matelex
connected refrigeration

Effective & Compliant

Testing the Matelex Indirect Automatic Leak Detection System for Commercial Refrigeration

This case study demonstrates how Matelex quickly detects leaks, reducing refrigeration systems' environmental and financial impact.

Background

To limit emissions from refrigeration systems, the European Union introduced the F-Gas Regulation in 2014, establishing a phased reduction in the use of high global warming potential (GWP) refrigerants and setting requirements for leak detection. This regulation has continued to evolve, with F-Gas 3 in effect since March 2024, reinforcing the mandate for permanent leak detection on HFC installations exceeding 500 metric tons of CO_2 equivalent and extending it to HFO installations above 100 kg (even though their GWP is lower).

In France, even stricter national regulations were introduced in 2019, requiring automatic leak detection systems using indirect measurement methods for refrigeration systems with charges above 500 metric tons CO_2 equivalent. These systems not only aim to detect leaks earlier but also allow a one-half reduction in mandatory annual leak checks, provided they meet certain performance thresholds. One of the criteria is that they send an alarm before the installation loses 10% of its refrigerant.

This study evaluates the performance of an indirect automatic leak detection (ALD) system developed by Matelex, known as PolarBox. The goal is to verify whether this technology can trigger an alarm before a system has lost more than 10% of its refrigerant charge, in line with regulatory expectations now implemented in the US under AIM Act 40 CFR § 84.108(g).

To evaluate the effectiveness of such systems, a study was conducted by CES (a joint lab between Mines ParisTech and ARMINES), in collaboration with French Agency for Ecological Transition. The PolarBox uses indirect detection based on system behavior modeling, triggering an alarm before 10% of the volume of fluid contained in the equipment is lost.

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Test Overview

A Matelex refrigeration engineer and a refrigeration technician from *CIC Refrigeration* responsible for the installation were present throughout.

Test Unit Selection

To replicate previous test conditions, unit CN1 was selected. Prior to the test, the system was fully recalibrated. This unit contains a nominal refrigerant charge of 1,320 lbs *(600 kg)* of R-404A. The selection was confirmed on-site by the Matelex engineer.

The system's activity log was reviewed and showed no leak alarms had been triggered in the past three weeks, indicating the system was operating normally. Additionally, it showed several measurements were recalibrated on April 19, 2017:

THESE RECALIBRATIONS WERE INTENDED TO IMPROVE THE ACCURACY AND RELIABILITY OF THE LEAK DETECTION SYSTEM AHEAD OF TESTING.

Measurements

At the start of the test, the transfer bottle was weighed with all fittings attached to accurately track the amount of refrigerant recovered. The initial tare weight was recorded at 62 lbs 6.5 oz *(28.365 kg)*.

To match previous test conditions, efforts were made to replicate the same discharge pattern—both in terms of flow rate and total mass recovered—based on a reference curve. Recovered refrigerant was weighed every 10 minutes.

Test Conditions

Test Conditions were set up to simulate a refrigerant leak. First, a transfer bottle was weighed and tared (zeroed out) after being connected to the system. Next, the refrigerant collected in this bottle was monitored in 10-minute increments.

THE TRANSFER CONTINUED WITHOUT INTERRUPTION UNTIL EITHER:

- The Matelex system triggered an alarm

OR

- The recovered refrigerant reached at least 10% of the system's nominal charge.

AWARD WINNING TECHNOLOGY

PolarBox is a patented, award-winning product (2023 AHR Expo, Tools & Instruments). It uses algorithmic learning to understand a system's normal behavior so it can detect leaks up to two months earlier than direct detection alone. Together with the PolarVisor web app it offers 24/7 visibility into a system's behavior, saving time and money while avoiding the stress of emergency repairs.

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Results

At 4:00 p.m., Matelex received a statistical alarm notification from the system. The team was notified and the engineer confirmed that the system had entered into 'alarm mode.'

The alarm message read "white level statistical alarm," indicating that Matelex detected abnormal conditions.

The test was stopped at 4:18 p.m. At that point, the quantity of R-404A measured on the precision balance was 59 lbs 8 oz *(27,047 g)*. To confirm accuracy, the transfer bottle was weighed separately, yielding a nearly identical reading of 59 lbs 8 oz *(27,052 g)*.

Following the test, the recovered refrigerant was returned to the system over the course of 1 hour and 30 minutes. A residual amount of 10.6 oz *(300 g)* remained in the transfer bottle.

TEST RESULTS	
Type of leak	Increasing leak
Average leakage flow rate	**51 sccm** *(3.1kg/h) [or 50.9 sccm (50.9 g/min)]*
Tracking the leak	Yes
Time leak detected	**5HR 35MIN**
Type of alarm	Statistical White Level
Amount of refrigerant lost	**55lbs 11oz** *(25.3kg)*
Loss with respect to the nominal charge of the unit	**4.2%**

Based on: Barrault, S., Nemer, M., Fayolle, F., & Pinel, K. (2017). Evaluation of the Polarbox system – Auchan Vélizy case study. CES MINES-ParisTech/ARMINES.

Interpretation of Results

A statistical leak alarm was triggered after approximately 59 lbs *(27 kg)* of refrigerant had been withdrawn—just 4.2% less than the system's nominal charge *(1320 lbs or 600 kg)*. This result is consistent with an earlier test, confirming that the recalibrated system exceeds performance expectations, operating at standards well above regulatory compliance.

Early detection through a statistical alarm indicates that it can effectively identify abnormal system behavior in time to prompt corrective action. This supports the continued use of indirect leak detection systems like Matelex to reduce the frequency of mandatory leak checks—without compromising environmental or operational standards.

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Background on Auchan Vélizy Superstore

Auchan Vélizy is a large hypermarket located in Vélizy-Villacoublay, a suburb of Paris, France. It is part of the Auchan Group, one of the largest retail chains in France and Europe, with a presence in multiple countries worldwide. Auchan operates a variety of retail formats, including hypermarkets, supermarkets, and e-commerce platforms, offering a wide range of products from food and household items to electronics, clothing, and more.

The Vélizy superstore is a flagship location within the greater Paris metropolitan area, serving a large community of local residents and commuters. As part of Auchan's commitment to sustainability and environmental responsibility, the Vélizy location is actively engaged in initiatives aimed at reducing its environmental footprint, particularly in the area of energy efficiency and emissions reduction.
In recent years, Auchan has placed a strong emphasis on sustainable practices in its refrigeration systems. This includes adopting advanced technologies for managing and monitoring refrigerants, which are potent greenhouse gases when released into the atmosphere. The Vélizy superstore has been involved in several pilot projects focused on improving refrigeration system efficiency and reducing the environmental impact of its operations.

In the context of this case study, the Auchan Vélizy superstore was the site of the leak detection tests, which aimed to evaluate the effectiveness of indirect leak detection systems. These tests are part of the store's broader efforts to comply with European regulations on refrigerant management, reduce energy consumption, and minimize emissions, all while maintaining the reliability and operational efficiency of its refrigeration equipment.

What this means for the U.S

US regulations vary by state and locale, with an overall trend towards requiring indirect leak detection. In New York, this requirement went into effect June 1, 2025, and shortly afterwards, Tops Market announced that it had completed an installation of 28 of our PolarBox / PolarVisor systems across 14 stores.

Glossary of Technical Terms

Tare Weight:
The baseline weight of equipment and fittings before any refrigerant is added to a system.

SCCM (Standard Cubic Centimeters per Minute):
A unit of measurement for flow rate, specifically the volume of refrigerant flowing through a system per minute.

Indirect Leak Detection:
Indirect leak checking is analysis of one or more of the following: Pressure(s), Temperatures, Compressor run current, Liquid level checks. Recharge volume where applicable , Visual inspection. Instead, the system tracks the overall performance of the refrigeration system based on statistical models.

Statistical Alarm:
An alarm triggered when unusual behavior is detected in the refrigeration system that could indicate a leak.

Nominal Charge:
The total amount of refrigerant that a refrigeration system is designed to hold under normal operating conditions.

Flow Rate:
The amount of refrigerant flowing through the system, typically measured in units like sccm.

Precision Balance:
An accurate scale used to measure extremely small quantities of refrigerant. It helps track how much refrigerant is being recovered during the test.

Refrigerant:
A substance used in refrigeration systems to absorb and release heat, allowing the system to cool. A common example is R-404A.

Dehydrator:
A device in refrigeration systems that removes moisture from the refrigerant. It helps maintain the efficiency of the system by preventing ice or frost build-up that could interfere with the refrigeration process.

Alarm Sensitivity:
A setting that controls how sensitive a system is to detecting leaks. It can be adjusted to trigger an alarm based on different levels of change in refrigerant levels or system performance.

Recalibration:
The process of adjusting system settings to ensure accuracy.

White Level Statistical Alarm:
A specific type of alarm triggered by abnormal conditions in the system.