

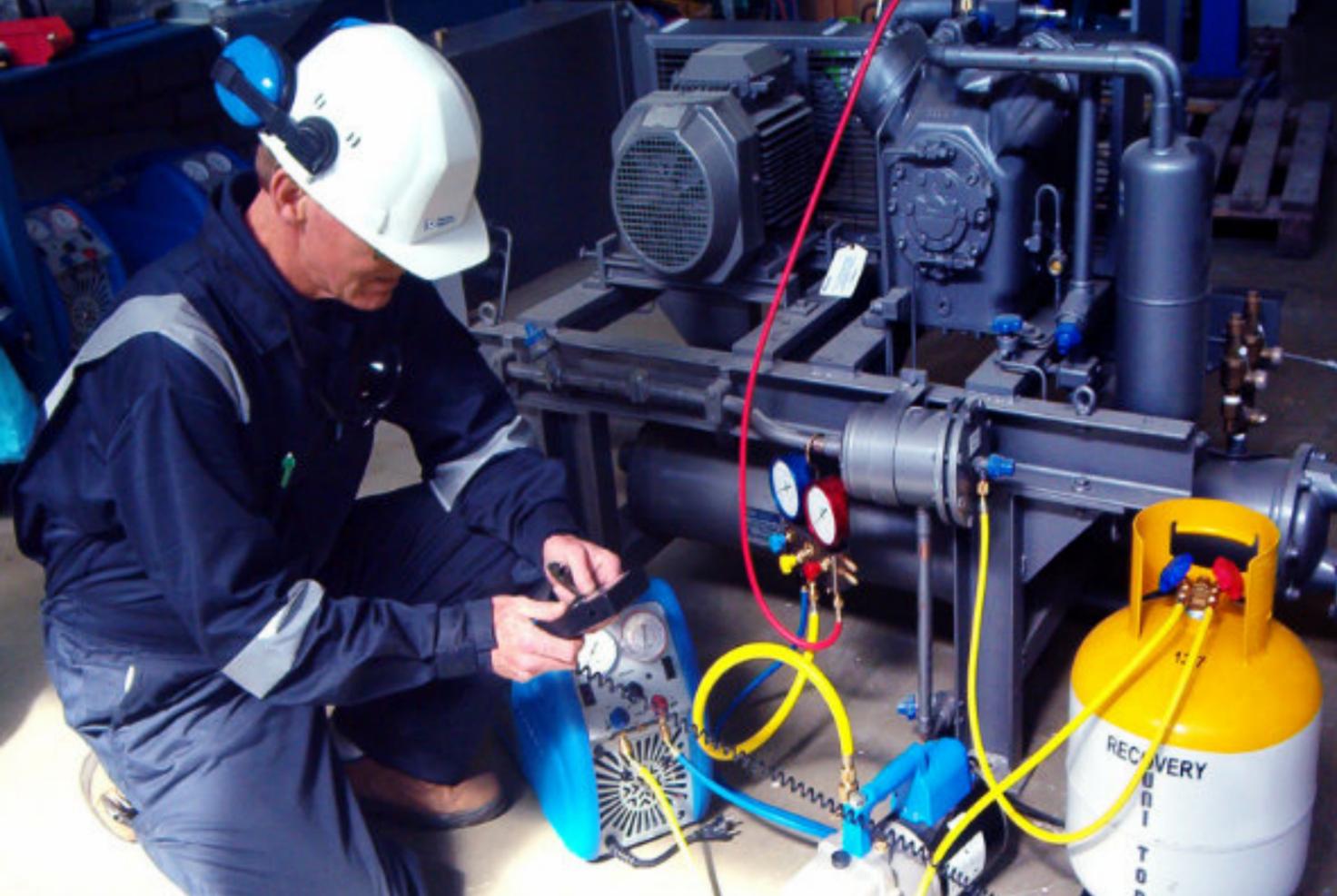
# Responsible refrigeration on ships – Enabling you to comply with regulations and reduce carbon emissions



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When it comes to greenhouse gas emissions (GHGs), it is natural for people to think of vehicles and focus on fuel consumption.

In the shipping industry, tackling fuel consumption is also often seen as the dominant solution for reducing carbon dioxide (CO<sub>2</sub>) emissions. In recent years, ship owners have been turning to cleaner fuels and optimising sailing routes.

However, while lowering fuel consumption is a key component to reducing emissions, there are other factors for the shipping industry to consider. Among these is addressing the need for better maintenance of refrigeration systems, which is one of the critical contributions to vessels' emissions.

Many refrigeration issues can be prevalent but less recognised.

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*"The maritime industry currently accounts for 2-3% of global CO<sub>2</sub> emissions, but scientists project that it could increase to 17% of total annual CO<sub>2</sub> emissions by 2050."*<sup>1</sup>

- S&P Global Platts Analytics

### Why should we maintain the integrity of the refrigeration system?

Alongside the main engine and the boiler, the refrigeration system is one of the heaviest electricity consumers on board. A leaking system requires more energy to deliver the necessary level of cooling. Every 10% loss of refrigerant in a system increases energy consumption by up to 20%, worsening the emission problem.

A further issue is the health and safety impact of a leaking refrigeration system. Synthetic refrigerants used in the system are typically heavier than air, odourless and colourless. Supposing leaks go undetected for a long time, refrigerant gas could displace air in a confined space like the walk-in freezer room, and the crew may unknowingly inhale the refrigerant, which can lead to asphyxiation. Leaks can cause the refrigeration system to operate below its full capacity, impacting the comfort level of the crew and the quality of goods and perishable food.

Infrequent or the lack of leak checks can mean that it may only be identified when temperatures start to rise. By this time, the damage to food and other heat-sensitive cargo may have already been done.

Additionally, an excessive refrigerant loss can cause damage to the system and shorten the lifespan of the compressor. Besides buying more refrigerant for a top-up, ship owners may need to spend more money on repair work. And as we all know, any unforeseen breakdown would have both cost and time implications. In fact, the cost for repair, loss of income, potential fine and financial compensation for liability in total may cost ship owners a loss of over \$100,000 a day!

### Refrigeration leaks add to global warming

Refrigeration systems are a crucial component of ships. Apart from performing the vital function of maintaining temperature and humidity for comfort cooling onboard, they keep cargo in optimal condition and prevent damage to perishable food.

For ships constantly on the move, leaks in the refrigeration system are a significant issue. In fact, they are one of the leading causes of emissions.

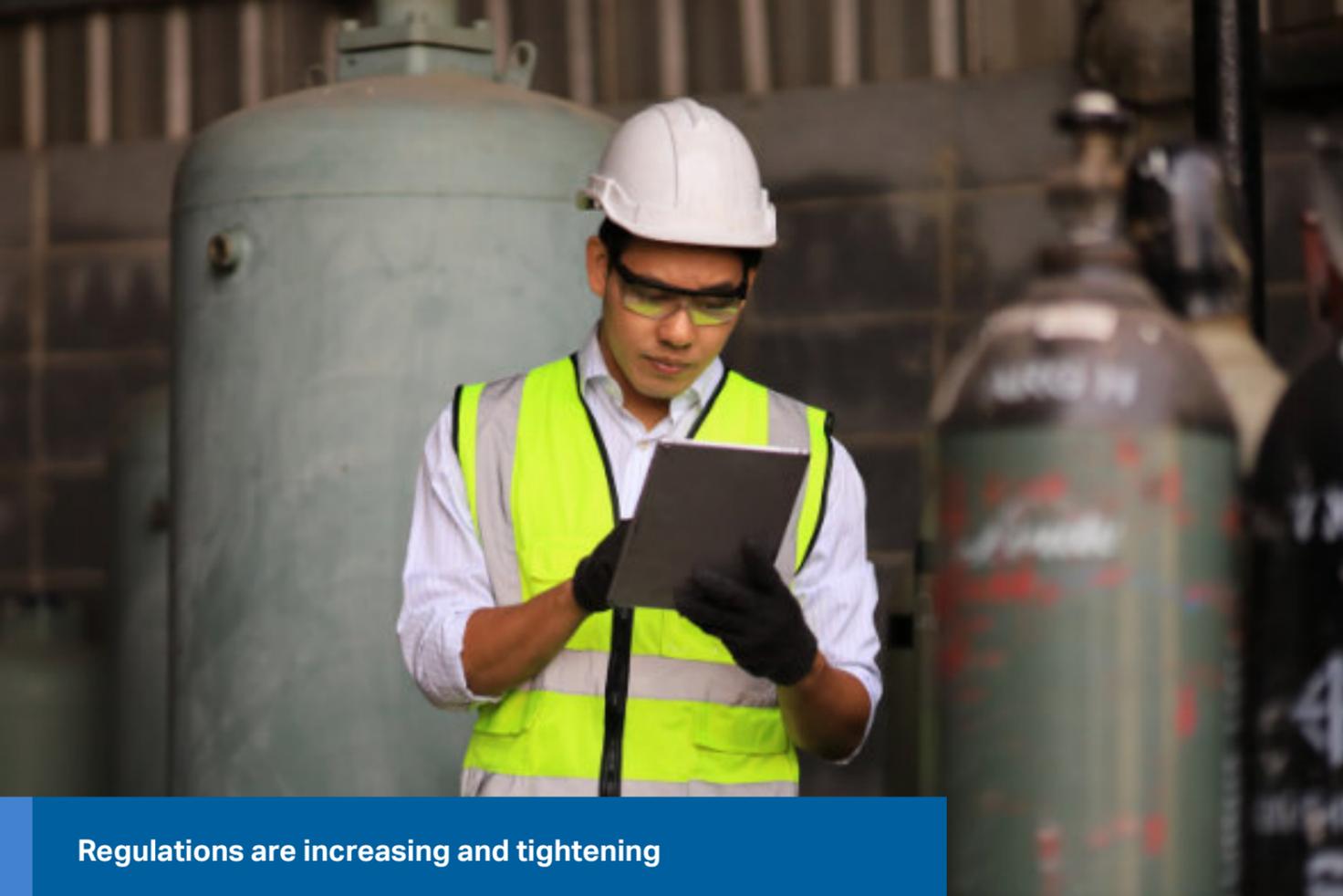
To put the scale of the problem into context, the total annual refrigerant loss in shipping in 2018 was the equivalent of 18.2 million tonnes of CO<sub>2</sub>.<sup>2</sup> That equates to 7.7 billion litres of gasoline consumed, or nearly 4 million passenger vehicles driven for a year.<sup>3</sup>

And the impact of 1 x 45kg R-404A cylinder, one of the more commonly used high GWP refrigerants, emits emissions equal to about 75k litre of gasoline consumed.

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*"Limiting global warming level to close to 1.5°C or even 2°C will be beyond reach, unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions."*<sup>4</sup>

- UN IPCC



## Regulations are increasing and tightening

For the past few years, several regulations have been introduced to govern the use of HFC refrigerants and how refrigeration systems should be maintained. These aim to phase out refrigerants with high global warming potential (GWP), favouring more environmentally friendly alternatives.

Among these are the [European Union's F-gas regulations](#) to control the use of fluorinated greenhouse gases by two-thirds of 2014 levels by 2030. F-gas regulation (517/2014) came into force in 2015 to reduce the use of hydrofluorocarbons (HFCs) and impose a service ban on those with a Global Warming Potential (GWP) of greater than 2,500 by 2020. These include refrigerants such as the commonly used R-404A, R-507 and R-422D.

Another major piece of international legislation is the [Kigali Amendment to the Montreal Protocol](#), which seeks a phased reduction of over 80% in the consumption and production of HFCs by 2047. As of 20 October 2021, 127 of the 197 parties to the Montreal Protocol have ratified the Kigali Amendment, and the number of supporting countries will only increase.

Considering the range of laws – from those mentioned above to the EPA rules in the US, IMO Marpol Annex VI and notations from class organisations such as Bureau Veritas, DNV, ABS and more – refrigeration is clearly heavily regulated. Such regulations include the prohibition on venting, proper recovery, disposition, reclamation of refrigerants, and requirements for leak prevention.

However, it can be challenging to follow these rules across different countries and regions. How many times have you had to double or triple check on which regulations to follow at specific locations during your seafaring trips?

## The implications of non-compliance

Due to lack of understanding, some ship owners may simply revert to the prescribed actions, such as mere compliance with the HFC phase-down schedule of a country by switching from high GWP R-404A to low GWP refrigerants. Others may not realise the need to check other aspects of the refrigeration systems or fill in logbooks, which are inspected at ports.

Additionally, some ship owners may not fully understand the HFC phase-down regulations in a particular country. For example, an EU-flagged ship may unknowingly continue to use high GWP R-404A refrigerant when operating outside EU waters. They may also be unaware of the specific requirements on leak prevention, refrigerant recovery, reclamation, and destruction stipulated by local authorities.

The consequences of non-compliance with regulations include the increased risk of environmental impact from the sector, leading to enhanced global warming and climate change. It can also mean business disruption, penalty fines and even imprisonment.

With the world's attention focused on reducing emissions and fight climate change, regulations will continue to increase and become more detailed in time.

Therefore, ship owners must leverage future-proof tactics that can help ensure compliance now and in the years ahead. One of the ways is to adopt a responsible refrigeration approach, regardless of flag or type of ship.



## What is responsible refrigeration?

### You may ask.

Responsible refrigeration is a comprehensive yet straightforward approach to decreasing refrigeration-caused emissions on board. It focuses on all the commonly overlooked areas of refrigeration by tackling direct and indirect emissions.

The key elements to reducing direct emissions include the adoption of low GWP refrigerant solutions, a thorough and robust process for refrigerant recovery and the use of an efficient leak detection system (including accurate hand-held detectors, an ultraviolet tracer kit and an effective monitoring system).

Ship owners should also adopt energy-saving products, optimise the settings on the refrigeration system, and ensure it is on full refrigerant charge.



### Key considerations for your systems

In today's market, there are many low GWP alternatives available for ship owners to replace higher GWP refrigerants and future-proof their systems effectively. By decreasing direct and indirect emissions from the vessel, they can increase efficiency and comply with regulations.

Let me elaborate on the considerations for new and existing systems, respectively.

For new build systems, only lower GWP refrigerants should be considered, supported by essential refrigeration equipment and tools such as a recovery package, and a leak detector for day-to-day maintenance.

For existing systems, the fact that the popular R-404A has been phased out in the EU from 2020, with other regions soon to follow, means there is an urgent need for existing users to switch over to lower GWP alternatives.

Unicool R-407F has been our recommendation as the most cost-effective solution for the existing R-404A system. R-407F is fully compatible with existing R-404A systems for low and medium temperature applications, requiring no technical upgrade or retrofitting. With a GWP of 1824, R-407F can immediately cut the global warming impact of the refrigerant by 53.5% and help reduce energy consumption by improving the efficiency of the existing system.

### A new generation of low GWP refrigerant solutions

Recently, a new range of low GWP HFO/HFC blends has been introduced to solve various refrigeration challenges on ships. They are R-452A, R-448A and R-449A.

R-452A is designed for low-temperature applications with an air-cooled condenser. It can reduce global warming impact by 45.4% and has low discharge pressure, making it suitable for new installation and retrofit of existing reefer containers.

R-448A and R-449A are recommended for new installations. Out of the many R-404A replacements that have been developed, R-448A and R-449A are the non-flammable solutions with the lowest GWPs (of 1387 and 1397, respectively) currently in the market. They are also excellent replacements for the existing R-404A system, reducing the global warming impact by over 64% and the energy consumption of the existing system. With the price and availability of R-404A severely affected by regulations, R-448A and R-449A have also been chosen by many EU and US owners as direct replacements for their existing systems.

For ships currently using R-507, if the system does not include a flooded evaporator, owners can follow the same retrofit recommendation as for R-404A. If it does have a flooded evaporator, upgrading the entire system to a lower GWP solution should be considered. Likewise, ships using the R-422D refrigerant should think about a complete system upgrade.

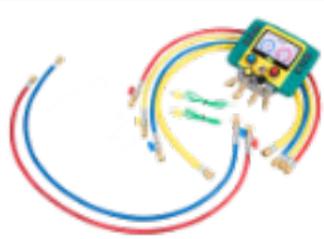
## Essential refrigeration equipment & tools

Alongside considering the type of low GWP refrigerants, it is essential to ensure crew members have the appropriate equipment to maintain and handle refrigerant properly and prevent unnecessary refrigerant loss



### Refrigerant Recovery Package

The Refrigerant Recovery Package is a must-have for every crew. The package consists of carefully selected quality equipment, designed for ship crew to handle refrigerant recovery or charging processes, evacuation, leak checks and maintenance for air-conditioning and refrigeration systems on board.



### Digi-manifold Set (4-way)

The new Digi-manifold set is a precise and more sustainable digital refrigeration measuring tool to help the ship's crew carry out recovery or charging processes, system optimisation and troubleshooting. This product enables cost and time savings, as only one tool is required to support all common refrigerants used in maritime applications.

With a high accuracy sensor, the ability to convert the pressure to temperature readings as well as calculate superheat and subcool automatically, along with wireless connection to the mobile app, it is recommended for all ships, particularly those undergoing a refrigerant system conversion.



### U.V. Tracer Kit

Invisible refrigerant leaks are tiny or intermittent leakages typically hidden in inaccessible areas which may not be detected with conventional methods. The Unitor Refrigerant Leak Detection U.V. Tracer Kit is an effective tool for pinpointing invisible refrigerant leaks in the system.

On top of that, other refrigeration tools like the refrigeration handy tools case, the hand oil pump, and the collection of fittings will enable the ship crew to carry out proper maintenance work on board.

## Environmental Return Management (ERM)



*"Roughly 90% of refrigerant emissions occur at equipment's end of life, which means that emissions are likely to increase before they start to decline."<sup>5</sup>*

- Project Drawdown

While having access to low GWP solutions and supporting products is essential, it is even more critical for ship owners to dispose refrigerants and recovery cylinders responsibly.

Our ERM service is designed to help ship owners dispose the refrigerants according to local regulations. It will be available in selected countries like the Netherlands, Belgium, UK, US, and Singapore.

## Sustainable refrigeration – the way forward

From the growing number of regulations worldwide, we know that the industry is starting to recognise refrigerants' significance within ship emissions. It is also clear that industry players in all regions and levels must now ensure full compliance or suffer the consequences. Converting to low GWP refrigerants and focusing on leak prevention can majorly support regulatory compliance, and at the same time, enable you to become more efficient.

The adoption of responsible refrigeration is imminent, and avoiding the tide of change is not an option. It is time for you to take an active role in our fight against global warming and climate change, and we are here to support you.



For more information, visit:



or follow us on:



References:

<sup>1</sup><https://www.spglobal.com/esg/insights/your-climate-change-goals-may-have-a-maritime-shipping-problem>

<sup>2</sup><https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx>

<sup>3</sup> US EPA Greenhouse Gas Equivalencies Calculator

<sup>4</sup><https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/>

<sup>5</sup><https://drawdown.org/solutions/refrigerant-management>