EQUINOX AUTOMATION

CASE STUDY

Fire & Gas Mapping for Ammonia Refrigeration System: Risk-Based Performance Design

PROJECT BACKGROUND AND CHALLENGES:

A client experienced issues with an ammonia (NH_3) industrial refrigeration system used to liquefy production gas for storage and export. The system included two ammonia compressors, multiple heat exchangers, and a bulk storage tank. The toxic hazards of ammonia were confined to the closed-loop refrigeration system and related process equipment.

Since ammonia (NH_3) is highly toxic if released, the facility sought to conduct a gap analysis of the existing NH_3 gas detection system. The goal was to ensure the layout design met the latest performance-based standards and provided effective coverage for the majority of release scenarios and potential personnel exposure.

The refrigeration process equipment included NH_3 compressors housed in a semi-enclosed compressor building, while other process equipment was located outdoors, all within a complex facility with high personnel occupancy.

Equinox Automation was engaged to conduct a gap analysis and recommend an updated ammonia gas detection layout for the refrigeration plant. The assessment followed the latest risk- and performance-based methodology in accordance with ISA-TR84.00.07-2018 guidance.

SOLUTION:

Our engineers applied a risk-based approach, a risk assessment was carried out to assess the process equipment for potential toxic gas release scenarios based on equipment failure rates. This analysis was used to calculate the correct performance targets for the facility toxic gas detection system design, which would effectively detect and mitigate any toxic ammonia release hazards by combining with alarms, site sirens and evacuation procedure effectiveness.

We carried out gas dispersion modelling to understand the potential hazard if ammonia is released due to equipment failure. This information was used as input in the next stage of Fire and Gas Mapping to model detector layouts to meet the specific coverage targets determined by the risk assessment.

The existing gas detectors were assessed to identify gaps against the calculated performance standards, utilising specialised 3D fire and gas mapping software. The analysis revealed several coverage gaps within the compressor building and outdoor areas.

By optimising the placement of existing detectors, we relocated several units to improve coverage in identified gaps. Additionally, we incorporated toxic open-path gas detection technology to enhance coverage over critical perimeters, protect personnel access routes, and leverage the superior detection capabilities of open-path systems.

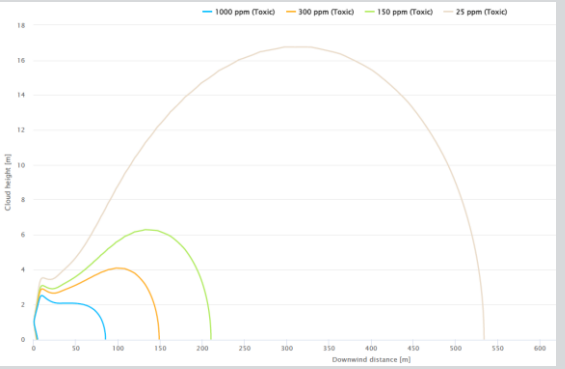

Figure 1: Hazard screening - example ammonia (NH3) toxic gas dispersion model.

Ammonia Exposure Thresholds		
Exposure Threshold	**WorkSafe NZ Standard**	**Potential Health Effects**
25 ppm	Time-Weighted Average over 8 hours (TWA)	Mild irritation of the eyes, nose, and throat; possible respiratory discomfort.
35 ppm	Short-Term Exposure Limit, 15 minutes (STEL)	More pronounced irritation to the eyes and respiratory tract; potential headache.
≈300 ppm	Immediately Dangerous to Life or Health (IDHL) (Not a WorkSafe NZ threshold)	Severe respiratory irritation, risk of pulmonary edema, and life-threatening effects.

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We completed the engineering study by delivering a detailed report and an updated gas detector layout drawing to accompany our recommendations.

RESULTS:

The ammonia gas detection gap analysis and optimisation enhanced the ammonia refrigeration chilled gas processing system's toxic gas detection, ensuring compliance with the latest performance-based standards and significantly improving safety at the facility.

Key improvements that we delivered:

- **Risk-Based Hazard Assessment** – Risk assessment, ammonia gas dispersion modelling, calculated performance targets based on equipment failure rate frequencies.
- **Improved Detection Coverage** – Optimized layout enhanced coverage in critical areas, compressor building and near higher occupancy outdoor areas
- **Optimised Detector Placement** - Relocating existing detectors reduced redundancy, maximising cost savings while closing identified gaps.
- **Applying new technology** – Recommending new open path technology to improve coverage and reduce maintenance.
- **Design Assurance** – A detailed report, design verification, and updated gas detector layouts ensured compliance with industry best practices and alignment with the latest fire and gas system performance-based design standards.

By applying a risk-based approach and advanced fire and gas mapping, Equinox Automation delivered a cost-effective, high-performance gas detection strategy, significantly improving the facility's ability to detect, respond to, and mitigate ammonia releases.

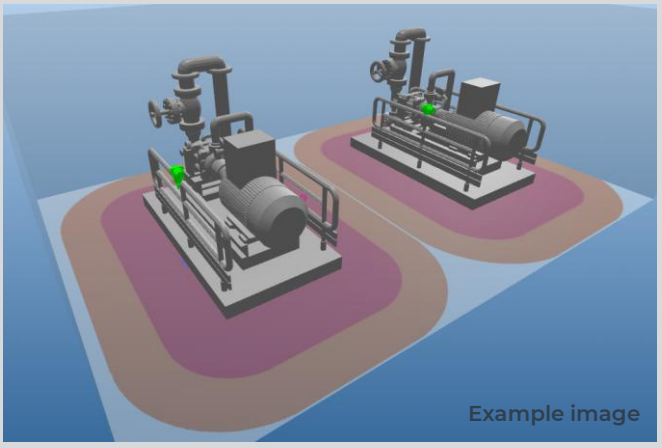

Figure 2: Designing ammonia compressor gas detector layouts using 3D gas detector mapping software tools.

If your facility requires expert assessment and optimisation of ammonia gas detection systems or other toxic gases, Equinox Automation specialises in risk-based fire and gas detection design.

Contact us to discuss how we can improve your plant's safety, ensure compliance, and protect both your people and your business.

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