Land and Water Science
61 Leet Street
Invercargill, 9810

Stephen Parry
Chief Executive
Gore District Council
PO Box 8
Gore, 9740

2nd December 2019

Dear Stephen

RE: NH_3 Monitoring Report 01 – 30 November 2019

Background

Gore District Council (GDC) engaged Land and Water Science to conduct continuous monitoring of ammonia (NH_3) gas emissions from the Mataura Mill dross storage site (121 Kana Street, Mataura) from April 2018. GDC requires emission values to comply with consent conditions that specify a limit of 5 ppm NH_3 discharged to air. In March 2017, Photonic Innovations (PI) installed two NH_3 sensors for comparison of the indoor and outdoor ammonia levels. Measurements are recorded continuously and reported as a 5-minute average for both the outdoor and indoor sensors. Weekly summaries of the indoor and outdoor emission results from monitoring between 01 November and 30 November are presented in this report.

November Summary

During November the maximum NH_3 concentration detected by the indoor sensor was 34.3 ppm (Figure 1 and Table 1) and 5.9 ppm for the outdoor sensor (Figure 2 and Table 2). **The maximum concentration breaches the threshold limit value (25 ppm) and nears the short term exposure level (35ppm) for occupational exposure to ammonia** (see Appendix for Material Data Sheet section 8). **Although a one-off event, it is recommended that any person needing to enter the building should first check the monitoring sensor prior to ensure concentrations are <25 ppm**. Mechanical venting via manually opening of doors, or other, to allow ventilation prior to scheduled access should result in the rapid dilution of ammonia. Rare spikes in ammonia concentration greater than the threshold occupational exposure limit for ammonia toxicity to humans is not unsurprising given the strong relationship between air temperature and ammonia concentration evident in the data.

Despite one large spike in ammonia, mean and median NH_3 concentrations during November were 4.8 and 4.6 ppm for the indoor sensor and were 0.8 and 0.6 ppm for the outdoor sensor. Both of these values fall below the 5 ppm threshold specified by the consent. However, the maximum ammonia concentration for both sensors exceeded the consented amount of 5.0 ppm on multiple occasions (Figure 1).

Daily (diurnal) variation in NH_3 concentration shows a consistent pattern in the data. Specifically, NH_3 concentration is strongly correlated with air temperature, reaching maximum values as air temperatures peak during the day and minimum values at night when air temperatures are at their lowest. Although diurnal variation is evident in the data, average daily air temperature is the greater control over the absolute concentration with maximum ammonia values recorded during the warmest months of the year and minimum concentrations recorded during the coolest months of

the year. The relationship between air temperature and NH_3 concentration for this reporting period is displayed in Figure 1 and Figure 2.

Table 1. Summary statistics for the indoor NH_3 sensor, 01 November – 30 November 2019. NH_3 measured in parts per million (ppm).

Date	01 - 02 Nov	03 - 09 Nov	10 - 16 Nov	17 - 23 Nov	24 - 30 Nov
Mean	2.3	4.8	3.5	2.9	4.5
Standard deviation	0.3	2.0	0.9	0.9	1.5
Median	2.3	4.6	3.3	2.7	4.2
Minimum	1.5	2.1	1.1	1.3	1.1
Maximum	3.4	34.3	7.1	6.0	9.0

Table 2. Summary statistics for the outdoor NH_3 sensor, 01 November – 30 November 2019. NH_3 measured in parts per million (ppm).

Date	01 - 02 Nov	03 - 09 Nov	10 - 16 Nov	17 - 23 Nov	24 - 30 Nov
Mean	0.8	0.8	0.8	0.7	0.8
Standard deviation	0.4	0.4	0.6	0.5	0.5
Median	0.6	0.7	0.6	0.6	0.7
Minimum	0.4	0.4	0.3	0.3	0.3
Maximum	2.7	4.9	5.9	5.8	4.5

01 - 02 Nov 2019

During this week, the indoor NH_3 concentration showed consistent diurnal variation for most of the week. Maximum indoor concentration was 3.4 ppm for this period. Mean and median values were both 2.3 ppm. The outdoor NH_3 concentration levels showed consistent variation for most of the week with higher concentrations consistent with warmer temperatures. Maximum outdoor concentration was 2.7 ppm for this period. Mean and median values were 0.8 and 0.6 ppm.

03 – 09 Nov 2019

During this week, indoor NH_3 concentration showed consistent diurnal variation for most of the week. Maximum indoor concentration was 34.3 ppm for this period. Mean and median values were 4.8 and 4.6 ppm. The outdoor NH_3 concentration levels showed consistent variation for most of the week with higher concentrations consistent with warmer temperatures. Maximum outdoor concentration was 4.9 ppm for this period. Mean and median values were 0.8 and 0.7 ppm.

10 – 16 Nov 2019

During this week, indoor NH_3 concentration showed consistent diurnal variation for most of the week. Maximum indoor concentration was 7.1 ppm for this period. Mean and median values were 3.5 and 3.3 ppm. The outdoor NH_3 concentration levels showed consistent variation for most of the week with higher concentrations consistent with warmer temperatures. Maximum outdoor concentration was 5.9 ppm for this period. Mean and median values were 0.8 and 0.6 ppm.

17 – 23 Nov 2019

During this week, indoor NH_3 concentration showed consistent diurnal variation for most of the week. Maximum indoor concentration was 6.0 ppm for this period. Mean and median values were 2.9 and 2.7 ppm. The outdoor NH_3 concentration levels showed consistent variation for most of the

week with higher concentrations consistent with warmer temperatures. Maximum outdoor concentration was 5.8 ppm for this period. Mean and median values were 2.9 and 2.7 ppm.

24 – 30 Nov 2019

During this week, indoor NH_3 concentration showed consistent diurnal variation for most of the week. Maximum indoor concentration was 9.0 ppm for this period. Mean and median values were 4.5 and 4.2 ppm. The outdoor NH_3 concentration levels showed consistent variation for most of the week with higher concentrations consistent with warmer temperatures. Maximum outdoor concentration was 4.5 ppm for this period. Mean and median values were 0.8 and 0.7 ppm.

Summary

During the monitoring period (01 – 30 November) indoor NH_3 concentrations reached a maximum of **34.3 ppm**, while mean and median concentrations were 4.8 and 4.6 ppm. **The maximum concentration breaches the threshold limit value (25ppm) and nears the short-term exposure level (35ppm) for occupational exposure. Any personnel needing to enter the building should check the monitoring sensor prior to entering and open doors to vent building before working.** Elevated NH_3 concentrations were detected by the indoor sensor when maximum temperatures reached 28.4°. The strong correlation between air temperature and ammonia concentration continues to be important.

Outdoor concentrations reached a maximum of 5.9 ppm, while mean and median concentrations were both 0.8 and 0.6 ppm. The indoor and outdoor sensor exceeded the consent conditions of 5.0 ppm on multiple occasions during the month of November. These values are consistent with warmer springtime temperatures. Overall, the temperature continues to be the most dominant control over NH_3 concentration.

Kind regards

Jessie Lindsay
Environmental and GIS Scientist
Land and Water Science Ltd

Dr Clint Rissmann
Director
Land and Water Science Ltd

For public access to the real-time data go to: ***http://35.189.3.224:3000/login***
Log in email: gcc@photonicinnovations.com and use the **password:** Pa5%w0rd

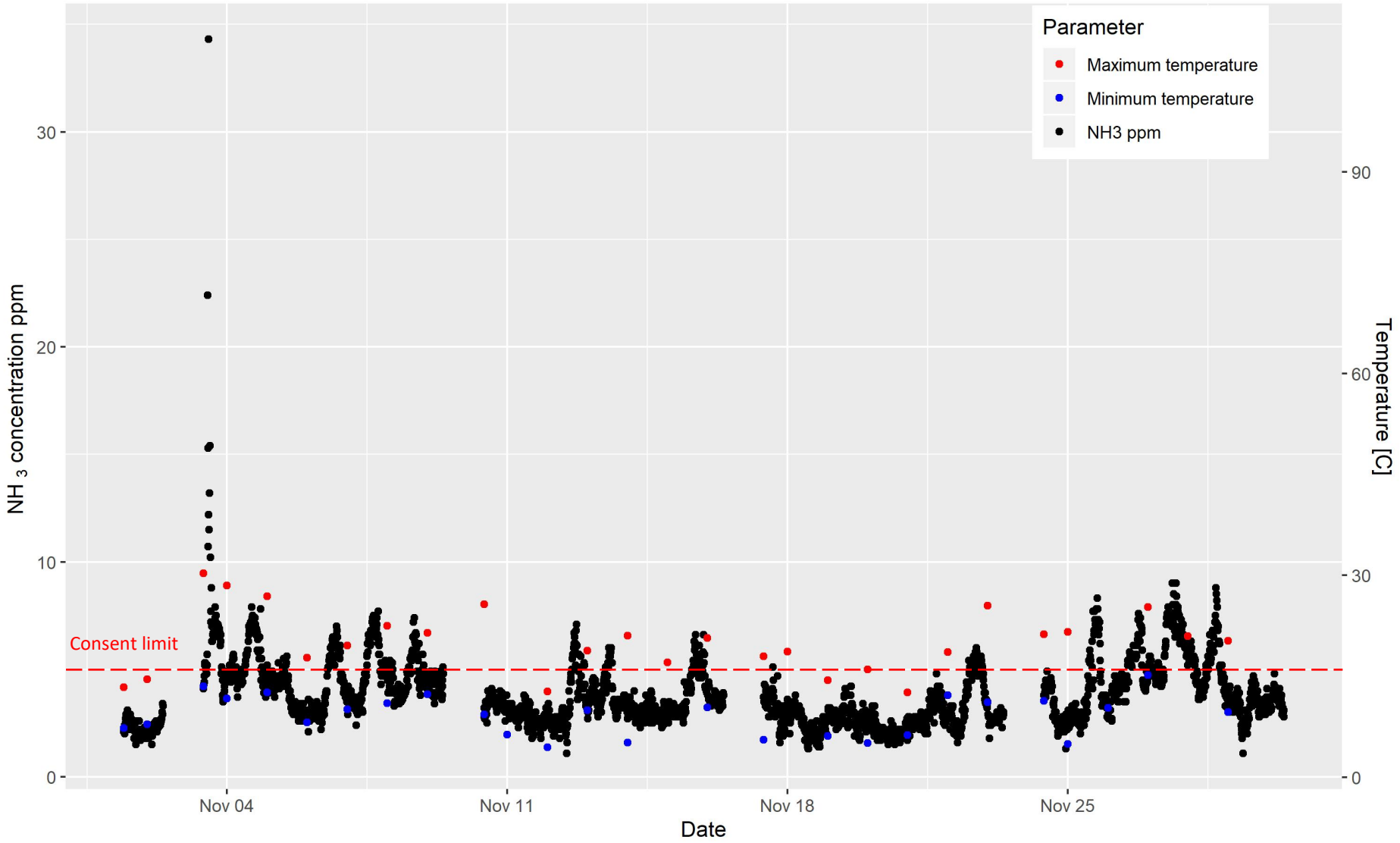

Figure 1: Continuous indoor NH_3 concentration and maximum daily temperature.

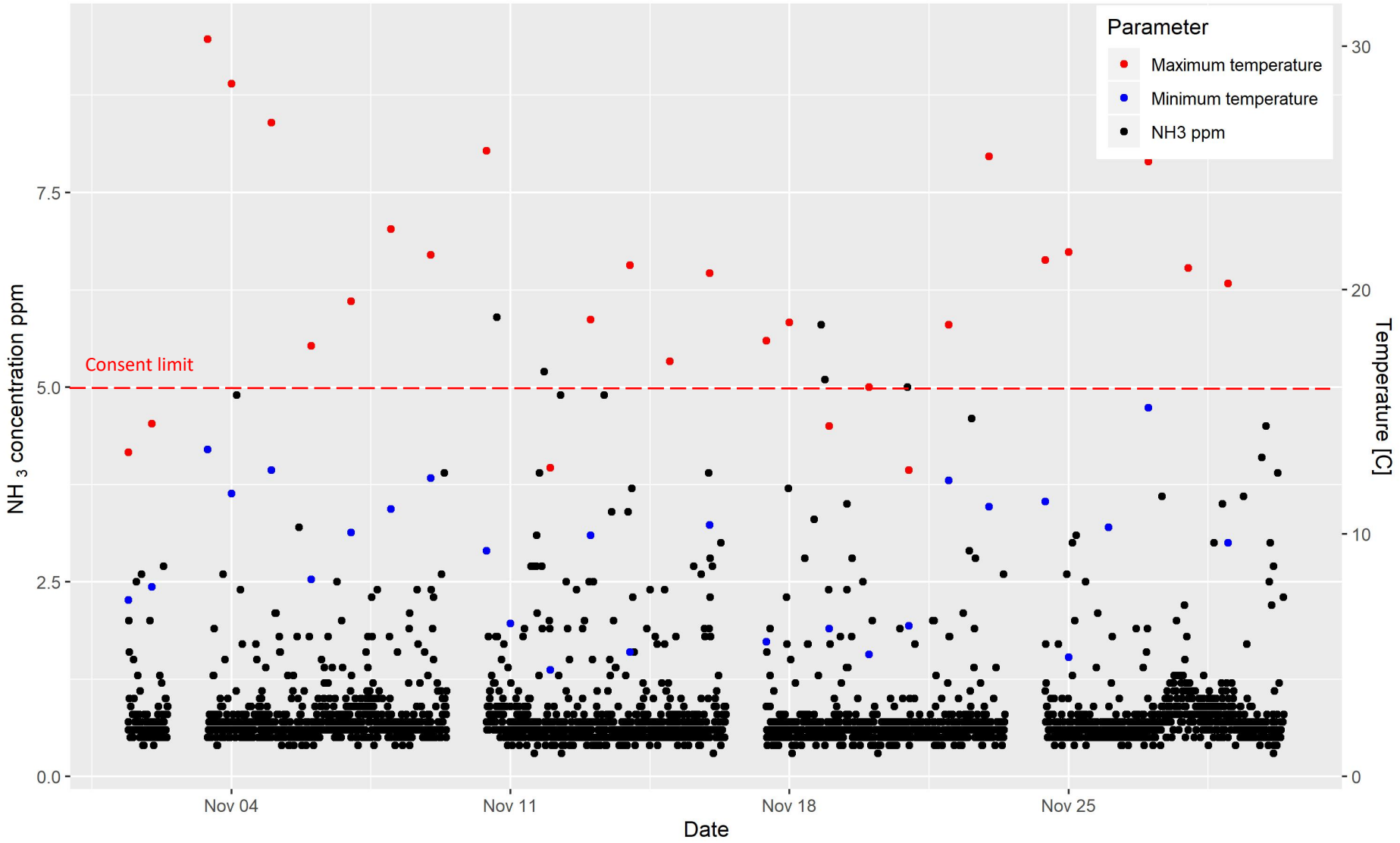

Figure 2: Continuous outdoor NH_3 concentration and maximum daily temperature.

MATERIAL SAFETY DATA SHEET (MSDS)

AMMONIA

(Please ensure that this MSDS is received by the appropriate person)

DATE: September 2015 Version 3

Ref. No.: MS025

1 PRODUCT AND COMPANY IDENTIFICATION

Product Name Ammonia

Chemical Formula NH_3
Trade name Ammonia
Colour coding Silver body with a Red(A.11) circle below the valve, and a yellow band immediately below the red circle
Valve CGA240-3/8 inch – 18 NGT right hand female

Company Identification African Oxygen Limited
23 Webber Street
Johannesburg, 2001
Tel. No: (011) 490-0400
Fax No: (011) 490-0506

EMERGENCY NUMBER **0860111185 or (011) 873 4382**
(24 hours)

2 COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	Ammonia
Chemical family	Corrosive, caustic, reactive gas
Synonyms	Anhydrous ammonia, R717
CAS No.	7664-41-7
UN No.	1005
ERG No.	125
Hazchem	Warning Corrosive toxic gas

3 HAZARDS IDENTIFICATION

Main Hazards Irritating or corrosive to exposed tissues. Inhalation of vapours may result in pulmonary oedema and chemical pneumonitis. Contact with liquid product may cause frostbite or freeze burns, in exposed tissues. All cylinders are portable gas containers and must be regarded as pressure vessels at all times.

Adverse Health Effects. Inhalation of high concentrations produces violent coughing due to the local action on the respiratory tract. If rapid escape is not possible, severe lung irritation, pulmonary oedema and death can result. Lower concentrations cause eye irritation, laryngitis and bronchitis.

Biological Hazards. Because of its alkaline properties, long-term exposure to flora can cause damage. Aquatic fauna can also be affected should the pH of their environment change due to long-term exposure to high concentrations of ammonia.

Vapour Inhalation. Ammonia acts principally on the upper respiratory tract, where it exerts an alkaline, caustic action. It produces respiratory reflexes such as coughing and arrest of respiration. It affects the conjunctiva and cornea immediately. Inhalation causes acute inflammation of the respiratory organs, coughing, oedema of the lungs, chronic bronchial catarrh, secretion of saliva and retention of urine.

Eye Contact Exposure to high gas concentrations may cause temporary blindness and severe eye damage. Direct contact of the eyes with liquid anhydrous ammonia will produce serious eye burns.

Skin Contact Liquid anhydrous ammonia produces skin burns on contact.

Ingestion Swallowing of the liquid results in severe corrosive action of the mouth, throat, and stomach.

Labelling Elements:
Hazard Pictograms

Signal Word: Danger
Hazard Statements:
H221: Flammable gas
H331: Toxic if inhaled
H314: Causes severe skin burns and eye damage
H400: Very toxic to aquatic life

Precautionary Statements:
(SEE FIRST AID MEASURES SECTION FOR TREATMENTS)
P260: Do not breathe gas/vapours
P262: Do not get in eyes, on skin, or on clothing
P264: Wash hands thoroughly after handling
P271: Use only outdoors or in a well ventilates area
P273: Avoid release to the environment
P391: Collect spillage
P284: Wear respiratory protection
P304+P340: IF INHALED: remove to fresh air and keep at rest in a position comfortable for breathing
P310: Immediately call a POISON CENTRE or doctor/physician
P320: Specific treatment is urgent (see first aid measures section)
P301+P330+P331: IF SWALLOWED: Rinse mouth. Do not induce vomiting
P303+P361+P353: IF ON SKIN (or hair): Immediately remove or take off all contaminated clothing. Immediately rinse skin with water/shower
P363: Wash contaminated clothing before re-use.
P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do so. Continue rinsing.
P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P401: Store in accordance with national regulations
P403+233: Store in a well ventilated place and keep container tightly closed
P405: Store locked up
P501: Do not dispose contents/container to storm water drains, treat as hazardous waste.

4 FIRST AID MEASURES

Prompt medical attention is mandatory in all cases of overexposure. Rescue personnel should be equipped with self-contained breathing apparatus. Any conscious person who has inhaled ammonia causing irritation should be assisted to an uncontaminated area and inhale fresh air. A person overcome by ammonia should immediately be carried to an uncontaminated area. If breathing has ceased, artificial respiration must be started immediately, preferably by trained personnel. If breathing is weak or has been restored by artificial respiration, oxygen may be administered. Summon a physician immediately for anyone who has been burned or overcome by ammonia. Until a physician arrives, and after having accomplished a thorough removal of ammonia as possible, keep the patient warm and quiet, and take such specific action as may be indicated.

Eye Contact Persons with potential exposure to ammonia should not wear contact lenses. Call a physician at once. Immediately begin irrigation of the eyes with copious amounts of clean water while holding the eyelids apart. Continue irrigation for 15 minutes. Repeat this procedure every 10 minutes for an hour, each time irrigating for a period of 5 minutes. If readily available, a 5% boric acid solution may be used instead of water, but irrigation must not be delayed while such a solution is sought or prepared. Prompt and thorough irrigation is of primary importance. Any standard anaesthetic solution for ophthalmic use ordered by the physician may be instilled for control of severe pain, but only after the 15 minute period of irrigation has been completed. Continuous cold boric acid compresses should be used for cases of severe injury, in addition to irrigation. No oils or ointments should be instilled until after the eye has been examined by a qualified physician, and then only as prescribed by him. Ulcers of the cornea should be treated by an ophthalmologist.

Skin Contact If skin contact is extensive and emergency showers available, the victim should get under the emergency shower immediately. Contaminated clothing and shoes should be removed under the shower. In other cases, the affected areas should be washed thoroughly with large amounts of running water for at least 15 minutes. Do not apply salves or ointments or cover burns with dressing; however, protect the injured area with a clean cloth prior to medical care. Do not attempt to neutralise the ammonia. Subsequent medical treatment is otherwise the same as for thermal burns

Inhalation The conscious person who has inhaled a concentration of ammonia which causes irritation effects should go to an uncontaminated area and inhale fresh air or oxygen. Eye, nose and throat irritation should be treated as described below for more serious exposures. However, if the exposure has been to minor concentrations for a limited time, usually no treatment will be required. A worker overcome by ammonia must be carried to an uncontaminated atmosphere and, if breathing is laboured or has ceased, given artificial respiration (back-pressure, arm lift, or mouth-to-mouth resuscitation) immediately, preferably by trained personnel. When breathing has been restored, 100% oxygen is administered, but not for more than 1 hour of continuous treatment at one time. Oxygen therapy may be interrupted after 1 hour, and reinstituted as the clinical condition indicates. Observe for laryngeal spasm and perform tracheotomy if indicated. In case of severe exposure, the patient should breathe 100% oxygen under positive exhalation pressure (4cm) for one-half hour periods every hour. Treatment may be continued in this way until symptoms subside or other clinical indications for interruption appear.

Contact with nose & throat. Irrigate the nose and mouth continuously for 15 minutes. If the patient can swallow, encourage him to drink large quantities of 0,5% citric acid solution or lemonade. Never give anything by mouth to an unconscious person.

Ingestion If liquid anhydrous ammonia has been swallowed, call a physician immediately. If the patient is conscious and able, he should drink large amounts of water to dilute the chemical. Do not induce vomiting if the patient is in shock, extreme pain or is unconscious. If vomiting begins, place the patient face down with head lower than hips; this prevents vomit from entering the lungs and causing further injury

5 FIRE FIGHTING MEASURES

Extinguishing media. Fog-water spray. (In the absence of fog equipment, a fine spray of water may be used.) Use media suitable for surrounding fire. Although ammonia does not represent a serious flammability hazard, mixtures of air and ammonia containing from 15% to 28% ammonia vapour by volume will ignite when sparked, or exposed to temperatures exceeding 651°C.

Specific Hazards High levels of ammonia can produce corrosive effects on tissues and can cause laryngeal and bronchial spasm and oedema so as to obstruct breathing.

Emergency Actions. Rescue personnel should be equipped with self-contained breathing apparatus. If possible, stop the flow of gas. Since ammonia is soluble in water, it is the best extinguishing media - not only in extinguishing the fire, but also absorbing the escaped ammonia gas. Evacuate the area. All cylinders should be removed from the vicinity of the fire. Cylinders that cannot be removed should be cooled with water from a safe distance. Cylinders which have been exposed to excessive heat should be clearly identified and returned to the supplier. CONTACT THE NEAREST AFROX BRANCH.

Protective Clothing. Self-contained breathing apparatus. Safety gloves, Goggles and shoes, or boots, should be worn when handling cylinders.

Environmental precautions. As the gas is lighter than air, ensure that it is not trapped in confined spaces. Knock down pockets of gas with fog-water spray, and ventilate the area using forced-draft if necessary. Prevent from entering sewers and drains.

6 ACCIDENTAL RELEASE MEASURES

Personal Precautions. Personnel working with anhydrous ammonia should be thoroughly familiar with safety precautions for handling a gas corrosive to human tissue as well as measures

for handling emergencies. A gas mask must be worn when breaking and making connections, or pressuring a system. Self-contained breathing apparatus should be available both up and down wind.

Environmental Precautions. Because of its high alkalinity and solubility in water, ammonia can alter the pH balances of surface water, soil and plants. Should they be exposed to high concentrations for any length of time, these changes in pH could be detrimental to both flora and fauna.

Small spills. Only personnel trained for, and designated to handle emergencies, should attempt to stop a leak. Respiratory equipment of a type suitable for ammonia must be worn. All persons not so equipped must leave the affected area until the leak has been stopped. If ammonia vapour is released, the irritating effect of the vapour will typically force personnel to leave the area before they have been exposed to dangerous concentrations. Knock down small amounts of ammonia using a fog-water spray.Prevent from entering sewers or drains. Ventilate the area using forced-draught ventilation if necessary.

Large spills Evacuate all unprotected personnel to upwind areas. Disperse leaks with water spray or fog to lower concentration of ammonia gas. Neutralise contaminated area with a dilute acid, and deluge with plenty of water. Rotate a leaking cylinder to allow gas instead of liquid to escape. Keep area isolated until all gas has been dispersed. Evaporation is very rapid causing ice to form on leaking cylinders

7 HANDLING AND STORAGE

Always store full cylinders in upright position. Avoid dragging, rolling or sliding cylinders. Use trolleys for handling. Cylinders should be stored in a well ventilated area on a hard dry surface. Ventilation inlets should be at ceiling and floor level. Cylinders must be used on a "first in - first out" basis. Keep cylinders away from sources of heat. Keep away from children.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Hazards. Inhalation of high concentrations produces violent coughing due to local action on the respiratory tract. If rapid escape is not possible, severe lung irritation, pulmonary oedema and death can result. Lower concentrations cause eye irritation, laryngitis and bronchitis. Exposure to high gas concentrations may cause temporary blindness and severe eye damage. Direct contact of the eyes with liquid anhydrous ammonia will produce serious eye burns. Liquid anhydrous ammonia produces skin burns on contact.

TLV	25ppm
STEL	35ppm

Engineering control measures. Engineering control measures are preferred to reduce exposures. General methods include mechanical ventilation, process or personal enclosure, and control of process conditions. Administrative controls and personal protective equipment may also be required. Use a suitable flameproof ventilation system separate from other exhaust ventilation systems. Exhaust direct to outside and supply sufficient replacement air to make up for air removed by exhaust system.

Personal protection	Eyes - Chemical goggles Hands - Rubber gloves Skin - rubber or plastic apron

9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DATA

Chemical Symbol	NH3
Molecular Weight	17,031
Specific Volume @ 20°C & 101,325 kPa	1405,6 ml/g
Boiling point @ 101,325 kPa	-33,4°C
Relative density (Air = 1) @ 101,325 kPa	0,599
Flammability levels in air	16 - 25% (by vol.)
Autoignition temperature	651°C
Colour	None
Taste	Alkaline
Odour	Pungent

10 STABILITY AND REACTIVITY

Conditions to avoid. Heating of cylinders, as the increase in pressure bears a direct relationship to increase in temperature. When the gas is exposed to temperatures in the range 449°C at 101,325kPa, dissociation will occur, with the release of nitrogen and hydrogen. The hydrogen could then form explosive gas/air mixtures. Never use cylinders as rollers or supports, or for any other purpose than the storage of ammonia.

Incompatible Materials. Most common metals are not affected by dry ammonia. However, when combined with water vapour, ammonia will attack copper, zinc, or alloys containing copper as a major alloying element. Therefore, these materials should not be used in contact with ammonia.

Hazardous Decomposition Products See above, Conditions to Avoid

11 TOXICOLOGICAL INFORMATION

Acute Toxicity	Ammonia is not a systemic poison
Skin & eye contact	Severe irritant
Chronic Toxicity	Chronic irritation to the eyes, nose, and upper respiratory tract may result from repeated exposure to the vapours.
Carcinogenicity:	No known effect.
Mutagenicity:	Genetic mutations observed in bacterial and mammalian test systems.

Reproductive Hazards: No known effect

National Legislation: None
(For further information see Section 3. Adverse Health Effects).

12 ECOLOGICAL INFORMATION

Ammonia gas can cause damage to the ecology due to its high alkalinity and affinity for water. pH changes can occur in the immediate environs of a spill which could affect both flora and fauna

13 DISPOSAL CONSIDERATIONS

Disposal Methods. Ammonia may be disposed of by discharge into water of sufficient volume to absorb it. Disposal of the resultant ammonium hydroxide, including and subsequent neutralisation products, must be done in an environmentally safe manner that, for example, will not be harmful to aquatic life. Large amounts should only be handled by the gas supplier.

14 TRANSPORT INFORMATION

ROAD TRANSPORTATION

UN No.	1005
Class	2.3 Toxic gas
Subsidiary risk	Corrosive, inhalation hazard
ERG No	125
Hazchem warning	Toxic gas

SEA TRANSPORTATION

IMDG	1005
class	2.3
Label	Toxic gas

AIR TRANSPORTATION

ICAO/IATA Code	1005
Class	2.3
Subsidiary risk	Toxic, corrosive gas
Packaging group	
- Cargo	200
- Passenger	Forbidden
Maximum quantity allowed	
- Cargo	25kg
- Passenger	Forbidden

15 REGULATORY INFORMATION

GHS Hazard class: Flam gas 2
Acute tox 3
(Inhalation)

Skin corr 1B

Acute aquatic 1

National Legislation OHSact and Regulations (85 of 1993)
Refer to SANS 10234 and SANS 1034 Supplement for explanation of the above

16 OTHER INFORMATION

Bibliography

Compressed Gas Association, Arlington, Virginia
Handbook of Compressed Gases - 3rd Edition
Matheson. Matheson Gas Data Book - 6th Edition
SANS 10265 - Labelling of Dangerous Substances

17 EXCLUSION OF LIABILITY

Information contained in this publication is accurate at the date of publication. The company does not accept liability arising from the use of this information, or the use, application, adaptation or process of any products described herein.