laboratory end use of ammonia indoors local exhaust ventilation may be in place. Personal protective equipment is also used to minimize the potential for dermal exposure during the transfer process. RPE is provided when required.
Technical conditions and measures at process VIVel (source) to prevent release
During laboratory use VIV may or may not be in place (refer to section 3 below for reVIVant exposure VIVels for these cases). All technological devices should have a proper quality certification, and should be regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not considered sufficient or in enclosed areas.
Organizational measures to prevent/limit release
Laboratory workers are fully trained in safe use of chemicals in general and in the use of appropriate PPE in order to prevent accidental release or exposure.
Conditions and measures related to personal protection, hygiene and health.
Workers may potentially be exposed to ammonia during laboratory use when filling containers and vessels or during transfer. Extract ventilation is provided at openings and points were emissions may occur. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers are well-trained in the required procedures and the use of appropriate protective equipment. Where good natural ventilation is found to be inadequate, mechanical (general) ventilation or local exhaust ventilation (VIV) is provided. Personal protective clothing (e.g. face/eye/ear protection, helmet, gloves boots and protective overall) is worn when any potential contact may arise. VIVel A clothing (full encapsulating suit with self contained breathing apparatus) is used when handling large liquid spills or vapour clouds. Impervious clothing and rubber gloves are used for small liquid spills and normal loading and unloading operations. Safety shower/eye wash facilities are provided at sites which handle or store ammonia. Filtering respiratory masks are worn in case on the accidental release of ammonia.

2.11	**Contributing scenario 11 controlling worker exposure for hand mixing with intimate contact and PPE only**
Worker exposure arising due to hand mixing with intimate contact and PPE only.	
Section 2.11 describes the potential exposure to workers during the professional end use of ammonia during hand mixing of formulations (with intimate contact and PPE only) using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	

Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia hand mixing in this case considered intimate contact and suitable PPE only.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (according to ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Workers should not be directly exposed to the mixing solutions without PPE in place. VIV is generally not required.
Technical conditions to control dispersion from source towards worker
No specific measures aside from good professional practice is required.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of mixing equipment and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional hand mixing of ammonia would generally be carried out indoors using low energy methods and in vessels which should reduce the potential for un-intended loss. The potential for professional workers to be exposed to ammonia during these processes is therefore negligible since PPE and low emission methods are used. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the hand mixing of ammonia or ammonia solutions are well-trained in the required procedures and use of appropriate protective equipment.

2.12	**Contributing scenario 12 controlling worker exposure for professional spraying**
Worker exposure arising due to professional spraying and air dispersive techniques	
Section 2.12 describes the potential exposure to workers during the professional end use of ammonia for spray applications using ammonia or ammonia containing solutions. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	

Product characteristics
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.
Amounts used
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.
Frequency and duration of use exposure
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during professional spraying is generally a short duration task, with limited potential for exposure.
Human factors not influence by risk management
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).
Other given operational conditions affecting worker exposure
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Technical conditions and measures at process VIVel (source) to prevent release
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible. Workers should not be directly exposed to the article treatment solutions.
Technical conditions to control dispersion from source towards worker
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.
Organizational measures to prevent/limit release
Workers are fully trained in safe use of the machinery associated with professional intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.
Conditions and measures related to personal protection, hygiene and health.
Professional end-uses of sprayed ammonia during air dispersive applications involve special equipment and high integrity specialized systems. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps or tanks etc). Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia. Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the professional end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

2.13	**Contributing scenario 13 controlling worker exposure for** use in heat and pressure transfer

	fluids
Worker exposure arising due to use in heat and pressure transfer fluids	
Section 2.2 describes the potential exposure to workers during the professional end use of ammonia use in heat and pressure transfer fluid applications of ammonia based solutions in dispersive but closed systems. Appropriate PPE and onsite control parameters are in place to limit the risk of exposure to workers involved in this task.	
Product characteristics	
Anhydrous ammonia is a colourless gas at room temperature and pressure with a typical purity of around 99.9%. The vapour pressure of ammonia, anhydrous is reported to be 8611 hPa at 20 °C. Anhydrous ammonia is very soluble in water: reported water solubility values are 48200-53100 mg/L. Anhydrous ammonia is considered to be flammable. Formulated aqueous ammonia has a vapour pressure of 287 hPa and is considered readily biodegradable.	
Amounts used	
Small amounts are expected to be used on professional sites each year. As wide dispersive uses significant on-site tonnages are not expected for professional use.	
Frequency and duration of use exposure	
Workers perform standard shifts of 8 hours per day and have standard working years of 220 days per year. Potential exposure to ammonia during use in heat and pressure transfer fluids is generally a short duration task, with limited potential for exposure.	
Human factors not influence by risk management	
Respiration volume under conditions of use: 10 m^3/d Area of skin contact with the substance under conditions of use: 480cm^2 (ECETOC default).	
Other given operational conditions affecting worker exposure	
Workers are fully trained in safe use and the use of appropriate PPE in order to prevent accidental release. Frequent monitoring for health effects may be conducted by medical surveillance programs.	
Technical conditions and measures at process VIVel (source) to prevent release	
Systems and transfer pipelines should be closed and sealed. During indoor processes or in cases where natural ventilation is not sufficient VIV should be in place. For outdoor processes VIV is not generally required however system closure should still be in place when possible. Workers should not be directly exposed to the article treatment solutions.	
Technical conditions to control dispersion from source towards worker	
VIV should be in place during indoor operations when natural ventilation is not sufficient. Reactors and pipelines should be closed and sealed systems when possible.	
Organizational measures to prevent/limit release	
Workers are fully trained in safe use of the machinery associated with professional intermediate use and in the use of appropriate PPE in order to prevent accidental release or unintended exposure. Frequent monitoring for health effects may be conducted by medical surveillance programs.	
Conditions and measures related to personal protection, hygiene and health.	
Professional end-uses of ammonia lubricants for use in heat and pressure transfer fluid applications involve special equipment and high integrity specialized systems. Workers may potentially be exposed to ammonia when conducting field activities (e.g. when operating valves, spraying machinery, pumps or tanks etc). Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) is worn when any potential contact may arise. All technological devices have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.	

Good occupational hygiene and exposure control measures are implemented to minimise the potential for worker exposure. Workers involved in the professional end use of ammonia are well-trained in the required procedures and use of appropriate protective equipment.

3	**Exposure estimation and reference to its source**

The assessment of worker exposure to anhydrous and aqueous ammonia during professional uses (ES 5) was carried out for process categories reVIVant to this scenario as identified by PROC codes: use and storage of ammonia in closed systems with no likelihood of exposure (PROC 1), use in closed, continuous processes with occasional controlled exposure (PROC 2), formulation using closed batch processes (PROC 3), use in batch or other processes (PROC 4), mixing or blending in a batch process (PROC 5), maintenance and clean-down (PROC 8a), transfer (PROC 8b), transfer of ammonia into containers (PROC 9), brush and roller applications (PROC 10), spraying (PROC 11), treatment of articles by dipping and pouring (PROC 13), and analysis of samples (PROC 15), hand-mixing (PROC 19) and heat and pressure transfer in closed systems (PROC 20).
A screening-VIVel (Tier 1) assessment of worker exposure was carried out using the ECETOC Targeted Risk Assessment (TRA) model. The ECETOC TRA was used to predict dermal exposures (expressed as a daily systemic dose in mg/kg bw) and inhalation exposure concentrations (expressed as an airborne concentration in mg/m^3) associated with each process defined by PROC codes.
Exposure to workers was assessed taking into account different operational conditions that may be associated with the professional use of ammonia and the impact of different exposure control measures. Exposures were determined for task durations of 1- 4 hours or >4 hours and assuming that process are carried out either outdoors, indoors without use of local exhaust ventilation (VIV) or indoors with the use of VIV. To reflect the use of personal protective equipment (PPE), dermal exposures were determined assuming either no gloves or gloves affording 90% protection of the hands are worn. To reflect the use of respiratory protective equipment (RPE), inhalation exposures concentrations were determined assuming either no RPE or RPE affording 95% protection is worn.
The ECETOC TRA model uses a simple algorithm to determine dermal exposures that does not take the physical-chemical properties of a substance into account. The same dermal exposures where therefore predicted for anhydrous and aqueous forms of ammonia. Parameters used in the ECETOC TRA model to assess inhalation exposures were: molecular weight (35 $g.mol^{-1}$ and 17 $g.mol^{-1}$ for aqueous and anhydrous forms respectively and vapour pressure (the vapour pressure of anhydrous forms of ammonia is 8.6×10^5 Pa at 20°C, whereas the vapour pressure of aqueous ammonia solution between 5 and 25% w/w ranges from 5×10^3 Pa to 4×10^4 Pa at 20°C. Systemic dermal exposures have been determined for a worker with bodyweight 70 kg.

The following values were obtained using ECETOC TRA for worker exposure

Dermal exposures predicted using the ECETOC TRA model

Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure mg/kg bw/d**	
		Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:					
Use in a closed process, no likelihood of exposure: storage (closed or bulk	PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03

container)					
Information for contributing scenario 3:					
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14
			Indoors with VIV	0.14	0.01
Information for contributing scenario 4:					
Use in closed batch process (synthesis or formulation)	PROC 3	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 5:					
Mixing or blending in batch process	PROC 5	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with VIV	0.07	0.01
Information for contributing scenario 6:					
Transfer into small containers	PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
		1-4 hrs or >4 hrs	Indoors with VIV	0.69	0.07
Information for contributing scenario 7:					
Transfer (charging/discharging) from or to vessels or large containers at non-dedicated facilities	PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
			Indoors with VIV	0.14	0.01
Transfer (charging/discharging) from or to vessels or large containers at dedicated facilities	PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69
			Indoors with VIV	0.69	0.07
Information for contributing scenario 8:					
Roller application or	PROC	1-4 hrs or >4	Outdoors / Indoors without	27.43	0.14

brushing	10	hrs	VIV		
		1-4 hrs or >4 hrs	Indoors with VIV	1.37	10.71
Information for contributing scenario 9:					
Treatment of articles by dipping and pouring	PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37
		1-4 hrs or >4 hrs	Indoors with LEV	0.69	0.07
Information for contributing scenario 10:					
Laboratory use : Quality control in a laboratory	PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03
		1-4 hrs or >4 hrs	Indoors with VIV	0.03	<0.01
Information for contributing scenario 11:					
Hand-mixing with intimate contact and PPE only	PROC 19	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	141.73	14.13
Information for contributing scenario 12:					
Non industrial spraying	PROC 11	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	107	10.71
		1-4 hrs or >4 hrs	Indoors with VIV	2.14	0.21
Information for contributing scenario 13:					
Heat and pressure transfer fluids in dispersive use but closed systems	PROC 20	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	1.71	0.17
		1-4 hrs or >4 hrs	Indoors with VIV	0.14	0.01

Inhalation exposure concentrations predicted using the ECETOC TRA model

				Anhydrous ammonia		**Aqueous ammonia (5-25% w/w)**	
Description of activity	**PROC**	**Exposure assumptions**		**Estimated Exposure Concentration mg/m3**			
		Duration	**Use of ventilation**	**No RPE**	**RPE (95% reduction)**	**No RPE**	**RPE (95% reduction)**
Information for contributing scenario 2:							

Used in a closed process, no likelihood of exposure: Storage (closed bulk or container)	PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	0.01	NA
		1-4 hrs or >4 hrs	Indoors without VIV	0.01	NA	0.01	NA
Information for contributing scenario 3:							
Use in a closed, continuous process with occasional controlled exposure (e.g. sampling)	PROC 2	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.53	0.18	4.38	0.22
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without VIV	22.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 4:							
Use in closed batch process (synthesis or formulation)	PROC 3	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.50	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Use in batch process (synthesis) where opportunity for exposure arises	PROC 4	>4hrs	Outdoors	49.58	2.48	61.25	3.06
		>4hrs	Indoors without VIV	70.83	3.54	87.5	4.38
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	29.75	1.49	36.75	1.84
		1-4 hrs	Indoors without VIV	42.5	2.13	52.5	2.63
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26
Information for contributing scenario 5:							
Mixing or blending in batch process	PROC 5	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94

		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 6:							
Maintenance, clean down	PROC 8a	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Transfer of ammonia (charging/discharging) from/to vessels or large containers at dedicated facilities	PROC 8b	>4hrs	Outdoors	74.38	3.72	91.88	4.59
		>4hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		>4hrs	Indoors with VIV	3.19	0.16	3.94	0.20
		1-4 hrs	Outdoors	44.63	2.23	55.13	2.76
		1-4 hrs	Indoors without VIV	63.75	3.19	78.75	3.94
		1-4 hrs	Indoors with VIV	1.91	0.1	2.36	0.12
Information for contributing scenario 7:							
Transfer into small containers	PROC 9	>4hrs	Outdoors	99.17	4.96	122.50	6.13
		>4hrs	Indoors without VIV	141.67	7.08	175.00	8.75
		>4hrs	Indoors with VIV	14.17	0.71	17.50	0.88
		1-4 hrs	Outdoors	59.50	2.98	73.50	3.68
		1-4 hrs	Indoors without VIV	85.00	4.25	105.00	5.25
		1-4 hrs	Indoors with VIV	8.5	0.43	10.50	0.53
Information for contributing scenario 8:							
Roller application or brushing	PROC 10	>4hrs	Outdoors	NA	NA	153.13	7.66
		>4hrs	Indoors without VIV	NA	NA	218.75	10.94

		>4hrs	Indoors with VIV	NA	NA	21.88	1.09
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without VIV	NA	NA	131.25	6.56
		>4hrs	Outdoors	NA	NA	13.13	0.66
Information for contributing scenario 9:							
Treatment of articles by dipping and pouring	PROC 13	>4hrs	Outdoors	123.96	6.20	153.13	7.66
		>4hrs	Indoors without VIV	177.08	8.85	218.75	10.94
		>4hrs	Indoors with VIV	17.71	0.89	21.88	1.09
		1-4 hrs	Outdoors	74.38	3.72	91.88	4.59
		1-4 hrs	Indoors without VIV	106.25	5.31	131.25	6.56
		1-4 hrs	Indoors with VIV	10.63	0.53	13.13	0.66
Information for contributing scenario 10:							
Quality control in a laboratory	PROC 15	>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	3.54	0.18	4.38	0.22
		1-4 hrs	Indoors without VIV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	2.13	0.11	2.63	0.13
Information for contributing scenario 11:							
Hand-mixing with intimate contact and PPE only	PROC 19	<4 hrs	Outdoors	NA	NA	153.13	7.66
		<4 hrs	Indoors without VIV	NA	NA	218.75	10.94
		1-4 hrs	Outdoors	NA	NA	91.88	4.59
		1-4 hrs	Indoors without VIV	NA	NA	131.25	6.56
Information for contributing scenario 12:							
Non-industrial (professional) spraying	PROC 11	>4hrs	Outdoors	NA	NA	613.20	30.66
		>4hrs	Indoors without VIV	NA	NA	876.00	43.80
		>4hrs	Indoors with VIV	NA	NA	175.20	8.76
		1-4 hrs	Outdoors	NA	NA	367.92	18.40
		1-4 hrs	Indoors without VIV	NA	NA	525.60	26.28
		>4hrs	Outdoors	NA	NA	105.12	5.26

Information for contributing scenario 13:							
Heat and pressure transfer fluids in dispersive use but closed systems	PROC 20	>4hrs	Outdoors	24.79	1.24	30.63	1.53
		>4hrs	Indoors without VIV	35.42	1.77	43.75	2.19
		>4hrs	Indoors with VIV	7.08	0.35	8.75	0.44
		1-4 hrs	Outdoors	14.88	0.74	18.38	0.92
		1-4 hrs	Indoors without VIV	21.25	1.06	26.25	1.31
		1-4 hrs	Indoors with VIV	4.25	0.21	5.25	0.26

The following RCR values were obtained using ECETOC TRA and the reVIVant DNELs
Quantitative risk characterisation of dermal exposures to anhydrous or aqueous (in preparations of 5- 25 % w/w) ammonia for professional workers (ES 5 – Professional 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**	
					Risk characterisation ratio	
	Duration	**Use of ventilation**	**No gloves worn**	**Gloves worn (90% reduction)**	**No gloves worn**	**Gloves worn (90% reduction)**
Information for contributing scenario 2:						
PROC 1	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
Information for contributing scenario 3:						
PROC 2	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	1.37	0.14	0.20	0.02
		Indoors with VIV	0.14	0.01	0.02	<0.01
Information for contributing scenario 4:						
PROC 3	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
PROC 4	1-4 hrs	Outdoors /Indoors without VIV	6.86	0.69	1.01	0.10

	or >4 hrs	Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 5:						
PROC 5	1-4 hrs or >4 hrs	Outdoors /Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.07	0.01	0.01	<0.01
Information for contributing scenario 6:						
PROC 8a	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.14	0.01	0.02	<0.01
PROC 8b	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 7:						
PROC 9	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	6.86	0.69	1.01	0.10
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 9:						
PROC 13	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	13.71	1.37	2.02	0.20
		Indoors with VIV	0.69	0.07	0.10	0.01
Information for contributing scenario 10:						
PROC 15	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	0.34	0.03	0.05	0.01
		Indoors with VIV	0.03	<0.01	0.01	<0.01
Information for contributing scenario 13:						
PROC 20	1-4 hrs or >4 hrs	Outdoors / Indoors without VIV	1.71	0.17	0.25	0.03
		Indoors with VIV	0.14	0.01	0.02	<0.01

Quantitative risk characterisation of inhalation exposure concentrations of anhydrous ammonia for professional workers (ES 5 – Professional end-use)

PROC code	Exposure assumptions	ES 4-exposure concentrations (EC) mg/m³	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**
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	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 VIV	22.25	1.06	0.47	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	49.58	2.48	1.04	0.05	1.38	0.07	3.54	0.18
		Indoors without VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	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 VIV	70.83	3.54	1.49	0.07	1.97	0.10	5.06	0.25
		Indoors with VIV	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 VIV	42.5	2.13	0.89	0.04	1.18	0.06	3.04	0.15
		Indoors with VIV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02
Information for contributing scenario 5:										

PROC 5	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	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 VIV	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
Information for contributing scenario 7:										
PROC 9	>4 hrs	Outdoors	99.17	4.96	2.08	0.10	2.75	0.14	7.08	0.35
		Indoors without VIV	141.67	7.08	2.98	0.15	3.94	0.20	10.12	0.51
		Indoors with VIV	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 VIV	85.00	4.25	1.79	0.09	2.36	0.12	6.07	0.30
		Indoors with VIV	8.5	0.43	0.18	0.01	0.24	0.01	0.61	0.03
Information for contributing scenario 9:										

PROC 13	>4 hrs	Outdoors	123.96	6.20	2.60	0.13	3.44	0.17	8.85	0.44
		Indoors without VIV	177.08	8.85	3.72	0.19	4.92	0.25	12.65	0.63
		Indoors with VIV	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 VIV	106.25	5.31	2.23	0.11	2.95	0.15	7.59	0.38
		Indoors with VIV	10.63	0.53	0.22	0.01	0.30	0.01	0.76	0.04
Information for contributing scenario 10:										
PROC 15	>4 hrs	Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	3.54	0.18	0.07	0.00	0.10	<0.01	0.25	0.01
	1-4 hrs	Indoors without VIV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	2.13	0.11	0.04	0.00	0.06	<0.01	0.15	0.01
Information for contributing scenario 13:										
PROC 20	>4 hrs	Outdoors	24.79	1.24	0.52	0.03	0.69	0.03	1.77	0.09
		Indoors without VIV	35.42	1.77	0.74	0.04	0.98	0.05	2.53	0.13
		Indoors with VIV	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 VIV	21.25	1.06	0.45	0.02	0.59	0.03	1.52	0.08
		Indoors with VIV	4.25	0.21	0.09	0.00	0.12	0.01	0.30	0.02

Quantitative risk characterisation of inhalation exposure concentrations of aqueous ammonia (in preparations of 5-25% w/w) in professional workers (ES 4 – Professional end-use)

PROC code	**Exposure assumptions**	**ES 4- 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
Information for contributing scenario 2:										
PROC 1	1-4 hrs or >4 hrs	Outdoors	0.00	NA	<0.01	NA	<0.01	NA	<0.01	NA
		Indoors without VIV	0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
Information for contributing scenario 3:										
PROC 2	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	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 VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 4:										
PROC 3	>4hrs	Outdoors	61.25	3.06	1.29	0.06	1.70	0.09	4.38	0.22
		Indoors without VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.50	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	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 VIV	87.5	4.38	1.84	0.09	2.43	0.12	6.25	0.31
		Indoors with VIV	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 VIV	52.5	2.63	1.10	0.06	1.46	0.07	3.75	0.19
		Indoors with VIV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02

Information for contributing scenario 5:										
PROC 5	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 6:										
PROC 8a	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	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 VIV	78.75	3.94	1.65	0.08	2.19	0.11	5.63	0.28
		Indoors with VIV	2.36	0.12	0.05	0.00	0.07	<0.01	0.17	0.01
Information for contributing scenario 7:										
PROC 9	>4hrs	Outdoors	122.50	6.13	2.57	0.13	3.40	0.17	8.75	0.44
		Indoors without VIV	175.00	8.75	3.68	0.18	4.86	0.24	12.50	0.63
		Indoors with VIV	17.50	0.88	0.37	0.02	0.49	0.02	1.25	0.06
	1-4	Outdoors	73.50	3.68	1.54	0.08	2.04	0.10	5.25	0.26

	hrs	Indoors without VIV	105.00	5.25	2.21	0.11	2.92	0.15	7.50	0.38
		Indoors with VIV	10.50	0.53	0.22	0.01	0.29	0.01	0.75	0.04
Information for contributing scenario 8:										
PROC 10	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 9:										
PROC 13	>4hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	218.75	10.94	4.60	0.23	6.08	0.30	15.63	0.78
		Indoors with VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
		Indoors with VIV	13.13	0.66	0.28	0.01	0.36	0.02	0.94	0.05
Information for contributing scenario 10:										
PROC 15	>4 hrs	Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	4.38	0.22	0.09	0.00	0.12	0.01	0.31	0.02
	1-4 hrs	Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	2.63	0.13	0.06	0.00	0.07	<0.01	0.19	0.01
Information for contributing scenario 11:										
PROC 19	>4 hrs	Outdoors	153.13	7.66	3.22	0.16	4.25	0.21	10.94	0.55
		Indoors without VIV	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 VIV	131.25	6.56	2.76	0.14	3.65	0.18	9.38	0.47
Information for contributing scenario 12:										
PROC 11	>4hrs	Outdoors	613.20	30.66	12.88	0.64	17.03	0.85	43.80	2.19
		Indoors without VIV	876.00	43.80	18.40	0.92	24.33	1.22	62.57	3.13
		Indoors with VIV	175.20	8.76	3.68	0.18	4.87	0.24	12.51	0.63
	1-4 hrs	Outdoors	367.92	18.40	7.73	0.39	10.22	0.51	26.28	1.31
		Indoors without VIV	525.60	26.28	11.04	0.55	14.60	0.73	37.54	1.88
		Indoors with VIV	105.12	5.26	2.21	0.11	2.92	0.15	7.51	0.38
Information for contributing scenario 13:										
PROC 20	>4hrs	Outdoors	30.63	1.53	0.64	0.03	0.85	0.04	2.19	0.11
		Indoors without VIV	43.75	2.19	0.92	0.05	1.22	0.06	3.13	0.16
		Indoors with VIV	8.75	0.44	0.18	0.01	0.24	0.01	0.63	0.03
	1-4 hrs	Outdoors	18.38	0.92	0.39	0.02	0.51	0.03	1.31	0.07
		Indoors without VIV	26.25	1.31	0.55	0.03	0.73	0.04	1.88	0.09
		Indoors with VIV	5.25	0.26	0.11	0.01	0.15	0.01	0.38	0.02

4	**Guidance to DU to evaluate whether he works inside the boundaries set by the ES**

Environmental releases:

- As no environmental exposure is presented no specific requirements aside from standard good professional practices are needed

Worker exposure:

In order to work within the boundaries of the ES the following conditions should be met:

- VIV should be in place in indoor facilities at times when natural ventilation is not sufficient.
- Where the potential for dermal exposure exists, gloves with a minimum efficiency of 90% and RPE with 95% efficiency should be worn.
- Health monitoring should be conducted regularly to ascertain the potential VIVels of exposure.
- Personal protective clothing (e.g. face/eye protection, helmet, gloves, boots and protective overalls) should be worn when any potential contact may arise.
- All technological devices should have a proper quality certification, and are regularly controlled and maintained to avoid the uncontrolled discharge of ammonia.
- Workers should be fully trained.

Any measured worker exposure VIVels should be confirmed to be below the reVIVant DNEL as presented in section 3 above.

The End of Safety Data Sheet.