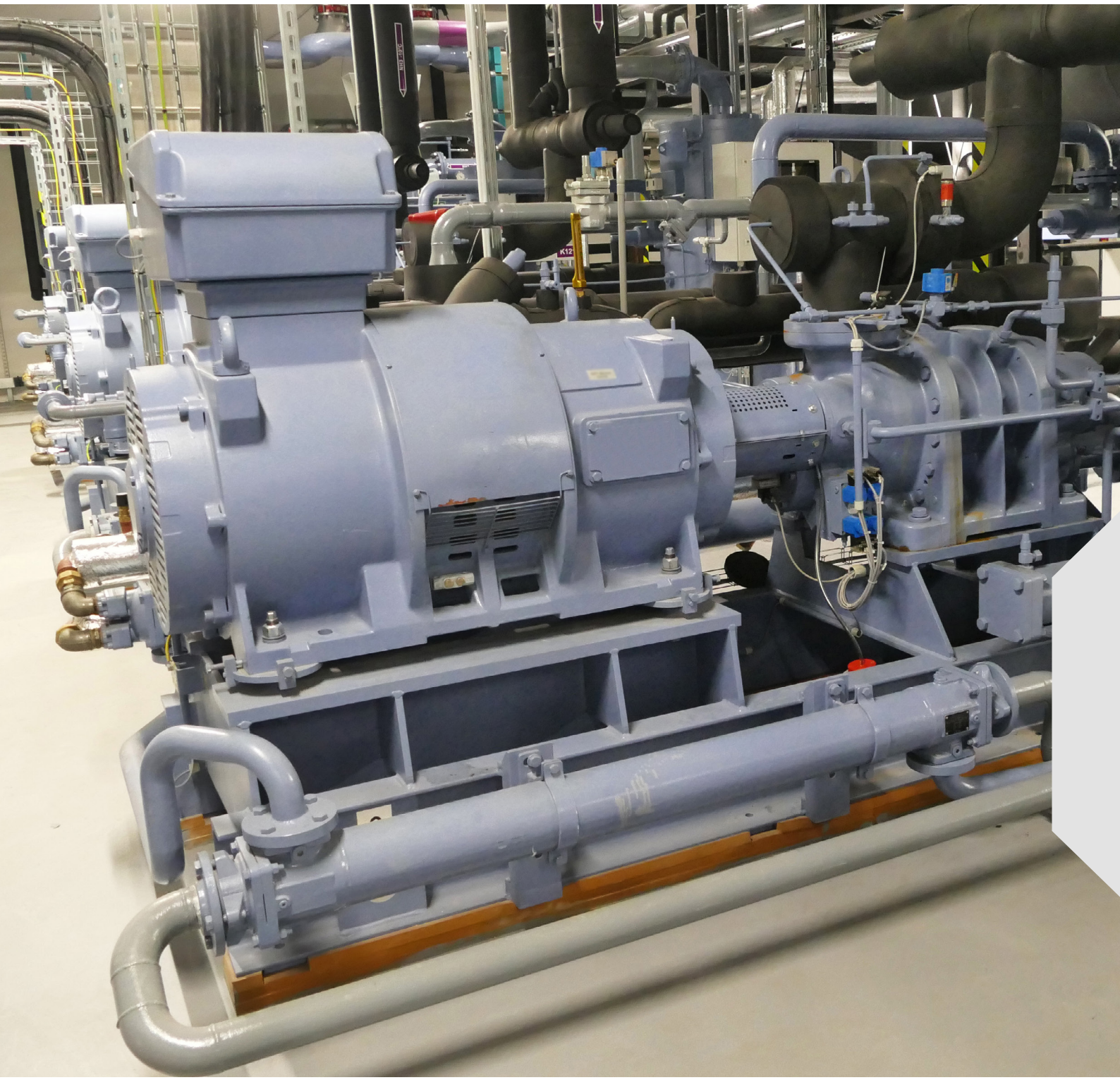
# Ammonia Monitoring
# **in Refrigeration Applications**

Fixed Gas Detection for Ammonia Safety Standards Compliance

MSA
*The Safety Company*



WE KNOW WHAT'S AT STAKE.

Refrigeration systems using Ammonia are considered cost efficient and do not destroy the ozone layer or contribute to the greenhouse effect linked to global warming. However, ammonia is a toxic gas, and the proper safety monitoring procedures and equipment must always be in place to help avoid serious accidental injury or death. When installed and maintained properly according to applicable standards, ammonia refrigeration is generally considered safe.

The requirements for ammonia gas detection systems are regulated by various standards but can also vary depending on local regulations in particular countries.

Widely recognized safety standards for ammonia refrigeration systems which should be considered by users, depending on the location where they operate, are as follows:

- ANSI/IIAR 2 Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems.
- EN 378 Refrigerating systems and heat pumps – Safety and environmental requirements.
- ISO 5149 Refrigerating systems and heat pumps – Safety and environmental requirements.

## Standards for Ammonia Industrial Refrigeration Systems


**ANSI/IIAR 2**
Published by the International Institute of Ammonia Refrigeration (IIAR) and approved by the American National Standards Institute (ANSI). The standard applies to any closed-circuit mechanical refrigerating system using ammonia specifically as a refrigerant. It is largely harmonized with ASHRAE Standard 15 – Safety Standard for Refrigeration Systems and captures the industry best practices for using ammonia in industrial applications.

**ISO 5149**
Published by the International Organization for Standardization (ISO). It applies to all refrigerating systems where the refrigerant is evaporated and condensed in a closed circuit, including heat pumps and absorption systems. The standard indicates the requirement for gas detection where the concentration of ammonia in an occupied space may exceed the practical limit. It has its equivalent standard in Europe which is EN 378.

**EN 378**
Published in Europe by European Committee for Standardization and applies to European Union member states for majority of refrigeration systems, including commercial refrigeration and stationary air conditioning applications. The standard indicates the requirement for gas detection where the concentration of ammonia in an occupied space may exceed the practical limit which is defined at 0,00035 kg/m$^3$.

*Note: See your national requirements for ammonia refrigeration systems.*

## Stay in compliance with these standards and review the main requirements for ammonia gas detection systems

| Number / Location of detectors | Alarm levels / Function | Alarm notifications | Maintenance | Personal safety |
|---|---|---|---|---|
| **ANSI/IIAR 2** | | | | **USA** |
| **Two refrigerant leak detectors** are required for each refrigeration machinery room with the purpose of triggering alarm and ventilation. | Various machinery room equipment like compressors, pumps and valves should be de-energized at a concentration not exceeding **40,000 ppm.**<br>Detector assignment:<br>**(No 1)** Alarm and normal mechanical ventilation system activation at the level **not greater than the corresponding TLV-TWA*.**<br>**(No 2)** Alarm and emergency mechanical ventilation system activation at the level not exceeding **1,000 ppm**<br>*See personal safety section of this table. | **Visual and audible alarms triggered by the detectors for:**<br>• inside area of the refrigerating machinery room,<br>• outside each entrance to the refrigerating machinery room. | Testing of ammonia detectors and the alarm system is required at intervals established at the facility.<br>**Generally in accordance with manufacturer's recommendation or based on documented experience.**<br>In case of missing recommendations the equipment shall be functionally tested on an **annual basis.** | **OSHA** sets Permissible Exposure Limits as the legal requirement in the United States. They are published as 8h TWAs also for ammonia in **1910.1000 Z1 Table:**<br>• **TWA 50 ppm** / 35mg/m3<br>OSHA has annotated the existing Z-Tables also with other recommended exposure limits, set by NIOSH and the ACGIH which are set at:<br>• **TWA 25 ppm**<br>• **STEL 35 ppm** |
| **EN 378-3 / ISO 5149-3** | | | | **Europe** |
| **One refrigerant detector** is required as a minimum for each refrigeration machinery room and/or occupied space.<br>Note:<br>• Ammonia systems with charge greater than 500kg, require gas detectors within heat transfer circuit of indirect systems.<br>• Machinery rooms with compressors require **minimum one detector** placed over the compressor unit.<br>• Refrigerant pumps in any areas require a detector placed over or near the pumps. | Ammonia system with charge greater than 50 kg require a gas detector to warn in case of fire risk and for control purposes.<br>Alarming levels and actions:<br>**(1st ) Pre-alarm** - mechanical ventilation activated for concentrations not exceeding **500 ppm (EN) or 200 ppm (ISO).**<br>**(2nd) Main alarm** – both refrigerating system and mechanical ventilation stopped, power supply to machinery rooms isolated automatically - for concentrations not exceeding **30,000 ppm**. | **Visual and audible alarms triggered** with both a loud beacon and a flashing lamp, within:<br>• Machinery room - warning inside and outside the machinery room. The alarm outside the machinery room may be installed in a supervised location.<br>• Occupied space – warning at least inside the occupied space.<br>**Additional alarm system requirements for charges above 3,000 kg (EN) or 4,500 kg (ISO):**<br>• User or owner responsibility is to ensure that a continuously attended station is provided as a central alarm station.<br>• Specialised personnel are required on site within 60 minutes of an alarm. | Testing of ammonia detectors is required at appropriate intervals established at the facility.<br>Correct functioning of alarms, mechanical ventilation and detectors needs to be regularly checked **at least once a year.**<br>EN 60079–29–2 specifies in detail the requirements for selection, installation, use and maintenance of detectors of flammable gases. | European Union exposure limits for ammonia are defined in Directive 2000/39/EC as following:<br>• **TWA 20 ppm** / 14mg/m3<br>• **STEL 50 ppm** / 35mg/m3<br>The community limits are set by the European Agency for Safety and Health at Work.<br>National limits are defined by country regulatory bodies. For example:<br>**France** - National Institute of Research and Safety – INRS. ED 984:<br>• **TWA 10 ppm / STEL 20 ppm**<br>**Germany** - Federal Institute for Occupational Safety and Health – BAuA. TRGS 900:<br>• **TWA 20 ppm**<br>**UK** - Health and Safety Executive - HSE. EH40/2005:<br>• **TWA 25 ppm / STEL 35 ppm** |

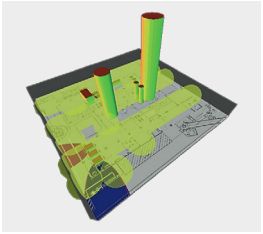
*Note: Ammonia leak detection systems help to keep facilities safe as required by the standards. However, the major concern with ammonia gas leaks is related to the effect of workers' health; therefore, personal safety across the whole facility should be considered to help in reducing the risk of exposure above the levels defined by regulatory agencies.*

## Additional considerations regarding physical location of detectors

As indicated by ANSI/IIAR 2 ammonia as a vapor is lighter than air. It rises and diffuses simultaneously when released into the atmosphere, which indicates the location of the detectors above possible leak sources or at ceiling height. However other conditions should be considered, such as those mentioned in EN 378-3 (p. 9.2) indicating that the location of gas detectors should be planned taking into account local airflow patterns, which are affected by ventilation sources or louvres. The possibility of mechanical damage or contamination should also be considered.

*For better planning and improving gas detection coverage, users can take advantage of MSA's Fire and Gas Mapping services.*

## Why Perform Fire & Gas Mapping?



MSA Fire and Gas Mapping is a solution that assists in the evaluation of fire and gas risks within a process facility and in the reduction of those risks towards an acceptable risk profile. Fire and gas mapping includes the placing of detectors in appropriate locations to achieve the best possible detection coverage, with a systematic and numeric method, which also considers external factors, such as wind direction and obstructions. The output of a mapping study includes graphical maps of residual risks, recommended detector placements and numerical estimates of detection coverage.

## Solutions

### Multiple Point Ammonia Monitoring

Reliable ammonia detection contributes to personnel safety and plant operability. The Chillgard® 5000 Ammonia Monitor protects equipment and people around a wide area due to its stable and selective sensing technology employed within an internal sampling system. It helps to comply with EN 378 and ANSI/IIAR 2.

The Chillgard® 5000 is the most selective and sensitive refrigerant leak detector on the market. With the ability to read down to 10 ppm, this monitor provides the earliest response to ammonia leaks. Unnecessary maintenance costs associated with calibration and exchange of sensors of multiple point detectors can be minimized by using a centralized sample draw system, with single Photoacoustic Infrared (PAIR) sensor technology. The Chillgard® 5000 is equipped with internal relays for fault, three levels of alarm and an external horn option for effective personnel warning as required by standards.

### Point Ammonia Monitoring

In addition to multiple point monitoring for ammonia leaks, it is important to monitor specific locations in machine rooms with compressed system equipment, where a leak is likely to occur. MSA offers a complete line of gas detectors that have the ability to also work as a stand-alone system.

One possible solution is the ULTIMA® X5000 Gas Detector with XCell® Ammonia electrochemical sensor, which addresses the challenges of short life and stability problems with traditional electrochemical cells.

MSA's next generation XCell electrochemical ammonia sensor features ionic liquid electrolyte, characterized by extremely low vapor pressure, preventing evaporation within changing environment. Contact with ammonia has virtually no effect on the lifespan of the sensor. It can withstand background gas concentrations due to the choice of the catalyst in the electrode material, which is not consumed during the chemical reaction with the target gas. Great improvements have also been made in the design and the position of the components within the sensor. This allows for the most-efficient interaction of the electrolyte, the electrode catalyst, and the target gas, regardless of environmental conditions, which enable the sensor to overcome extreme humidity and temperature levels. The result of this breakthrough design is a stable, dependable sensor performance, over a longer life span under demanding operating conditions and environments.

### Perimeter Ammonia Monitoring

Certain plants require ammonia monitoring over wide areas where a large number of detectors may have to be installed. In such cases, perimeter monitoring with open path detectors is an ideal solution, complementing traditional technologies to help enhance the overall safety performance of the gas detection system.

These devices are typically located around the perimeter of a plant, process or storage area; or positioned in close proximity to specific items of a plant, that pose a real risk of gas escape, like compressors, pump sets, pressure reducers, valves and pipe flanges. The Senscient ELDS™ Gas Detector from MSA creates a highly reliable full detection perimeter around any plant for the detection of ammonia, and is suitable for use inside the plant as well as in process areas. The technology behind ELDS Open Path Gas Detectors relies on Enhanced Laser Diode Spectroscopy (ELDS) to detect a specific toxic gas. In the event of a gas leak, the sensor's laser technology recognizes and analyzes a gas' specific harmonic fingerprint, and issues an alarm when the gas is present. Moreover, Senscient ELDS has a speed of response of <3 seconds and will detect ammonia anywhere it intercepts the beam. This results in faster isolation of the leak and a reduction in the volume of ammonia that escapes.

*MSA offers multiple fixed solutions to suit your specific site and the ammonia risks you face, but we also have a wide range of Personal Protective Equipment for use in this dangerous application. Contact us today to learn more about how we can help.*

# MSA—**The Safety Company**

*Our business is safety. We've been the world's leading manufacturer of high-quality safety products since 1914. MSA products may be simple to use and maintain, but they're also highly-sophisticated devices and protective gear—the result of countless R&D hours, relentless testing and an unwavering commitment to quality that saves lives and protects millions of hard working men and women each and every day. Many of our most popular products integrate multiple combinations of electronics, mechanical systems and advanced materials to help ensure that users around the world remain protected in even the most hazardous of situations.*

## Our Mission

MSA's mission is to see to it that men and women may work in safety and that they, their families and their communities may live in health throughout the world.

**MSA: WE KNOW WHAT'S AT STAKE.**



MSA operates in over 40 countries worldwide. To find an MSA office near you, please visit ***MSAsafety.com/contact-us***.

**AC1958**