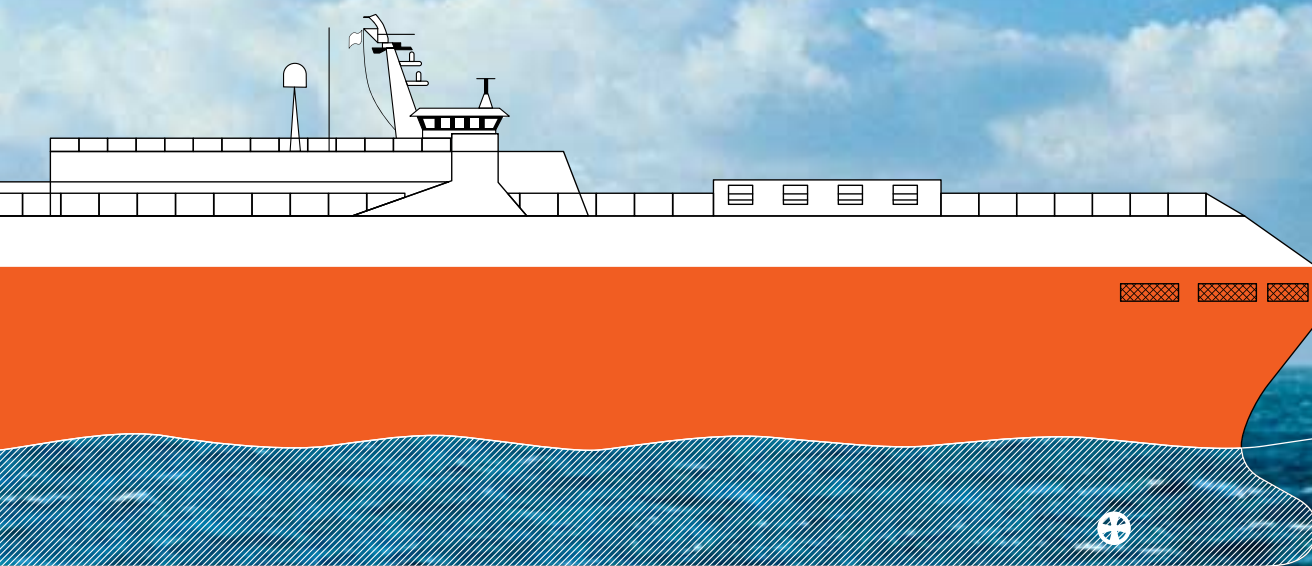
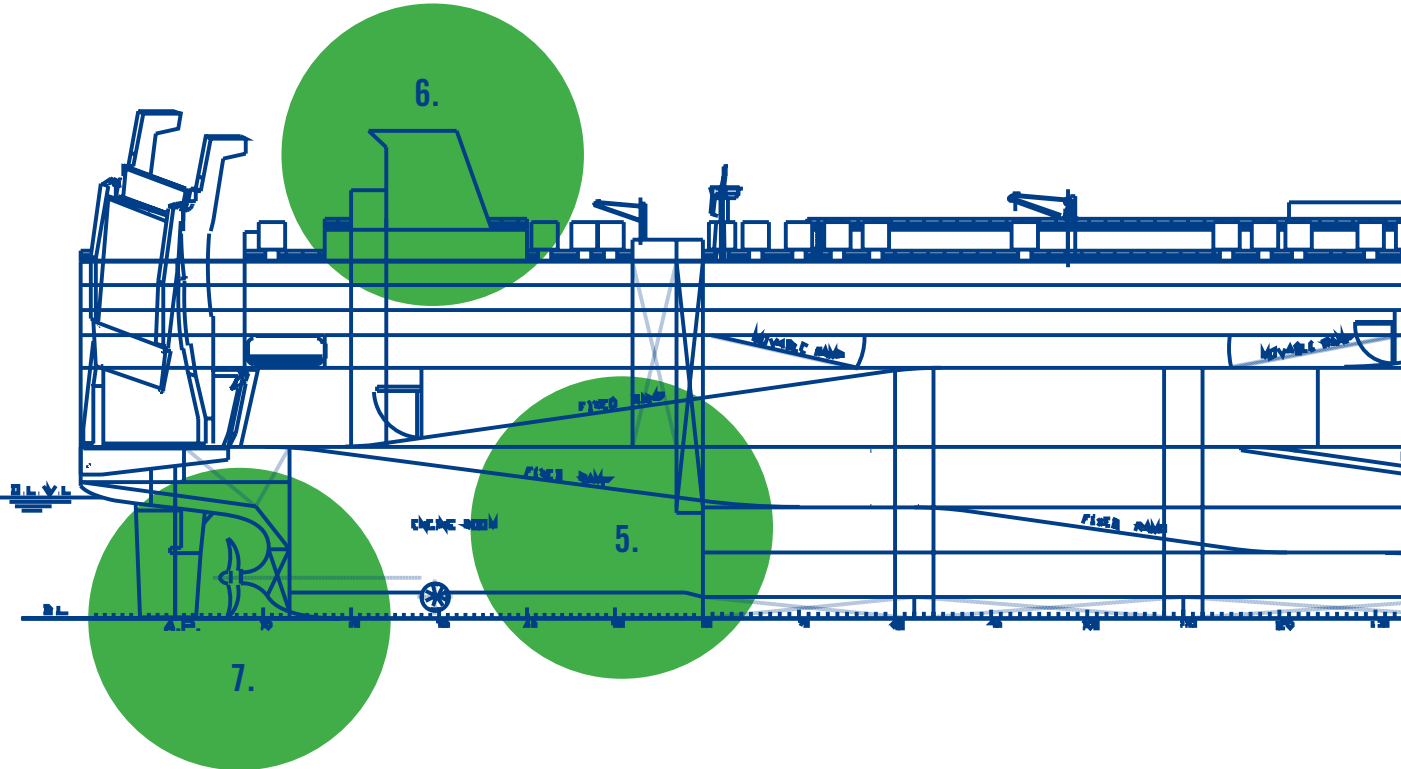




Environmental report 2005 Wilh. Wilhelmsen



# ENERGY OPTIMISATION



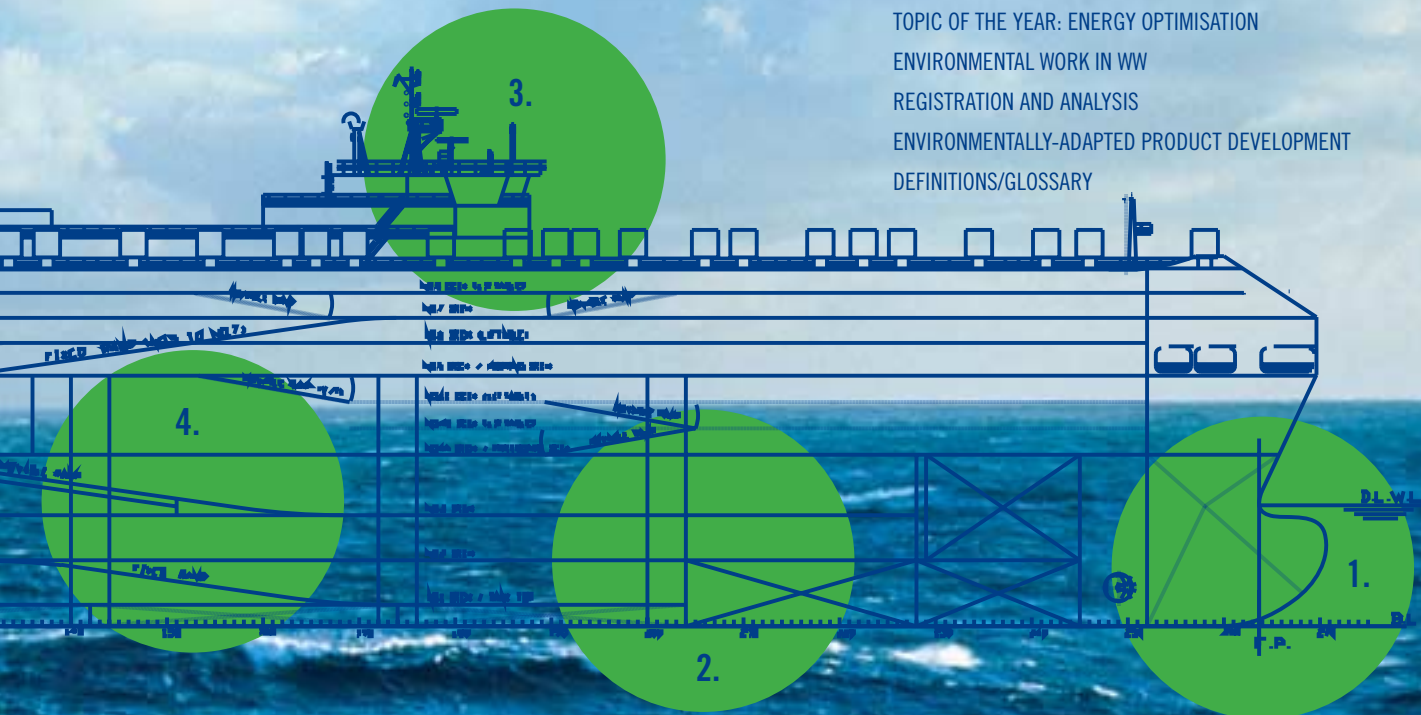
- 1. OPTIMUM SHIP DESIGN
- 2. CLEAN HULL
- 3. OPTIMUM VOYAGE PLANNING
- 4. OPTIMUM CARGO PLANNING
- 5. OPTIMISING SHIP'S ENGINES
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# CONTINUOUS FOCUS ON THE ENVIRONMENT

Shipping is the most environment-friendly way to transport commodities around the world when measured in energy units per quantity of cargo carried and distance. At the same time, vessel operation embraces a number of processes which affect the natural environment.

WW takes environmental challenges seriously, and we work from different approaches and in a variety of ways to help ensure that our business leaves the fewest possible traces in the environment. Our environmental commitment was broad in 2005, and will continue with undiminished vigour in 2006.

Apart from shipping, our business segments include logistics and maritime services. We aim for a process which leads not only to increased understanding of the way our operations actually affect the natural world, but also to continuous improvement towards a cleaner environment.

Barber Ship Management and Unitor Chemicals, which form part of Wilhelmsen Maritime Services (wholly owned by WW), are certified to the ISO 14001 environmental management standard, which helps to ensure continuous improvement and provides a means of determining that environmental work is being pursued in line with the plans we have defined. Under ISO 14001, we are required to keep updated on all environmental requirements in our business and to pursue

our operations within these limits. We even endeavour to lie ahead of developments in legislation and statutory regulations, and ensure that our business pollutes less than the international rules require. In 2005, for instance, the average sulphur content in bunkers used on our ships was 1.72%. This is well below the international requirement, which the International Maritime Organisation (IMO) regulated in 2005 to a maximum of 4.5%. That IMO standard will be tightened in 2006 to 1.5% in the Baltic area, with the North Sea due to follow in 2007.

The easiest way to reduce emissions of sulphurous exhaust fumes is to use bunkers with a low sulphur content. However, utilising low-sulphur bunkers poses a number of cost, technical and operational challenges. These are discussed in this report.

Damage to the environment is best avoided through preventive measures. We accordingly analyse the environmental impact of our business on a continuous basis. This allows us to identify critical areas and work actively to implement measures which reduce the environmental load.

Through our environmental efforts, we will seek to reduce energy consumption as well as environmentally-harmful emissions or discharges where we can influence these. We have, for instance, gone further than prevailing environmental standards require in connection with building ships. Our series of new car carriers under construction in Japan consumes less energy than existing vessels. Cargo loading has also been improved on these ships, while their bunkers tanks have been positioned to reduce the threat of oil leaks in the event of accidents. The design of these newbuildings provides not only good transport economics but also a substantial environmental gain.

Our contingency plans for responding to pollution include both preventive work and crisis management. Regular exercises are implemented on all WW ships. Our attitude and behaviour towards the media will be characterised by openness and an acceptance of the general public's need for information.

We acquired product and equipment supplier Unitor in the summer of 2005. This acquisition is in line with our strategy of

expanding in the maritime service industry. Operationally, Unitor has been incorporated in Wilhelmsen Maritime Services.

Including Unitor in our group gives us a unique opportunity to work actively on developing environmentally-adapted products for the shipping industry.

As part of an international business, we actively support efforts to establish a common international regulatory regime. We believe that international regulations administered by a collective body will provide better overall environmental protection than a number of regional and national requirements. Regulations for international maritime activities are provided by IMO. The WW group influences this agency's environmental work through active contact with the international organisations, shipping associations and national government bodies represented on the IMO.

Finding the most appropriate and cost-effective solutions calls for research and technological development. We have accordingly established an innovation programme which embraces the development of new technology to reduce negative environmental influences. As part of this programme, we collaborate actively with various research institutions and professional teams at national and international level.

We have focused in this report on optimising shipboard energy consumption, which allows environmental emissions and discharges to be reduced as a direct result of using less fossil fuel. ■



Ingar Skåug  
Group CEO, WW ASA



# THE MOST IMPORTANT ENVIRONMENTAL IMPACTS OF THE BUSINESS

The WW group takes environmental challenges seriously. Various aspects of vessel operation which have consequences for the environment are described below, together with measures WW has adopted or wishes to adopt to minimise the environmental impact of the business.

## OPERATIONAL DISCHARGES TO THE SEA

This category embraces such aspects as waste, discharges of bilge and ballast water, toxins from antifouling and the risk of oil spills in the event of accidents or excess bunkering.

### Ballast water

Ballast water often needs to be taken on when a vessel is not filled with cargo, in order to keep the propeller submerged and to provide sufficient stability. In certain cases, ballast water can be needed even when the ship is laden. It is pumped into the vessel in one port and out in another. Large volumes of water are frequently required to achieve the necessary stability. This depends on the type of vessel, its size and how it is loaded. A typical ro-ro carrier has a ballast-water capacity of about 13 000 tonnes.

Much attention has been given to ballast water after the undesirable spread of new types of algae, plants and marine organisms has been registered in certain areas. One cause is the shipment of ballast water from one port region to another. The expansion of these new arrivals can displace existing species through competition over food. Another challenge is posed by organisms which foul power station intakes and coolant systems, as in the North American Great Lakes where zebra mussels have flourished. This costs the US community several hundred million dollars per year.

Bacteria which could cause dangerous epidemics may also be spread in ballast water.

The International Maritime Organisation (IMO) recently established regulations for ballast water treatment. In the longer term, these will require the installation of shipboard systems which neutralise marine organisms in ballast water before it is pumped out. The new IMO regulations have not been ratified, nor are any approved systems for ballast water treatment commercially available on the market.

WW's aim is to reduce or eliminate micro-organisms in ballast water and to limit the intake and discharge of such water where possible. A system for handling ballast water has been adopted in the WW fleet, along with a plan for internal transfer of ballast between

the tanks. When the ships are in deep water on the high seas, the ballast water is replaced in order to ensure that the seawater on board is as clean as possible on arrival in port. WW also participates with its vessels in regular sampling of ballast water in connection with studies initiated by foreign government agencies.

To increase understanding of this problem and ensure an optimal treatment of ballast water, a special training programme has also been established for the group's officers. Continuous training and education will ensure that this issue is tackled in the most environment-friendly possible manner.

### Antifouling

Antifouling coatings are intended to prevent marine growth on the vessel hull. Keeping a hull as smooth as possible reduces fuel consumption, and thereby exhaust fumes. The drawback with traditional antifouling is that they not only kill weeds and other foulings but also add toxins to the sea. This applies particularly to the tin-based TBT coatings.

The IMO has banned the application of tin-based antifouling, but it is still permissible to operate vessels which have been coated in this way. From 2008, however, all ships must be coated with a tin-free product.

WW's ships are already coated with tin-free antifouling. Good contacts are maintained with coating suppliers, and the group is involved in a Norwegian research project engaged in evaluating other types of antifouling. WW is currently testing silicon-based products – which are wholly non-toxic – on propellers and rudders.

### Bilge water

Polluted oily water will always occur on a ship as a result of cleaning engine rooms and machinery components, exhaust boilers and the like.

In addition, bunkers contains water which must be removed in the ship's oil/water

separator. The oily water is stored in special tanks and was formerly discharged directly to the sea. Today, it has to undergo a treatment process before being released. The recovered oil must be delivered to land in an acceptable way for further treatment.

Discharging illegal quantities of oily residues from ships has long been a known problem. In recent year, heavy fines and in some cases prison sentences have been imposed on people found guilty of such illegal dumping.

The IMO's regulations require that oily water discharged to the sea must contain less than 15 parts per million (ppm) of oil. These rules also specify the distance from land and the vessel's speed.

Managing oily water calls for great attention from the crew and the management on land. WW is endeavouring to develop new equipment for treating such waste which will reduce its oil content to five ppm, significantly below the IMO requirement. The group is also installing upgraded metering equipment to ensure improved registration and better security for discharges. On newbuildings and when replacing existing systems, WW is assessing separators and other hardware which can reduce discharges below the level set in existing regulations.

In addition to organising international conferences on this issue, WW has made oily water discharge an important subject in its in-house training of seafarers.

### Waste

Waste management can be a challenge for certain types of ship, particularly cruise liners and passenger ferries which have to deal with large volumes of refuse.

The IMO has established regulations for waste treatment, including requirements for incinerators on ships.

WW's ships have established a plan for waste management and sorting. The newest vessels in the fleet are fitted with their own waste treatment centres. Experience with these facilities will be assessed with a view to establishing similar installations on all the vessels.



Combustible shipboard waste is burnt in the vessel's incinerators. Ships are required to return hazardous waste to land. This cannot be accomplished in certain ports because of the lack of receiving facilities. WW is also concerned to see unnecessary packaging returned to land before the ship leaves port. It is easier to process waste on land than at sea.

### Chemicals

Various types of chemicals are used on ships, including substances required for special cleaning of machinery components or as additives to boiler water. Many of these chemicals are harmful to the environment, but less damaging alternatives can also be found. WW is concerned to use the least harmful product where such an option exists.

When cleaning components, part of the water containing the chemicals will end up in the oily water collection tanks. Separating out the more environmentally-favourable products from this water can be a problem because of the way the oil is distributed as fine particles (emulsion). A solution for an environmental problem in one process can thereby easily present different challenges in another process.

WW wants to reduce the quantities of chemicals used, and keeps statistics of its purchases.

### Accidents

Accidents at sea can happen, and may have disastrous consequences for those on board and for the environment. The scope of such accidents can be extensive because of the size of vessels and the substantial volumes of oil and chemicals they carry. In many cases, human error is both the direct and the indirect cause of an incident. New regulations are often introduced in the wake of major accidents.

The WW fleet carries limited quantities of oil and chemicals. Oil volumes are largely confined to bunkers, required to drive the ship and generate electricity, lubricants for machinery, hydraulic oil for ramp systems and the like.

Accidental spills present a constant risk. WW focuses on preventing accidents at sea,

and is particularly concerned to train personnel both at sea and on land. Focused training programmes are pursued, partly by the group's own training centre for seafarers at Mumbai in India. A high level of emergency preparedness and well-drilled routines can limit the consequences should an accident nevertheless occur.

The group cooperates closely with the Vestfold Regional College in Norway to hold regular seminars specially developed for WW officers on safety training in critical conditions. Emergency response exercises for handling accidents are staged regularly both at sea and on land.

A total of roughly 10 litres of oil was leaked in 2005 from the hydraulic system on the stern ramp on one of the WW ships.

### OPERATIONAL EMISSIONS TO THE AIR

Emissions to the air consist primarily of combustion gases from the main and auxiliary engines as well as refrigeration plants, vaporisation from the cargo, and leaks from refrigeration and fire fighting systems. An internationally-accepted standard is used to measure combustion gases in grams per tonne cargo transported per kilometre (g/t-km).

The quality of bunkers oil for ships is unfortunately declining. A consequence of rising demand for more refined products which are worth more to the oil companies, this trend helps to boost fuel consumption by vessels which contributes in turn to increased emissions. WW also regards with concern the tendency for the average sulphur content to rise in heavy oil for the world fleet.

### Sulphur oxides

Bunkers oil used as fuel in ship's engines contain sulphur. The amount depends on where the crude oil comes from and how it has been refined. Some crudes, such as those

from the North Sea, have a low sulphur content while ones produced in other parts of the world contain higher quantities.

A typical marine bunkers oil contains about 3.5% sulphur. When the oil is burnt, the resulting combustion gases contain sulphur oxides. About 4% of global sulphur oxide emissions are estimated to come from marine transport. These substances present a health hazard and can cause serious respiratory problems. They also contribute to acid precipitation.

The best method of reducing such emissions is to use bunkers with a low sulphur content, since sulphur oxide volumes are proportionate to the amount of sulphur in the oil. Such fuel oil is in short supply because demand so far has been low. Its price is also significantly higher because it costs more to produce. Using low-sulphur bunkers also presents certain technical operating challenges.

Particulates in exhaust fumes are another source of pollution. Reducing the sulphur content in bunkers also cuts the volume of such particulates.

Both the European Union (EU) and the IMO have adopted standards for the sulphur content in bunkers as well as other measures to reduce emissions. An international maximum level of 4.5% for sulphur in bunkers was introduced in 2005. From 2006, ships sailing in the Baltic will only be able to use fuel with 1.5% sulphur. This requirement is due to be extended to the North Sea in 2007. These two regions are defined as sulphur oxide emission control areas (SECAS). California will also introduce a regional requirement in 2007 which demands that diesel or gas oil be used in all auxiliary engines – used for power generation – when entering or staying in any port in the state.

The WW fleet consumed some 383 000 tonnes of bunkers in 2005, with an average sulphur content of 1.72%. This yielded an additional cost for WW's overall activities of about USD 12 million – a clear expression of the group's desire to help reduce environmentally-harmful emissions.

As an alternative to reducing the sulphur

*cont on page 7*



**SARATH RAJ**  
**NAVAL ARCHITECT**  
**WILHELMSSEN MARINE CONSULTANTS**  
**(FORMERLY BARBER MARINE CONSULTANTS)**

*Sarath Raj was born at Cochin in the Indian state of Kerala, and is a naval architect working on various project for the WW group as well as external clients. He has been employed since 2003 by Barber Marine Consultants, which became Wilhelmsen Marine Consultants (WMC) in April 2006. This change of name involves few differences, and WMC will still offer its services through Wilhelmsen Maritime Services.*

WW takes environmental challenges seriously. In addition to being a prime mover in establishing internationally-recognised and accepted environmental standards, the group devotes substantial resources to developing environment-friendly solutions for vessel operation.

“Although WW operates with an environment-friendly fleet, we still have scope for developing more energy-optimal and environmental solutions,” says Sarath Raj. “We also have opportunities for safety improvements and other solutions which make shipboard operation simpler and better. I’m glad WW is making a commitment to research and development, because innovative thinking is needed if we’re going to be able to develop new and better solutions.”

Barber Marine Consultants, which became Wilhelmsen Marine Consultants in April 2006, is responsible for designing new ships and conversions of older vessels. It pursues substantial research and development on energy optimisation and environmental protection. The new series of car carriers under construction at the Mitsubishi Heavy Industries yard in Nagasaki, Japan, incorporates a number of advances.

“We’ve moved the oil tanks away from the vessel sides, for instance,”

reports Raj. “That reduces the likelihood of oil leaks in the event of hull damage. The hold has also been optimised to increase cargo capacity, improve manoeuvrability on the cargo deck and enhance the efficiency of loading and discharging operations.”

Mitsubishi Heavy Industries has also contributed with a new hull form as well as a stator fin to boost propeller efficiency. That helps to reduce the vessel’s energy consumption and greenhouse gas emissions.

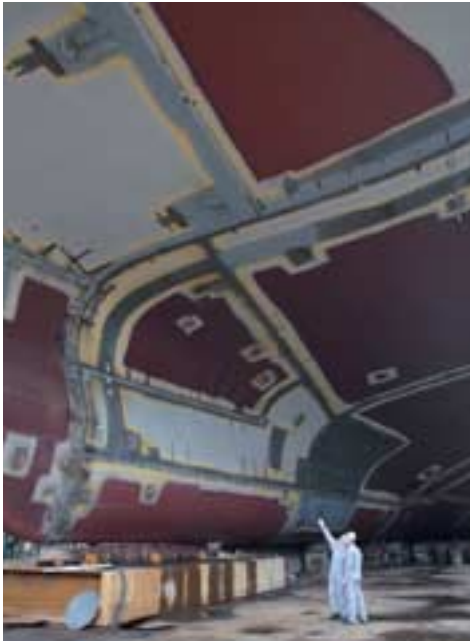
“Although I haven’t been personally involved in developing the latest advances on these ships, I apply these ideas when working on new generations of car carriers,” says Raj.

Work at Wilhelmsen Marine Consultants is not confined to designs for the WW group’s ships, he adds.

“In addition to contributing to the development of a new generation of ro-ro carriers for Wallenius Wilhelmsen Logistics and various modifications to the Mark I vessels in Wilhelmsen Lines Shipowning, I have a number of projects for external clients. During 2006, these will include tanker conversions as well as newbuilding projects.”



WW is building eight new car carriers at the Mitsubishi Heavy Industries yard in Nagasaki, Japan. A number of innovations for optimising energy consumption are being installed on these vessels to reduce the amount of fuel they burn and thereby their environmental impact. The pictures show construction of one of the carriers, which will be ready for delivery in the spring of 2006.



emissions from new engines. A nitrogen oxide certificate is issued on delivery of a newbuilding, and the validity of this document assumes that replaced/maintained engine components are approved by the engine supplier.

Reduction of nitrogen oxides is influenced in part by engine technology solutions which improve the combustion process. WW's new vessels have engines which lie below the prevailing IMO requirements.

WW's goal is to reduce the fleet's average nitrogen oxide emissions per unit transported by 25% over an eight-year period (2000-08). Installing a new type of fuel valve will provide better combustion control, which in turn reduces nitrogen oxide emissions. Building new ships results in improved engines with much lower nitrogen oxide emissions than older types. With the newbuildings currently on order, WW is therefore well placed to reach its target.

#### Carbon dioxide

Carbon dioxide influences the greenhouse effect. Carbon emissions from ship's engines are directly related to fuel consumption. Measures to optimise energy consumption, combined with well-motivated crews, help to reduce these emissions. Burning one tonne of bunkers oil releases about 2.8 tonnes of carbon dioxide.

The Kyoto protocol does not apply to international shipping, and no international regulations currently apply to carbon emissions. However, the IMO encourages voluntary reporting of carbon dioxide emitted.

WW seeks high operating efficiency for ship's engines in its fleet. This yields low fuel consumption and thereby reduces carbon dioxides emissions. Efficient ship design with good energy utilisation and energy-saving operational measures help to cut the release of greenhouse gases.

#### Refrigeration and fire fighting gases

Leaks from refrigeration and fire fighting systems can result in the release of hazardous gases to the air. Older refrigeration systems use refrigerants which contain hydro-chlorofluorocarbons (HCFCs), while older fire fighting systems often contain halon. Both these gases help to deplete the ozone layer.

In addition to the Montreal protocol, IMO

regulations cover the use of environmentally-harmful greenhouse gases on vessels. The EU has additional regulations.

Refrigerating systems on WW ships are used to keep provisions cold and for air conditioning in the crew quarters. None of its vessels have refrigerating systems on the cargo decks. The environmental impact of its fleet is therefore limited. At the same time, emissions of refrigerants are continuously monitored on the basis of the quantities purchased and stocks on board each vessel. WW is also replacing older refrigerants with more environmentally-adapted products.

#### Recycling of ships

A ship has a normal life of 20-30 years depending on the quality of its materials and construction solutions and the extent of its maintenance. Steel corrosion, particularly in the ballast tanks, is frequently crucial for the lifetime of the vessel.

Once a ship is too old for operations, it is sent for scrapping. Depending on such factors as its age, the vessel could contain toxic and environmentally-harmful materials which need to be handled in an acceptable manner.

No international regulations govern the scrapping of ships. However, this challenge is on the agenda for the IMO, the Basel Convention and the International Labour Organisation (ILO). The IMO has drawn up guidelines for scrapping, but these are not mandatory. Norway will contribute to the adoption of binding standards which help to protect health, safety and the environment during scrapping.

WW's ships have an economic life of roughly 30 years. The group is concerned that vessels are recycled in an acceptable manner for health and the environment. When ordering new tonnage, careful consideration is given to the materials used in order to ensure the most acceptable possible process when the vessels are later recycled. ■

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content in bunkers, the regulations permit the use of technology which removes sulphur oxides from exhaust fumes. Such equipment is currently under development. WW is contributing actively to a project being run by the Norwegian Shipowners Association to study opportunities for reducing sulphur oxides in exhaust fumes.

#### Nitrogen oxides

Nitrogen oxides are a product of the combustion process in ship's engines. Estimates indicate that shipping accounts for about 7% of the nitrogen oxides emitted worldwide. They cause the build-up of an unhealthy smog and formation of ground-level ozone as well as contributing to acid precipitation.

IMO requirements limit nitrogen oxide

# TOPIC OF THE YEAR: ENERGY OPTIMISATION

This year's topic focuses on energy optimisation on vessels, which embraces a number of measures with the collective aim of reducing shipboard energy consumption. In addition to sparing the environment from unnecessary burdens, such optimisation provides various benefits in terms of transport economics.

By implementing a range of measures from design to voyage planning, WW can help to develop the most economic fleet in energy terms. Various energy-saving measures are presented below.

## SHIPPING AS A TRANSPORT MODE

Generally speaking, maritime transport is an environment-friendly mode of transport when measured in energy units per quantity of cargo carried and distance. The speed of a vessel is also limited by comparison with road transport, which again contributes to a good environmental performance. This is because the higher the speed, the higher the emissions. A typical WW ship is designed for a speed of around 20 knots.

Although ships are a good way of transporting commodities in environmental terms, the world's merchant fleet consumes a great deal of energy which in turn generates harmful emissions. The fuel used on ships is an oil product which ranks amongst the heaviest grades to emerge from the refining process. Compared with lighter oil products such as petrol, paraffin and aviation fuel, these heavy fractions contain several polluting components such as sulphur and other environmentally-harmful substances. Polluting substances which are difficult to detect can also be added to heavy oil. Minimising fuel consumption, and thereby emissions of combustion gases, is therefore important. Last but not least, bunkers oil is a fossil fuel and accordingly non-renewable.

## OPTIMUM SHIP DESIGN

When designing and building new vessels, WW devotes considerable work to developing and testing various energy-saving solutions. This activity is pursued by Wilhelmsen Marine Consultants (WMC, formerly Barber Marine

Consultants), which forms part of Wilhelmsen Maritime Services (wholly owned by WW). In addition to design, WMC is responsible for supervising WW's newbuildings.

Shipyard specifications, drawings and solutions are discussed in detail before making the final choices. Hull and propeller solutions are tested in ship model tanks in the hope of achieving constant reductions in vessel resistance to the sea and thereby cut fuel consumption.

WW has ordered eight new carriers from Mitsubishi Heavy Industries (MHI) in Japan, of which three have already been delivered. Two more are due to delivery in 2006, with the final three scheduled for completion in 2007 and 2008.

Big improvements in terms of fuel consumption have been made on these vessels by comparison with earlier ships. This reflects in part a new hull form which reduces resistance to the water. MHI has also patented a stator fin which is placed on the rudder to utilise residual energy from the propeller. An advanced propeller design and an energy-saving main engine complete the picture.

Cargo capacity has also been increased on these carriers by design measures which achieve better utilisation of the cargo holds. This reduces emissions per unit carried.

The overall result is not only good transport economics, but also major environmental gains in the form of lower emissions. These new carriers accordingly provide a good example of the way environmental benefits can also yield good economic solutions.

## OPTIMISING SHIP'S ENGINES

The ship's main engine consumes large quantities of bunkers oil. A modern ro-ro carrier uses in the order of 50 tonnes per day, or roughly 15 000 tonnes a year. Keeping the main engine and its auxiliary systems in the right condition makes it possible to save 1-3% fuel. That could reduce annual consumption for the WW fleet by almost 500 tonnes per ship.

At a bunkers price of just under USD 300 per tonne, such a reduction could have a substantial cost benefit – almost USD 150 000 per vessel on an annual basis. At the same time, emissions per ship would be cut by roughly 1 400 tonnes of carbon dioxide, around 15 tonnes of sulphur oxides and about 38 tonnes of nitrogen oxides.

Qualified crews on the ships and a professional management department on land help to ensure that the engine and its systems are in good condition. A number of measures can be taken to ensure optimum operation of the propulsion machinery:

- prevent soot and deposits in exhaust channels which reduce engine efficiency
- monitor exhaust temperature, which gives a lot of information about engine condition
- adjust the fuel pumps and nozzles to ensure correct combustion
- monitor consumption of cylinder oil for correct combustion and wear on pistons and cylinder linings
- analyse the quality of bunkers oil and ensure that equipment for processing this fuel is in good condition.

## CLEAN HULL AND PROPELLER

The underwater hull on a ship is coated with an antifouling to prevent the growth of unwanted organisms. Traditional antifoulings contain metal compounds such as copper. Tin compounds were often used before. Although such substances are very effective, they are also highly toxic.

The International Maritime Organisation (IMO) has banned the use of such materials for environmental reasons. By 2008, all ships must use tin-free antifoulings. WW's vessels already meet this requirement.

Even though a ship is coated with an antifouling, algae and other marine organisms

will still grow on the hull. The extent of such growth depends on the kind of antifouling applied and the amounts used. The time between antifouling applications (the docking interval) and the waters in which the ship sails are also important factors. A fouled hull and propeller increase the ship's water resistance by 5-20%. The degree of resistance depends on the quantity and type of fouling (algae, barnacles or the like). Higher resistance boosts fuel consumption if vessel speed is to remain unchanged from a smooth hull condition. That in turn increases emissions of environmentally harmful combustion gases and soot particles.

WW's fleet is docked at 2.5-year intervals. In addition to maintenance of the whole vessel, algae and other marine organisms are cleaned from the hull and new antifouling applied. It is also possible to send divers below the ship with rotating brushes. And growth can be removed by remotely-operated vehicles (ROVs) equipped with the necessary cleaning tools. If the ROV tool is not in direct contact with the antifouling, this protects the coating while reducing the amount of toxin released.

The WW group pays close attention to the condition of the underwater hull and propellers, and undertakes the necessary cleaning if growth is of a nature which increases resistance to the sea.

## VOYAGE PLANNING

A number of WW's ships sail in dedicated trades where the loading and discharging ports as well as departure and arrival times are predetermined. This means that voyages can be planned to a much greater extent than for vessels where these parameters are not known. Systematic voyage planning combined with a well-motivated crew can reduce bunkers consumption by 5-15%.

On the long intercontinental voyages, WW's ships are in contact with weather forecasting services which provide advance information about conditions along the relevant routes. On the basis of this information, the optimum route can be chosen to avoid as much bad weather as possible. The weather forecasts are continuously updated during the voyage so that plans can be adjusted. It is not given that the shortest distance in nautical miles is necessarily the most economic in energy terms.

The vessel's resistance increases with bad weather and opposing currents if speed is to be maintained. This boosts fuel consumption and thereby emissions. Extremely bad weather also increases the risk of shipwreck as a result of moving cargo, damage to the hull and/or engine breakdown, with the consequences that this can have for crew and the environment.

## CHOICE OF SPEED

Communication between the ship and its operator is important to ensure that the right speed is chosen for reaching its destination. A 1% increase in speed could boost bunkers consumption by more than 3%. If the vessel arrives at port and has to wait to load or discharge, the increased use of bunkers combined with the waiting time will give a poor result in terms of energy economics.

## CARGO PLANNING

The vessel's resistance increases with its draught. The deeper it is laden, the higher its fuel consumption. Some ships need ballast even when fully laden. That relates to their centre of gravity and stability. Heavy loads placed on decks high up the ship must often be compensated with ballast lower down to ensure that the right stability is maintained. Carrying too much ballast means unnecessary use of energy. Replacing ballast with cargo wherever possible is better transport economics. This makes cargo planning very important to ensure that consignments are correctly positioned in terms of both accessibility and stability.

*cont on page 11*



*Top: A number of measures to optimise energy use help to reduce fuel consumption by the ships and their consequent emissions/discharges of environmentally-harmful substances. Mitsubishi Heavy Industries has developed a stator fin to get more energy out of the propeller, for instance.*

*Centre: Another measure is analysis of the oil used. Third engineer Kenneth Siatong on Toledo analyses lubrication oil.*

*Above: Voyage planning is a third method. Captain Euclides C Ladines on Toledo charts an optimum route based on the latest weather forecast.*



**ASLE ROAR OLSEN**  
**INSPECTOR**  
**BARBER SHIP MANAGEMENT**  
**WILHELMSSEN MARITIME SERVICES**

*Asle Roar Olsen from Kristiansund in Norway is the inspector for WW's Mark IV carriers – Tamerlane, Tamesis, Talisman and Tarago. He is responsible for ensuring that these vessels operate in a safe, environment-friendly and efficient manner, and in accordance with international laws and regulations. Starting as a ship's boy in 1977, he became an inspector in 1997.*

Although shipping is one of the most environment-friendly ways of transporting commodities, vessel operation embraces a number of processes which collectively affect the natural environment.

“As an inspector, I’m responsible for ensuring that the ships I monitor operate in a way which minimises their environmental impact,” says Asle Roar Olsen. “Regular inspections of all technical equipment on the vessels ensure that they work as efficiently as possible. We also ensure that the crew knows how machinery and other technical equipment should be operated in order to reduce the environmental burden to a minimum.”

He was involved with five dockings in 2005. “We never know what to expect when the ship’s underwater hull comes into view. So it’s always just as exciting when we dock a vessel and inspect its bottom, rudder and propeller.”

Olsen explains that ships in the WW fleet are dry-docked every 2.5 years, and adds that the group wants to maintain a high standard for its vessels and accordingly docks them more often than the rules require. All the vessels are also visited by inspectors when they are in European waters, around three times a year.

“Frequent maintenance reduces the likelihood of major damage during operation, and accordingly makes an important contribution to a ship’s economic life.

“An important part of the docking is the removal of barnacles and other marine organisms from the hull. A clean hull and propeller reduces the vessel’s friction against the sea, with lower fuel consumption and ultimately smaller emissions of polluting substances as the result.

“In cooperation with the crew, I’m responsible for ensuring that all technical equipment is in tip-top condition, and that the vessel operates in a safe and environment-friendly manner. Frequent inspections and close dialogue with crew increase the likelihood that everything functions in an optimum way and reduces the possibility of anything going wrong. If anything functions less efficiently than we might prefer, we quickly come up with solutions to overcome the problem.”



Inspector Asle Roar Olsen inspects work done on the rudder together with a representative for the Tsuneishi yard, where Tamerlane was docked in January 2006. Electrician Arne Schaufel on Tamerlane checks all the electrical equipment on the bridge after maintenance work.

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## TRIM

A ship's resistance to the sea also varies with its trim, defined as vessel's fore-and-aft angle to the water. Poor trim can cause an energy loss of 2-4%. The optimum trim varies with the ship's draught but also with its speed. Model trials with a vessel at the design stage is a common way of determining its optimal trim.

## SHIP OF THE FUTURE

Wallenius Wilhelmsen Logistics (WWL – owned 50-50 by WW and Wallenius Lines) wanted to develop a conceptual vessel for Expo 2005 in Japan. In cooperation with Wilhelmsen Marine Consultants (formerly Barber Marine Consultants), it created E/S *Orcelle*. E/S stands for "environmentally sound".

Named for a south-east Asian dolphin threatened with extinction, this vessel does not use fossil fuel but relies on sun, wind and waves.

A model of the ship was exhibited in the Norwegian pavilion at the world exposition, and attracted a great deal of attention. The purpose of the project for WWL was partly to stimulate research and development relating to alternative energy sources.

Although the conceptual model will not see the light of day in the near future, WW intends to continue research on certain of the elements identified in the development of *Orcelle*.

## SUMMARY

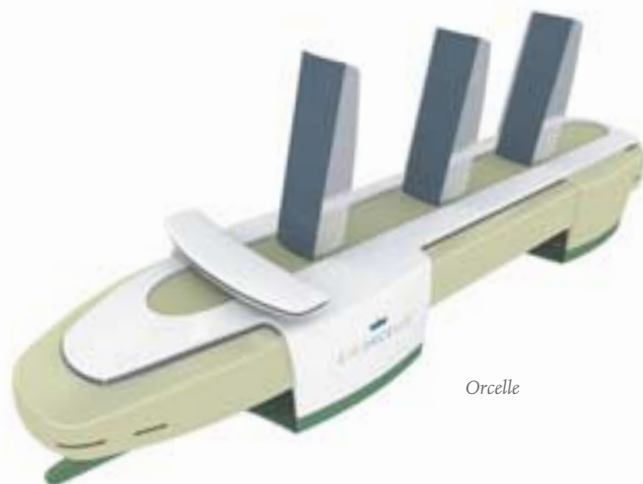
Accepting a conscious responsibility for the environment and being a driving force for vessel operation which causes the minimum

environmental impact are important to WW. Developing and implementing energy-efficient solutions are an important part of this responsibility.

Work on new energy-efficient solutions will continue in 2006. These solutions have a big intrinsic value in relation to the impact of WW's business on the environment. Their development will also be influenced by a number of external factors. High bunkers prices encourage research on the use of alternative energy sources. Rising taxes on environmentally-harmful emissions/ discharges, more stringent national and international environmental standards, and

tougher environmental requirements from cargo owners will stimulate not only research but also the phasing-in of environmentally-adapted solutions and products.

WW will be involved during 2006 in projects looking at the treatment of exhaust fumes from the ship's main engine. It will also play an active role in seeking solutions to the ballast water issue. In addition, the group is pursuing a number of other projects which will hopefully yield energy-efficient solutions in coming years. ■



Orcelle

# ENVIRONMENTAL WORK IN WW

WW comprises a number of companies, and the management of each of these lays the basis for environmental work through the company's quality assurance system.

Environmental targets for vessel operation have been developed jointly by Wilhelmsen Lines Shipowning and Barber Ship Management (ISO 14001 certified). The management organisation for each ship is responsible for technical monitoring and for recommending environmental measures which should be implemented on board.

The master on each ship is responsible for daily follow-up, and for taking the necessary action to protect the marine environment.

In close cooperation with Wallenius Wilhelmsen Logistics (owned 50-50 by WW and Wallenius Lines), WW works continuously on environmental issues. Common goals and status are discussed at annual environment meetings.

A number of WW subsidiaries have established an environmental management system and are ISO 14001 certified by Det Norske Veritas. This certification includes vessels controlled by Wilhelmsen Lines Shipowning, which means in part that an

environmental programme has been drawn up and an environmental committee established. The latter meets at least three times a year, and is responsible for setting targets and monitoring progress for the programme. An extract from the environmental programme covers the most significant aspects in WW. See page 13.

WW has its own inspection programme in which every ship is visited once a year by in-house safety inspectors. These inspections focus on health, safety and the environment. In addition to conducting an assessment of vessel condition, the crew are interviewed and emergency response exercises are staged. Courses are also given on board, and discussions held on how the crew – both alone and in cooperation with the land organisation – can achieve further improvements in safety and environmental protection.

Wilhelmsen Maritime Services (previously Barber Marine Consultants) works on solutions which improve the environmental impact of new and existing WW ships, and the aim is to work continuously on achieving vessels which have a minimal impact on the environment.

WW keeps updated about and is engaged with environmental developments relating to shipping. The group is represented at various conferences and seeks to convert learning and knowledge into action on its vessels.

A collaboration was initiated during 2005 between WW and Norway's Bellona

environmental foundation. The two sides discuss environmental impacts and priority areas, and jointly develop constructive solutions.

WW is actively involved in a forum organised by the Norwegian Shipowners Association on reducing sulphur emissions from ships. This body comprises a number of Norwegian shipping companies together with representatives from engine manufacturers, oil producers, consultants and research communities. Experience and knowledge relating to the use of low-sulphur oil is exchanged through the forum. WW is also actively involved in a working party assessing the treatment of exhaust fumes to remove sulphur oxides.

Vessel operation is constantly developing, and many of the measures being tried out today on individual ships aim to reduce the emission/discharge of polluting substances. If the results are successful, WW's intention is to extend their use to more ships in coming years. Where the most significant environmental aspects are concerned, procedures and long-term goals have been established in which performance and status are regularly reviewed. ■



A fouled hull and propeller can increase vessel resistance in the water by 5-20%. During a docking, barnacles and other marine organisms are removed from the underwater hull and a new coat of tin-free antifouling applied.

EXTRACT FROM THE ENVIRONMENTAL PROGRAMME FOR 2005

ASPECT	AIR	SEA	OTHER	OBJECTIVE	TARGET	MEASURES	STATUS
NO <sub>x</sub> main engine operations	x			Reduce NO <sub>x</sub> emissions	Reduce NO <sub>x</sub> emissions per unit transported by 25% within eight years (2000-2008).	Install slide valves on Mark IV ships in 2005. NO <sub>x</sub> measurements on main engines in newbuildings.	Not completed because of problems with cylinder linings. Installation will be continued in 2006. NO <sub>x</sub> measurements carried out on engine test bed.
NO <sub>x</sub> main and auxiliary engine operation	x			Reduce sulphuric acid emissions	Reduce SO <sub>x</sub> emissions by using low-sulphur bunkers. Wallenius Wilhelmsen Logistics' bunkering instruction to be observed.	Efficiency of low-sulphur operation under evaluation for auxiliary engines. Exchange of experience with other operators. Bunkers data recorded.	EU directive observed. Marine diesel oil (MDO) with max 0.2% used for auxiliary engines which run on MDO. Average sulphur content in oil on WW ships was 1.72% in 2005.
Antifouling	x			Longer docking intervals than 2.5 years	Reduce antifouling use. Evaluate results.	Planning longer intervals than every 2.5 years between dockings. Followed up at next environmental meeting.	Experience with tin-free antifouling is worse than expected for growth. Outcome is higher fuel consumption and more frequent cleaning of underwater hull. Longer interval between dockings cannot accordingly be recommended.
HCFC (R-22)	x			Reduce pollution of the environment	Registered quantity consumed in 2004 to be reduced by 5% during 2005. Environment-friendly refrigerants used on Mitsubishi newbuildings.	Follow up consumption in 2005. Evaluate whether R404 refrigerant is an environment-friendly alternative.	Results for refrigerant use in 2005 will be available in mid-February 2006. On-going evaluation of alternative refrigerants. <i>Taiko</i> plans to replace air-conditioning system in 2006. Another ship to follow later in same year. New 134a refrigerant.
Chemicals and cleaning agents	x	x		Reduce use of environmentally-harmful chemicals	Produce statistics of purchased chemical quantities. Two ships will use environmentally-adapted products for testing.	Prepare statistics of purchased quantities. Test ships: <i>Tamesis</i> and <i>Takasago</i> . Evaluate consumption and efficiency.	Test results of more environmentally-adapted products will be evaluated. Preparing a new programme for 2006.
Bilge water		x		Reduce polluting discharges of oily water to the sea	Install 5 ppm oil/water separators on existing ships. Wilhelmsen Lines Shipowning's ships to be fitted with 5 ppm separators.	Install 5 ppm separators on two Wilhelmsen Lines Shipowning vessels ( <i>Tasco</i> and <i>Tagus</i> ) during 2005.	Will be installed in 2006 because of pressure on delivery dates ( <i>Tagus</i> Jan 2006, <i>Tasco</i> Sep 2006).
Painting		x	x	Use more environment-friendly paint on board	Evaluate environment-friendly paint. Be updated about new products. Return empty paint cans to supplier.	Ask paint suppliers for advice. Follow up new products at all times. Cooperate with suppliers over measures.	Few acceptable environment-friendly paint alternatives. Follow developments.
Ballast water		x		Eliminate micro-organisms in ballast water	Follow developments in ballast water management and the development of IMO regulations.	Discuss the ballast water issue in meetings of the environment committee and follow up decisions.	Continue to follow up various types of equipment which are being tested.
Consumption of cylinder oil		x	x	Reduce cylinder oil consumption	Install slide valves on four ships. Install swirl injection principle (SIP) system on newbuildings from Mitsubishi Heavy Industries.	Slide valves to be installed on four ships in service during 2005. Installed SIP system in Mitsubishi Heavy Industries ships in 2005.	Will be installed in 2006. SIP system installed in Mitsubishi Heavy Industries newbuildings.
Environmental training	x	x	x	Enhance understanding of environmental issues	Enhance understanding.	Refresher courses for officers and crew in the first quarter of 2005.	Computer-based training course related to ISO 14001 has been sent to the vessels. Strong focus on environmental issues at all conferences for masters and other officers.

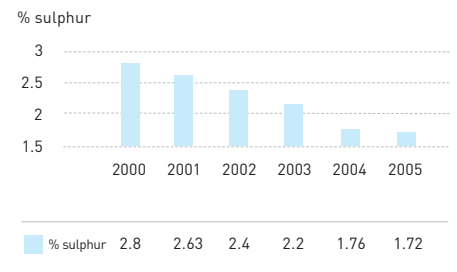
# REGISTRATION AND ANALYSIS

Barber Ship Management, which is responsible for ensuring that the vessels are operated safely, environmentally and efficiently, has developed its own computer system for registration and analyse of operational data as well as undesirable incidents and non-conformances. This information is compared with pre-defined quality parameters to ensure that the ships do not have unacceptably high levels.

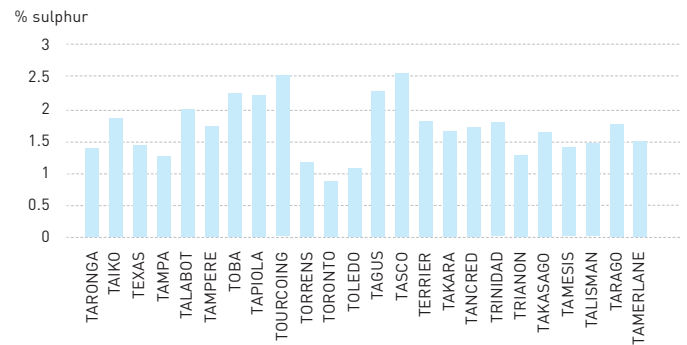
## SULPHUR CONTENT IN BUNKERS OIL

Ships owned by WW consumed about 383 000 tonnes of bunkers in 2005, with an average sulphur content of 1.72%. This resulted in an additional cost of about USD 12 million when the group's total activities are included.

The average trend for sulphur content in bunkers oil has shown a good decline since 2000. Over a five-year period, WW's fleet has reduced the sulphur content by 1.08 percentage points, corresponding to an improvement of almost 40%. It is difficult to achieve a further reduction from the present level because of a shortage of low-sulphur bunkers in the market.



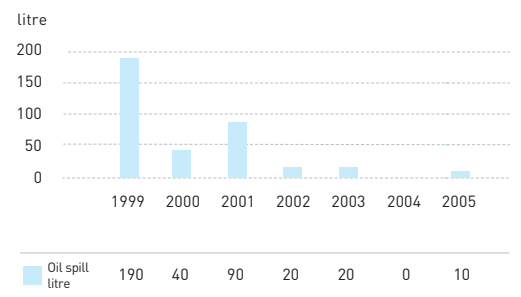
The graph to the right shows the percentage sulphur content in bunkers oil in 2005 for each of WW's vessels. The sulphur figures are based on laboratory measurements of samples taken every time the vessels load bunkers. Variations in the sulphur figures arise because some of the ships operate on routes where the availability of low-sulphur bunkers varies considerably. The bunkers quality of low-sulphur products varies in different geographical areas, and bunkers with a higher sulphur content must be used in some cases to ensure acceptable operation of the ships.



## OIL SPILLS BY THE FLEET

One accidental oil spill was registered in 2005, involving a total of 10 litres of hydraulic oil. Although this spill is regarded as very small, almost unmeasurable, and the oil in this instance had a high viscosity and vaporised easily, the WW group takes such incidents seriously.

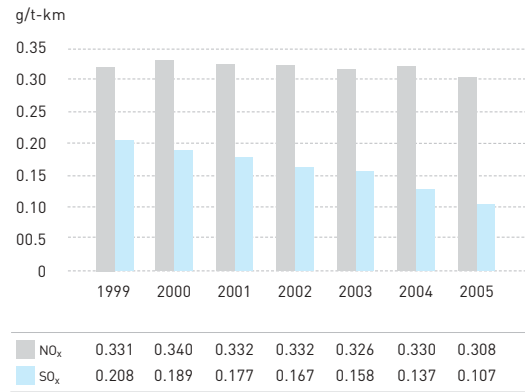
Good seamanship and routines have helped to yield positive results. The group seeks to prevent accidents through training and motivational efforts. Should an accident or incident occur, it will be analysed to identify the underlying causes so that similar episodes can be avoided.



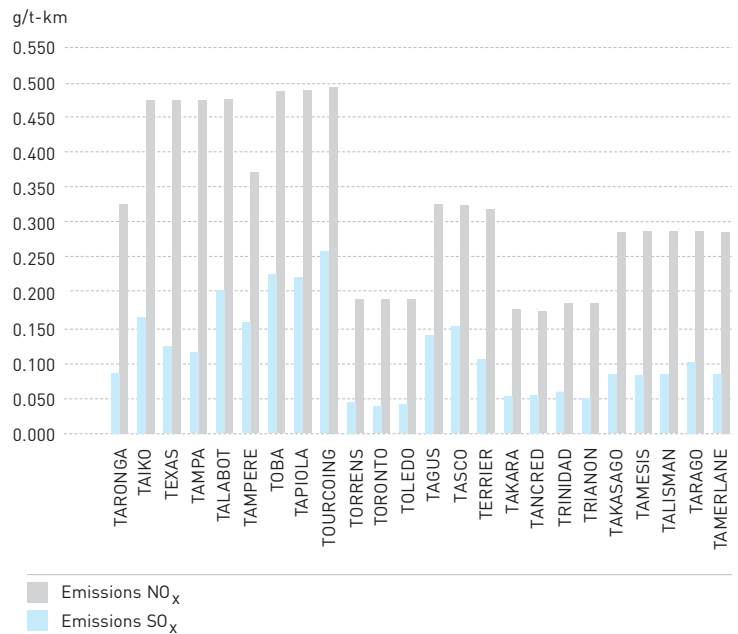
## FLEET'S TOTAL NO<sub>x</sub> AND SO<sub>x</sub> EMISSIONS

The graph shows average emissions for all WW-owned ships in 1999-2005. Registered emissions are calculated on the basis of the ship's service speed and cargo volume. Sulphur oxide (SO<sub>x</sub>) emissions are calculated on the basis of the registered sulphur content in the bunkers oil. Emissions of nitrogen oxides (NO<sub>x</sub>) are based on theoretical calculations from the ship's engines. These emissions are calculated in grams per tonne cargo transported per kilometre.

Emissions of nitrogen and sulphur oxides were reduced in 2005 compared with 2004. The availability of newer ships featuring environmentally-adapted ship's engines with improved combustion processes, as well as increased use of low-sulphur bunkers for the whole fleet, are factors contributing to the reduction.



The graph shows emissions of nitrogen and sulphur oxides for each of WW's ships. These emissions are calculated in grams per tonne cargo transported per kilometre. The variations partly reflect varying engine efficiencies between the ships, cargo hold volumes and sailing speeds. Newer vessels have lower nitrogen-oxide values, in part because of more environment-friendly engines. The sulphur content of bunkers oil also varies individually for each of the ships.

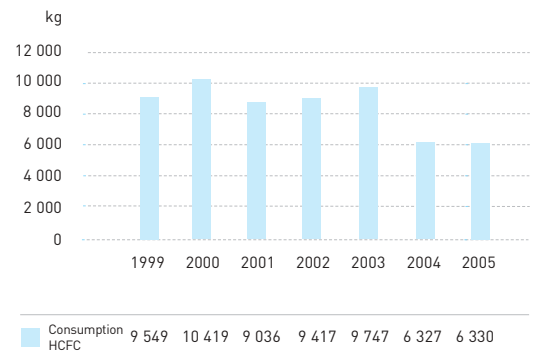


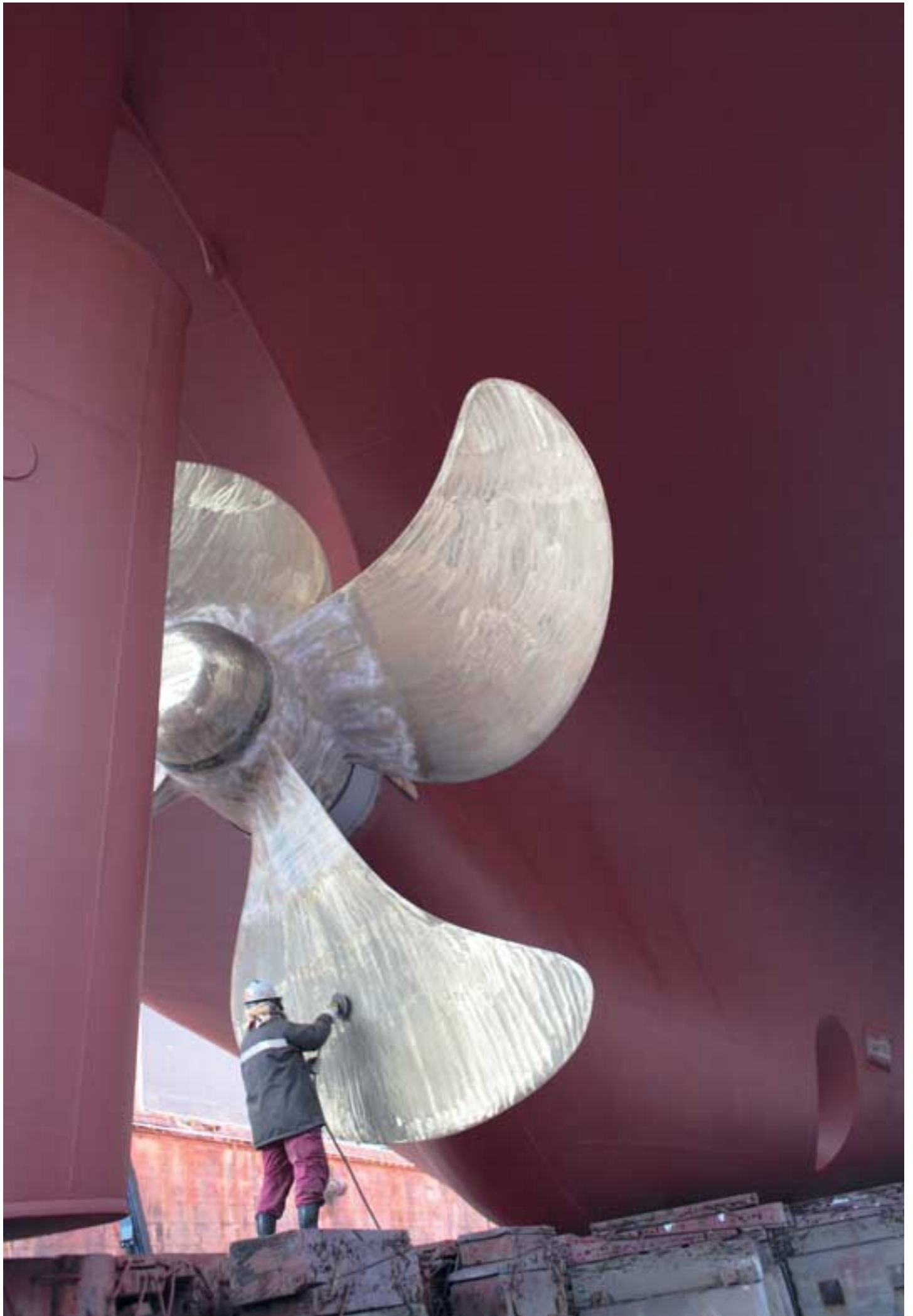
## FLEET'S CONSUMPTION OF REFRIGERANTS

The curve shows consumption of refrigerants (hydro-chlorofluorocarbons – HCFCs) since 1999. These substances are used in air conditioning plants and for keeping provisions cold.

WW's goal is to reduce the use of HCFCs and replace older refrigerants with more environmentally-adapted products. The volume of purchased coolants and the registration of stocks on each ship help the group to measure consumption and take action to achieve further improvements.

The 2005 figure includes the five Mark I ships. Allowing for these vessels, the actual reduction is around 7%.





# ENVIRONMENTALLY-ADAPTED PRODUCT DEVELOPMENT

Unitor was acquired by WW in the summer of 2005 and included operationally in Wilhelmsen Maritime Services.

Products delivered by Unitor include chemicals and refrigerants for shipboard use. Through its acquisition of this company, WW can now also make an active contribution for the first time to developing environmentally-adapted products for the shipping industry.

## CHEMICALS

Chemical products play a substantial role in the total burden imposed by a ship on the natural environment. Possessing a major supplier of such substances which is ISO 14001 certified provides a guarantee that all aspects of chemical use have been addressed.

### ISO 14001 certification

Unitor Chemicals became the first company of its kind in Norway to secure ISO 14001 certification in 2000. This was a natural consequence of a purposeful commitment to developing environmentally-adapted chemicals which began as early as the 1980s. The certified environmental management system, which is subject to audit by Det Norske Veritas, covers product development, production, warehousing, distribution and marketing of marine chemicals, testing equipment and other equipment used in connection with the chemicals.

Certification also requires sub-suppliers of product components, knowledge and services to

have a satisfactory environmental management system. As a result, Unitor Chemicals primarily uses chemical companies with substantial resources as suppliers and partners for research and development. These include Shell, Exxon, Akzo Nobel, BASF and Ceca. This gives Unitor Chemicals' marine customers an assurance that every link in the supplier chain which could have a potential impact on the natural environment is under control and accords both with the ISO 14001 standard and with relevant environmental regulations.

### Use of environmentally-adapted products

Researching, developing and marketing environmentally-adapted products are not enough in themselves. These products must be brought to market and actually adopted in practice. To have a genuine impact on the environment, it is crucial that environmentally-harmful products are actually removed from the market and replaced by less damaging products.

Some of the most harmful chemicals have been banned under international agreements, such as the Montreal protocol of 1996 and the European Union's directive on cleaning agents. All the chemicals in Unitor's product range meet the new EU standards introduced in 2005.

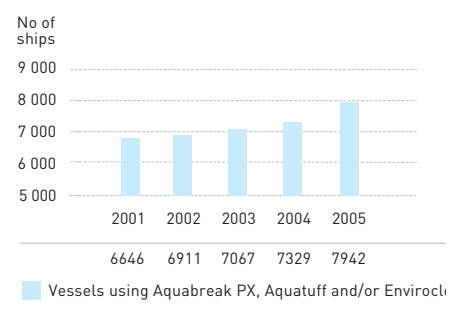
According to the Norwegian Product Control Act, the end user of chemical products which could have a negative impact on health or the environment must assess whether alternatives are available which reduce the risk

of such effects. If so, the alternative must be preferred providing this is possible without unreasonable expense or inconvenience.

A chemical developed in accordance with the ISO 14001 standard must not only have an environmentally-adapted formulation. The market and the individual user must consider its performance to be just as effective as, and its price to be competitive with, the product to be replaced. Users should not need to feel that they are converting to a product with poorer quality.

Unitor Chemicals has accepted this requirement. The goal is that all new environmentally-adapted products must be at least as cost-effective as the existing chemicals on the market. This is the only way to ensure that the new products are taken up and thereby have a genuinely positive impact on the environment.

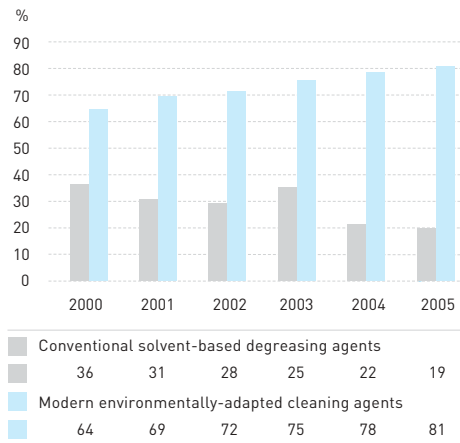
The company's ability to meet these special demands is demonstrated by the steady increase in the number of ships using such environmentally-adapted products as Enviroclean, Aquabreak PX and Aquatuff. The graph below shows that the number of vessels using these products rose significantly during 2005, in line with the Unitor Chemicals target for the year.



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Another method used by Unitor Chemicals to measure how far new environmentally-adapted products are taking market share from more conventional solvent-based substances is to measure the percentage distribution of sales. As the graph below shows, the trend is very clear and in line with the company's targets.



To be classified as environmentally-adapted, a chemical product must present a low risk during transport, storage and use. Converting to such a product must also have a positive effect on general shipboard safety and health conditions.

Safe use of chemicals embraces more than their properties. The way they are applied is just as important. Each product is accordingly supplemented with a label which provides full user guidance, a health and safety datasheet and a large range of dosing systems and equipment needed to apply the chemical in the safest, most economic and most efficient way. Unitor Chemicals also holds courses for crew on the correct use of its products.

#### Chemicals with a positive environmental effect

A group of chemicals which also experienced strong growth in 2005 are those which intrinsically or as part of a process have a directly positive effect on the environment. Typical examples include Unitor Bilge Water Flocculant, which is used to separate oil from bilge water, biologically-active chemicals (called Gamazymes by Unitor) which break down organic waste from the galley and the sewage system, and additives for bunker oil which reduce emissions of unburnt hydrocarbons in exhaust fumes.

Another category of products which enjoyed a big expansion in sales during 2005 was oil spill clean-up equipment. This growth has not been prompted by a rising number of pollution incidents, but by stricter requirements for the quantity of clean-up equipment which must be kept on board and at emergency response stations on land in order to limit the environmental consequences of a possible marine oil spill.

#### Requirement for continuous improvement

An ISO 14001 certified company is required to pursue continuous improvement. Since ships continue to pollute the environment, standards must be further tightened. Unitor Chemicals accepts this responsibility by playing an active role in developing and implementing new products, concepts and services.

The company will accordingly pursue such projects in 2006 as the introduction of new environmentally-adapted chemicals and concepts for tank and cargo-hold cleaning which not only save time but also reduce consumption.



## REFRIGERANTS

Unitor Refrigeration has had an environmental focus for many years, and now has the largest number of refillable refrigerant cylinders for the world's merchant ships. National legislation is increasingly adopting this recycling solution and banning the use of disposable cylinders.

Through its Marpol environmental arm, the IMO introduced a new regulation in 2005 to prevent air pollution from ships.

Unitor Refrigeration has responded with several packages to help shipping companies meet these requirements. They have proved a success for everyone concerned in reducing chlorine emissions to the air.

The refrigerant recovery package is one such solution. With all the required approvals, this equipment avoids the deliberate venting of ozone-depleting substances to the air. Thousands of vessels have so far purchased this solution.

### Inspection

Another approach is to offer environmental system inspections (ESIs) to vessels for their refrigeration systems. This requires a Unitor service engineer to board the vessel about once a year to check all piping, controls

systems, valves and compressors. A report is then produced so that the ship can take the necessary action to prevent leaks or breakdowns with the system.

Hundreds of vessels have signed up to this service, and many claim to have reduced running costs for the inspected systems over time. These certificates conform to environmental class and national requirements such as the Foundation for the Approval of Refrigeration Contractors (Stichting Erkenningregeling voor de uitoefening van het Koeltechnisch Installatiebedrijf), the Environmental Protection Agency and the Swedish Board for Accreditation and Conformity Assessment.

### Handling refrigerants

Finally, the continued phase-out of ozone-depleting substances such as chlorofluorocarbon (CFC) and hydro-chlorofluorocarbon (HCFC) refrigerants and halons calls for international waste management systems in order to ensure that such products are disposed of in a legal and environmentally-sound manner.

As the world's largest supplier of refrigerants to the marine industry, Unitor has tackled this requirement by introducing its Enviro Return Management (ERM) programme. This unique waste management system permits the import and disposal of a variety of ozone-depleting substances at major EU ports as well as in Singapore.

The ERM programme is organised in such a way that used CFC and HCFC refrigerants as well as halons can be taken ashore and sent to a local waste reception facility for disposal. It accords with applicable international waste treatment regulations, and is approved by the relevant local authorities. ■

*Below left: Refrigerant cylinders have a code which is recorded before they are loaded on board. This allows Unitor to know where they are worldwide with the aid of a tracking system.  
Below centre: Unitor operates the world's largest fleet of renewable refrigerant cylinders.  
Below right: The refrigeration systems on ships are checked for leaks and possible faulty operation during regular environmental inspections.*



# DEFINITIONS

**Bunkers:** Collective term for fuel oil used on ships. Its origin is uncertain, but could derive from the English word “bunk” – a storage space on vessels for sails and in times past for coal or for people (bunk = bed). Steamers stored their coal in a coal bunker.

**Heavy oil:** A collective term for residues from oil refining. It comprises a blend of substances left over from processing and necessary components which make it useable as fuel.

# GLOSSARY

Antifouling	Normally contains toxic compounds to prevent marine growth. Non-toxic products are gradually being introduced to the market.
Aquabreak PX	Product name for an environmentally-adapted cleaning agent which can be used throughout the ship.
Aquatuff	Product name for an environmentally-adapted cleaning agent used in cargo holds.
Ballast water	Contains micro-organisms which can cause harm outside their home environment. Ballast water is taken on board during the discharge of a cargo to improve a vessel's stability, changed while at sea and pumped out when the next cargo is loaded.
Barnacles	Organisms which grow on the underwater hull and increase its resistance to the water.
Bilge water	Dirty water which collects in a ship's bilges and may be contaminated with small quantities of oil from engine room drains, etc.
Bilge water flocculant	Chemical used to separate oil from waste water.
CFC	Chlorofluorocarbon compounds. See HCFC.
CO <sub>2</sub>	Carbon dioxide – a combustion product from burning all types of fuel. The amount of carbon dioxide in the atmosphere may increase the temperature at the Earth's surface – known as the greenhouse effect.
Enviro Return Management	System for legal and environment-friendly management of used ozone-depleting refrigerants.
Enviroclean	Product name for an environmentally-adapted degreasing agent for engine rooms and tank cleaning
Environmental system inspections	Inspection of refrigeration systems to ensure optimum operating conditions and prevent leaks
EPA	Environmental Protection Agency
Gamazymes	Bioactive cleaning agents used in galleys, crew quarters and passenger sections on cruise liners.
g/t-km	Denotes emissions in grams per tonne of cargo shipped over a kilometre.
Halon	Previously used on ships as an effective fire-extinguishing medium, harmful to the ozone layer in the atmosphere.
HCFC	Hydro-chlorofluorocarbon compounds, such as freon 22 (R22).
HFC	Hydrofluorocarbon.
HFO	Heavy fuel oil. Used in ship's engines and boiler systems.
IMO	International Maritime Organisation. Body created to regulate international maritime trade.
ISO 14000	ISO standard for environmental management.
Low NO <sub>x</sub> nozzles	Fuel valves specially developed to reduce formation of nitrogen oxides (NO <sub>x</sub> ) from combustion.
Mark I-IV	In-house WW designation for various series of ship, categorised by age.
Marpol	IMO convention on the prevention of marine pollution. Regulates environmental pollution by ships.
MDO/MGO	Marine diesel oil/marine gas oil.
Nitrogen oxides (NO <sub>x</sub> )	Environmentally-harmful gases formed by the engine's combustion process.
ppm	Parts per million (1 ppm = 0.000001 or 1 mg/kg).
Refrigerants	Used in refrigeration and freezing plants.
SECA	Sulphur oxide emission control area – a sea area defined by the IMO where the sulphur content of bunkers must not exceed 1.5% or emissions of sulphur oxides to the air must be below 6 g/kWh.

Slide valve	Fuel valves which are fully emptied on each stroke, and thereby counteract afterburning.
Sludge	Mixture of water and oil formed during treatment of heavy fuel oil.
Sulphur oxides (SO <sub>x</sub> )	Sulphur in the bunkers combines with oxygen in the combustion process to form sulphur oxides. These react with moisture in the air to produce sulphurous and sulphuric acid.
Swedac	Swedish Board for Accreditation and Conformity Assessment.
TBT	Tributyltin, used in tin-based antifouling.
Unitor Bilge Water Flocculant	Flocculant agent used to separate oil from waste water.
Unitor's Refrigerant Recovery Package	Advanced equipment package for secure recovery of refrigerants. It satisfies all relevant marine regulations.
Viscosity	A liquid's resistance to flow.



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