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THE NAVAL ARCHITECT
International Journal of The Royal
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Printed in Wales by:
Stephens & George Magazines
Merthyr Tydfil

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Registered charity No. 211161

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A one-year subscription in 2004 to *The Naval Architect* costs £95 (UK), £100 (Europe), and £110 (Rest of the world).

Audited Circulation 9838
JAN - DEC 2003
ISSN 0306 0209



THE NAVAL ARCHITECT



In China's rapidly expanding shipbuilding industry, even new 'greenfield' yards are seeking expansion. The already large Shanghai Waigaoqiao Shipyard (SWS) is planning a further construction dock to augment its existing two. Meanwhile, the newest production equipment from Japan, Europe, and the USA is in operation to support such plans; here at SWS, flanges are being welded automatically to pipes. A special update on China's shipbuilding industry, with emphasis on production and productivity, begins on page 49.

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Fighting hard in Finland

DIFFICULT times in European shipbuilding (a subject highlighted in this column last March) are beginning to have repercussions on the industry in Finland - as, of course, they are elsewhere, such as in Spain and France, and until very recently, Germany. Once, there were several independent yards in Finland but today, almost all new construction work is concentrated in the two yards of what is today Aker Kvaerner Masa-Yards, also in the united yards at Rauma of Finnyards (formerly Rauma-Repola and Hollming). An extensive consultancy and subcontracting industry supports the home yards but perhaps more importantly includes many prestigious names, such as Deltamarin, Wärtsilä, ABB, and Evac, whose names are known in the furthest corners of the earth.

Cruise liners have played a leading role in the fortunes of Finland's marine industries, ever since the then Wärtsilä Marine delivered what is generally considered to have been the first-ever modern purpose-built liner - *Song of Norway* - to Royal Caribbean in 1970. With her exaggerated clipper bow and very modest raked superstructure, this ship and her two sisters were considered the pinnacle of modern design at the time. Today, their equally modest gross of 18,000gt has been multiplied several times over, until the Eagle-type *Voyager of the Seas* reached 137,000gt in 2000 - and today 160,000gt with the newly ordered Ultra-Voyager.

The scary costs of designing, building, and outfitting such leviathans, with their superlative standards of cabin luxury and totally magnificent public rooms might have put off less determined owners and shipbuilders. Nevertheless, Wärtsilä

specially planned to work with ExxonMobil in the extremely difficult areas around Sakhalin island (Sakhalin-1 field) in the Okhotsk Sea.

This vessel will be another to employ the highly innovative Kvaerner Masa/ABB double-acting principle - an hull form specially designed to travel astern in thick ice, when the two 6.5MW Azipods (on the FESCO ship) will turn through 180deg when the ship is going astern. Several other ships featuring this pioneering concept (developed with the help of one of the world's leading ice model tanks, Masa-Yards' Arctic Technology Centre, in Helsinki) are already in service.

The FESCO ships are the first Finnish-constructed icebreakers for Russia since the nuclear-powered *Taymyr* and *Vaygach* of the 1980s, but prior to that Wärtsilä Marine had constructed large numbers of such ships for that country, including six for FESCO, also a series of SA-15 class icebreaking cargo ships. What the future holds for more icebreaker contracts from Russia is an interesting question, as a re-emerging domestic shipbuilding industry in that country flexes its muscles, as discussed in *The Naval Architect* September 2002 and in June 2003 - the latter article particularly concerning icebreaker design.

A third and fourth strings to Masa-Yards' bow are LNG tankers and ferries. In the 1990s, the company invested a considerable sum in a brand-new factory at Turku to build sections for Moss-type cargo tanks. Unfortunately, only one contract has ever been secured - for a quartet of 135,000m³ designs for the Abu Dhabi National Oil Co. More success has been found in the ferry field, including the bold feature of an internal promenade (since adopted by some cruise liner operators). For many years, the yard's highly imaginative think-tank has created a number of most adventurous concepts for the future, sometimes in association with Wärtsilä diesel engines and ABB electrical systems; one interesting design that has recently seen the light of day is the ENVIROPAX passenger ferry, discussed in this issue of *The Naval Architect*.

Not far away at Rauma, Aker Kvaerner Finnyards is equally in need of more substantial orders, although by current European standards the workload is reasonable: a medium-size Baltic cruise liner for Birka Line, a second cruise ferry for Tallink, and a new small fast naval craft for the Finnish Navy, plus a short-term upgrading task for Silja Line's pioneering gas turbine-powered ferry *Finnjet* from 1977. However, the cruise liner and ferry will both be delivered this year, so it is the steelwork departments that will quickly, or already, be feeling the chilly draught.

Finnyards has wide experience of ferry and icebreaker construction but at present yards everywhere are chasing precious few projects. Management at both Finnyards and Masa are going to need strong nerves in the coming months. Meanwhile, marine manufacturing industries in Finland continue to score some notable successes in the export field. In particular, we can mention Wärtsilä's dual-fuel diesel engines that will usher in a new breed of LNG tanker at ALSTOM Chantiers de l'Atlantique in France - and hopefully elsewhere soon, Marioff's Hi-Fog 2000 watermist firefighting system on many vessels but soon to make a new appearance on Brittany Ferries' latest ship, *Pont-Aven*, very nearly complete at Meyer Werft, and UPM-Kymmene's brand-new order to supply a large quantity of plywood for China's very first home-built LNG tankers at the Hudong-Zhonghua yard; this will form part of the complex membrane cargo tank insulation system. Nevertheless, Finland's shipbuilders are going to have to fight hard for new orders and manufacturing companies may have to look increasingly towards export markets. 

Cruise liner and ferries have long formed a key part component of both shipbuilders' and subcontractors' workloads in Finland's marine industries. A new project currently under way is that to build at Kvaerner Masa-Yards' Turku site what is believed to be the largest ever cruise-ferry, for Color Line. Seen here is an impression of the one of the splendid public spaces, the internal Fantasy Promenade, a high internal walkway - a revolutionary feature first seen on the *Silja Serenade* in 1990.



Marine joined a small highly successful band of builders of such vessels - until the massive costs of such projects helped cause a terminal wobble in 1989.

From that disaster arose the current Masa-Yards - a name believed by some to be an acronym of Martin Saarikangas, the larger than life part-saviour of the two yards at the time. Masa-Yards has gone from strength to strength under the umbrella of the Kvaerner group and now Aker Kvaerner, but in 2004 the two yards - and particularly the city-based Helsinki site, are in desperate need of new orders (along with so many other mainstream yards in Europe), although the Turku complex does hold orders for the Ultra-Voyager cruise ship mentioned above, plus the largest-ever cruise-ferry, a 75,000gt design for the Norwegian operator Color Line. At the same time, the design and production of one-deck-high steel sections has been transferred from Helsinki to Turku, and for the last two years design departments have been integrated.

Last December, a contract was confirmed for a ship of a type that for several decades has ranked alongside cruise liners as a premier speciality of Finland: icebreakers. The new contract is actually for a ultra-modern supply/standby ship for the Far East Shipping Co (FESCO), of Russia, and is

A special feature on Finland begins on page 6.

Largest-ever Italian cruise ship ordered

A VERY large new cruise liner has been ordered by Costa Crociere, to be built at Fincantieri's Genoa yard, Sestri Ponente. Building work is set to begin this spring, and the order is worth approximately €450 million. The yet unnamed vessel will join Costa's fleet in the summer of 2006.

The ship will be of 112,000gt, 250m long, with a breadth of 35.5m, with space for 1502 cabins and a total guest capacity of 3800. Of the 1502 cabins, 920 (that is 61%) will have an ocean view, and 38% of cabins will have a balcony. She will be larger than both *Costa Fortuna* (featured in *Significant Ships of 2003*) and *Costa Magica* (currently under construction at Sestri Ponente). Once complete, this new liner, it is claimed, will be the biggest passenger ship in the history of Italian seafaring.

As to be expected today, a diesel-electric propulsion system will be fitted, with two 21MW propulsion motors controlled by synchroconverters. Electrical power will be generated by six medium-speed diesel engines of the Wärtsilä 12V46C type and each developing 12.6MW. They will be resiliently mounted and coupled to 11kV generators. Maximum speed will be 23.20knots, with a service speed of 19.60knots. The two shaft lines will be fitted with FP, five-bladed propellers. Low voltage power, through transformers, will be distributed at 690V for auxiliary and hotel services, and the vessel will be equipped with three bow and three stern thrusters, each rated at approximately 1700kW.

A steam generation plant will consist of two oil-fired boilers, with a capacity of 15,000kg/h each, together with six exhaust-gas boilers having capacity of approximately 3500kg/h each, with saturated steam production at 9bar. Fresh water production will be ensured by three multi-effect evaporators and one reverse-osmosis desalinator for a total capacity of around 2000tonnes/day.

An integrated waste treatment system will include food waste transportation by means of a vacuum system (the latest technique) to convey it for burning, together with dry waste and sludge, in two incinerators, each with a thermal capacity 1600kW.

Like other Costa fleet members, the new ship will offer guests a host of telecommunications services, whereby they can use their mobile phones while they are at sea, thanks to the agreement between Costa Crociere and TIM, signed last September. More details on current and recent cruise liner projects can be found in our Cruise Liner feature elsewhere in this issue.

PAINT RESTRUCTURE FOR GLOBAL TARGET - Nippon Paint is restructuring its marine coatings subsidiary to increase its presence in the global marine paint market for newbuildings, shiprepair, and maintenance, and will provide customers with its products, services and know-how throughout the world. Re-launch of the company is planned for November 2004. Nippon Paint also plans to secure a market share among the top three companies in the international marine paint marketplace.

In associated news, Nippon Paint and London-based International Coatings Ltd are terminating



A 3D CAD drawing of the new Costa cruise ship which will be built at Fincantieri's Sestri Ponente yard. This 250m long hull has been designed to operate in the Mediterranean all-year round, and interiors will be especially planned for winter sailing.

their association in marine coatings, as of October 31 2004. Until then, Nippon Paint will continue to service marine customers under its ongoing product and delivery system in association with International Coatings.

SAFETY OF CHUTE EVACUATION SYSTEMS CONFIRMED - Transport Canada has assessed the safety of both types of vertical chute marine evacuation systems used by BC Ferries, and has confirmed that both are safe for use by all passengers, including infants. Extensive tests were carried out after concerns were raised about the suitability of these systems for infants, the elderly, and severely disabled passengers.

At the end of last year, the Northern Ireland manufacturer RFD conducted tests in the presence of Transport Canada on the Marin-Ark chute, and, it claimed, successfully demonstrated the ability to safely evacuate children under five years of age, and the disabled. In order to expedite the evacuation of all passengers in emergency situations, alternate means of escape for passengers confined to wheelchairs will supplement the chute system. Readers may recall that a volunteer died at Dover during trials on a vertical chute (*The Naval Architect* October 2003, page 24).

LONG-TERM CHARTERS FOR STENA P-MAX TANKERS - Total Oil has signed a five-year charter for the first two Stena P-MAX tankers currently under construction at Croatian shipyard Brodosplit, for delivery in 2006. These P-MAX (product-max) vessels are medium sized, short and wide bodied, with reduced draught (*The*

Naval Architect October 2003, page 6). The tankers have an intermediate loading capacity of 65,000tonnes, between standard 45,000dwt vessels and 70,000dwt-80,000dwt Panamax types. They follow the other twin-screw super-safe Stena tankers, the V-Max and the C-Max.

This new design of tanker has been specifically engineered to reduce the risk of accidents and oil pollution, with close cooperation between Total and Stena. P-MAX ships have two engine systems, twin rudders, and twin propellers for maximum reliability and manoeuvring. Navigation and bridge systems have been enhanced for better control of a ship, especially in heavy traffic – the bridge has a 360deg view. The vessels also have enhanced structural and ice strengthening, so the tankers can follow icebreakers in ice up to 800mm thickness. Ⓢ

PEOPLE

DR HANS PAYER, executive board member responsible for technology and maritime services at Germanischer Lloyd, formally retired at the end of last year. He was active in the society for 27 years, and specialised in container ship development and ship safety.

A number of new appointments have been made at the American Bureau of Shipping. **FRANK DRAKE** has been made Americas divisional lead surveyor, **BABU ANGEL** divisional lead surveyor for the Pacific division, and **CHRISTOS NOMIKOS** divisional lead surveyor, Europe. Ⓢ

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ENVIROPAX: a new concept for high-speed ro-pax ferries

A new Finnish project aims to harness the benefits of contra-rotating propellers, Azipods, and Wärtsilä's new CODED machinery concept to conceive a 21st century environment-friendly ferry. Already, this proposal has been applied to a new pair of ferries ordered in Japan.

A JOINT research and development project, ENVIROPAX, between Kvaerner Masa-Yards, ABB Marine & Turbocharging, and Wärtsilä, has now been progressing for one year. The target of this is to utilise the potential of contra-rotating propulsion (CRP), with Azipods, in the development of fast ro-pax vessels. That is, to have attractive fuel economy, good manoeuvrability, high comfort levels, the same cost as traditional vessels of this type, and be environmentally sound.

Initial model testing of the CRP propulsion concept took place in 2000 at Marintek, followed in 2002 by a cavitation study at the Krylov Institute, where a new calculation method was also developed, and by steering-force work during 2002 and 2003 at the Helsinki Technical University. Improved efficiency has been achieved, and a hub design patent was secured in 2002 on eliminating the problems related to hub vortex.

Power distribution between the forward and aft propellers, as well as optimisation of hull form have been other main topics of ENVIROPAX research. Several hull forms were studied using the CFD Shipflow code, followed by resistance and propulsion model tests at VTT in Finland. Extensive model tests have also been carried out in Japan by Mitsubishi for the pair of ro-pax ferries it is building (see later text in this article).

Kvaerner Masa-Yards designed the hull form using the Shipflow CFD code, ensuring it was optimised for CRP Azipod propulsion. Targets of this arrangement included low resistance, high propulsion efficiency, slender underwater hull, and adequate space for a geared diesel-driven CRP propulsion plant, and lower cargo holds. The aim was to create a vessel with a high service speed (around 28knots), planned for short turn-around times in port, and attractive capacity for ro-ro cargo and passengers.

The concept's general theme includes:

- three cargo decks and four decks for accommodation
- a lower cargo hold intended for trailers, accessed by a fixed ramp from the main trailer deck
- stern ramp and bow door construction prepared for cargo loading and discharge on two levels if required
- an internal tilting ramp between main and upper decks
- lift and stairs situated in a centre casing
- main public deck on top of the upper trailer deck and two decks above for passenger and crew cabins
- machinery to be divided into two parts: main diesel-mechanical propulsion



The ENVIROPAX vessel, designed by Kvaerner Masa-Yards, Wärtsilä, and ABB, is a new concept for fast ro-pax ferries. It combines CRP Azipod propulsion, CODED machinery, and is environmentally sound. This highly interesting project is based on much combined background work, design, and construction gained by the three partners. Results from a joint CRP ro-pax development project within the Finnish R&D programme Sea Tech 2000+ have been utilised, as well as experience from the latest ro-pax ships designed and built in the 1990s by Kvaerner Masa-Yards, from Azipod development and production references by ABB, and from the newest advances in the diesel field by Wärtsilä. The ENVIROPAX has been planned for typical overnight routes in the Baltic, Mediterranean or North Seas with distances up to around 600nm.

situated in the hull, and an electrical power plant (for the Azipod and hotel services) above the cargo decks, aft of the superstructure.

Thrust load in an ENVIROPAX ferry would be divided over two contra-rotating propellers, where rotational losses are recovered by the aft propeller. A single-skeg hull form offers a good wake-field and low resistance, and cavitation characteristics are reduced due to smaller loads on the blades. The propulsion system also offers low excitation forces due to a small optimum propeller diameter, and large hull clearance. Using a CRP plant, a 15%-20% gain in power (power reduction) can be achieved, claim the promoters; however, the actual saving does depend on the loading of a comparable single propeller.

This propulsion concept has already been applied to two Japanese long-haul ferries, set for delivery this year. ABB and Wärtsilä have supplied a CRP Azipod system for these 17,000gt ro-pax designs under construction at Mitsubishi Heavy Industries' Nagasaki shipyard (*The Naval Architect* June 2003, page 6). To be owned by Shin-Nihonkai Ferry, these ships will, it is believed, be the largest and the fastest in Japan.

Instead of a conventional rudder, each 224.5m long single-skeg vessel will be equipped with a steerable 17.6MW Azipod unit installed in a contra-rotating mode aft of a mechanically-driven main propeller, to provide a maximum speed of 31.5knots. The main shaftline is powered by two Wärtsilä 12V46C engines through a twin-input/single-output reduction gear. This contract also covers the 27MW main electrical power plant, with three main alternators and a 6.6kV main switchboard.

Much of the material in this special feature has been contributed by Henrik Segercrantz.

CODED machinery and alternative pod systems

Future ENVIROPAX vessels would utilise Wärtsilä's new combined diesel-electric and diesel-mechanical machinery unit (CODED) proposal, discussed in *The Naval Architect* September 2003, page 11. This means there is a low power demand, a flexible use of installed power, no separate generator capacity needed for bow thrusters, a common power margin for the hotel and propulsion load, lower transmission loss, as well as lower cost.

TECHNICAL PARTICULARS ENVIROPAX FERRY (TYPICAL)

Length, oa.....	200.00m
Length, bp	185.00m
Breadth.....	27.20m
Draught, design.....	7.00m
Draught, scantling.....	7.30m
Depth to bulkhead deck.....	9.75m
Depth to deck 7.....	20.75m
Gross.....	34,000gt
Deadweight, high season (trailers and 350 cars on upper deck).....	4200dwt
Deadweight, low season (2480lane metres trailers only).....	5500dwt
Cargo lane metres.....	2480
Car capacity (upper deck).....	350
Passengers.....	1500
Passenger cabins.....	200
Crew.....	60
Crew cabins.....	44
Small pod	
Installed power.....	49.6MW
Propulsion power.....	43.6MW
Large pod	
Installed power.....	49.3MW
Propulsion power.....	42.2MW
Service speed.....	28.00knots



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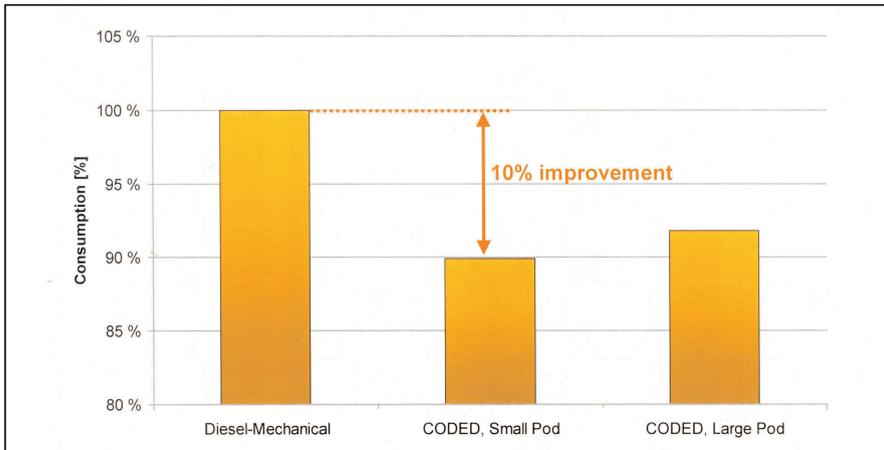
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HEMPEL



This diagram illustrates the total fuel consumption of the small and large podded ENVIROPAX ferries, compared with a normal ro-pax vessel. A 10% improvement can be seen for the small pod.

ENVIROPAX offers two machinery alternatives with the same performance; a small Azipod with a pod/CPP power ratio of 27:73 (10MW FP Azipod unit, 4.8m diameter right-handed, and 29MW mechanical CP propeller, left-handed 5.6m diameter), or a large Azipod (19MW Azipod FP right-handed unit, 4.8m diameter, and 19MW CP propeller, 5.6m, left-handed); the latter therefore has an equal power split between the two propulsors. The power split between the electrical pod and mechanical propeller influences many aspects of the design and performance of the hull, such as hydrodynamic efficiency, transmission losses, and investment cost. It is envisaged that for the large-pod version, main engines would be Wärtsilä 16V38B models, with 9L38 models to drive the alternators.

Optimum propulsion power ratio

One of the main objectives of ENVIROPAX model tests (carried out by MARIN, in The Netherlands, and by Mitsubishi, in Japan) was to determine the power split's influence on

propulsion efficiency. There is currently little information available about what influences the power ratio between a pod and the mechanical propeller on total propulsion efficiency. However, this concept is believed to need an optimum power ratio, close to 50/50, in order to achieve the highest fuel efficiency.

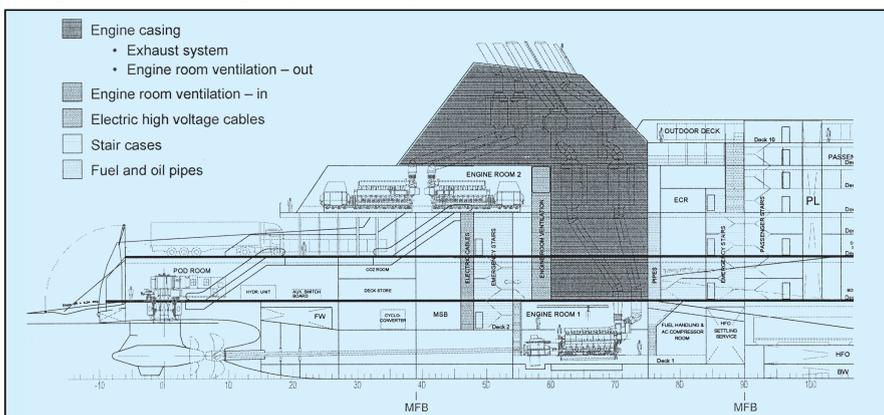
When the power split is higher or lower than 50/50, there is an increase in power demand. When capital cost is also considered, the optimum power ratio (for best economy) is reached at a lower pod power.

A number of considerations had to be taken into account when designing this concept. The pod diesel-alternator room, for example, is unusually high up, due to the location of auxiliary system components. The aim was to minimise the number of pipes and cabling between the upper and lower engine rooms.

Environmentally sound machinery

The ENVIROPAX concept also needed to be environmentally sound, due to new and future

The centreline casing arrangement on the ENVIROPAX ro-pax ferry. The high level of the diesel-alternator room (housing four sets) is a new design feature and allows a simple ventilation arrangement, as well as logically placed escape routes and staircases.



legislation, as well as public image for operators. Part of this will be met by employing the EnviroEngine concept on Wärtsilä's four-stroke engines, which encompasses: low NOx combustion, common-rail fuel injection for smokeless operation, primary NOx emission reduction technologies (direct water injection and combustion air saturation system), and secondary NOx emission reduction technology (selective catalytic reduction).

The direct-water injection system is already available with many Wärtsilä medium-speed engines. The newer combustion air saturation system (CASS) however, is currently under development, with the first pilot plant being tested in ships. Emission levels of only 5g/kWh-7g/kWh are expected.

A selective catalytic reduction (SCR) process offers lowest NOx emissions - less than 2g/kWh. It works via a reducing agent (such as an aqueous solution of urea) injected into the exhaust-gas stream. The urea decays into ammonia which, in the presence of a catalyst, converts NOx into harmless nitrogen and water vapour.

Wärtsilä's compact SRC plant incorporates a combined silencer and SRC unit tailored for its engines. It is only marginally larger than a conventional silencer and can usually fit into the same casing as for a normal ship without SCR units. A modular design allows relatively simple retrofit, and a plant would reduce NOx by 85%-95%, and its sound attenuation is 25db(A)-35db(A).

The catalytic process in the SCR unit requires temperatures of 300°C-450°C; this means that boilers must be located above SRC units, since exhaust temperatures after the boiler are too low for the SRC process. These units also require a straight exhaust-pipe section between the urea injection nozzle and the SRC system to allow the urea to mix with the exhaust.

The straight-pipe section is easy to accommodate in an ENVIROPAX ship since SRC units are located high up above both car decks - a wider engine casing at car-deck level would be required in order to fit the SRC lower down the hull. This is not normally desirable since it would reduce available lane metres and obstruct cargo flows; it would also lead to a situation where exhaust-gas boilers are located very high up in the superstructure. Using SRCs however, is more expensive than primary NOx reduction technologies such as direct water injection and combustion air saturation systems.

Fuel consumption and costs

Total fuel consumption would be low in an ENVIROPAX vessel, almost 10% lower in the small pod version, compared with a typical ro-pax vessel. Machinery cost for this concept is approximately 20% of the total ship price, and the difference between an ENVIROPAX and a typical ro-pax is only marginal - 0.8% for the small pod, and 1.3% for the large version.

Total economic costs, according to calculations, are better than a ro-pax. Calculated saving is over €1 million annually for the small-pod version. ENVIROPAX should also offer more cargo capacity than a typical ro-pax.

Another successful year for Vacon

FOUNDED in 1993, Vacon Plc specialises in the development, manufacture and worldwide marketing of Vacon frequency converters in the power range from 0.2kW to 3MW for applications in industry and the public sector worldwide. Vacon's operating revenues in 2002 were a €97.5 million, a record for the company. The company employs some 420 people and has three production units in Finland plus a network of 11 subsidiaries and more than 100 distributors in 75 countries. Utilising its wide network of subcontractors and suppliers, only operations of strategic importance, such as assembly and testing, are carried out by Vacon itself.

Vacon's share of the frequency converter market for ships has been continuously growing, and the company is claimed as the fastest growing manufacturer in the world, holding around 2% share of the fragmented world market. Compared with its competitors, Vacon is said to be the only company that specialises in frequency converters alone.

For cruise ships only, Vacon has, to date, delivered more than 700 converters to be used for winches, and air conditioning as well as ventilation fans. Here, cooperation with other suppliers is vital; for instance, Rolls-Royce and Vacon have developed a customised version of the Vacon frequency converter that suits Rolls-Royce's needs regarding mooring and anchoring winches. Other types have been developed for trawling, towing, and for the offshore sector. Winches with frequency converter drives are said to have many advantages over other alternatives: they offer continuous speed control, a lower noise level, accurate torque supervision, and a reduced need for maintenance and cabling.

Vacon has developed its regenerative frequency converter, provided with special software and with or without a closed-loop control, especially for cable-laying and applications requiring continuous braking. The drives consist of one unit connected to the supply through a filter, and the other units (634 all together in eight ships) connected to the motors and fed by a common DC-bus. An ISO 14001 Environment Certificate was awarded to Vacon in June 2000.



A Vacon CXR regenerative drive controlling cable-laying operations.

Recent deliveries have included converters for the entire *Voyager* class series of cruise liners, of which the fifth, *Mariner of the Seas*, was handed over by Kvaerner Masa-Yards' Turku yard last October. This includes frequency converters to control 18 anchor and mooring winches, sea water cooling pumps for the diesel engines, as well as ventilation equipment. All in all, 240 units control the liquid-cooled air conditioning equipment fitted in cabin modules and the swimming pools on the sun deck, which have Vacon-controlled pumps. Spirit-class cruise ships from Masa-Yards' site in Helsinki are also equipped with Vacon frequency converters. For example, Vacon drives, in the power range up to 90kW, control seven



Vacon CX drives with a power of up to 90kW control anchor and mooring winches, air conditioning compressors, and ventilation fans on *Carnival Miracle*.

anchor and mooring winches, air conditioning compressors, and ventilation fans on *Carnival Miracle*.

Production expands to China

In October last year, Vacon Plc signed a memorandum of understanding with the Finnish company Scanfil Plc, for the production of Vacon NXL low-power (under 3kW) frequency converters in Suzhou, China. This contract aims for a long-term cooperation in production and development of Vacon's logistics process. Scanfil Plc is a global contract manufacturer and systems supplier for communication and industrial electronics. The Vacon factory is planned to start the production in Zuzhou during the first half of the current year. Ⓡ

UPM plywood contract for first Chinese-built LNG tankers

UPM-Kymmene, one of the leading forest products companies in the world, has won a major contract to supply WISA-LNG plywood for China's first liquid natural gas (LNG) tankers. The Finnish company first began supplying plywood for gas carriers in 1969, and to date, has supplied material for the insulation of close to 80 ships. The largest plywood order so far came from Korea in 2001, consisting of 50,000m³ of plywood for a total of 20 tankers. Currently, the company is supplying this product for more 30 new LNG carriers on order in South Korea, Spain, and now in China.

In mid-January, UPM signed a major letter of intent with Hudong-Zhonghua Shipyard in China.

According to the agreement, UPM will supply a total of 15,000m³ of plywood for use in the insulation of that country's first-ever LNG tankers planned to be built at this yard - contracts are believed to have been signed for two ships but a total of five are planned. The plywood will be delivered to China from UPM's plywood mills in Finland during the next three-to-four years.

UPM's plywood supplies began back in 1969, with the deliveries of complete plywood insulation boxes to the LNG carriers *Polar Alaska* and *Arctic Tokyo*, built at Kockums Shipyard in Malmö, Sweden (now closed). Both vessels have been in operation for 35 years and are still trading, for British Gas.

WISA-LNG plywood is used in the Technigaz and Gaztransport membrane-type tank containment systems. These are based on two layers of insulating plywood, with polyurethane sandwich panels or plywood boxes separating the inner LNG tank from the hull. As the temperature inside the tank is -162°C, it is vitally important to establish the best possible insulation between the LNG and the outer atmosphere. The inner tank has a thickness of only 0.7mm-0.8mm (Invar steel), and the plywood boxes or sandwich panels must be strong enough to withstand the total weight of the LNG cargo and the sloshing forces when the cargo moves inside the tank in heavy seas. Ⓡ

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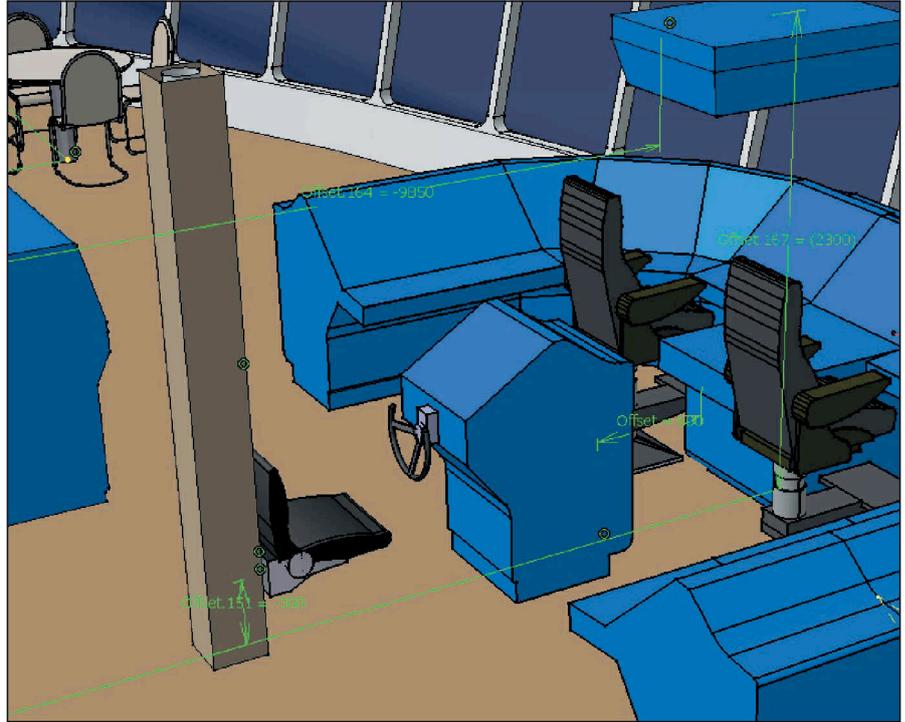
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Designing for an efficient navigation bridge

AN interesting service offered by the leading Finnish consultancy Deltamarin is a 3D computer-aided modelling method for perfecting an efficient navigation bridge layout. This is based on so-called parameterised presentation, whose objectives are to improve the quality of bridge definition and design, to simulate all functions, to reduce technical and commercial risks, and to shrink design and engineering lead time. The concept is claimed to pave the way for a safe, standardised layout and installation.

Such a process starts with the selection of a basic model and proceeds through types of navigation console layout, basic and detail geometry, console and panel details, simulations and design review and visibility check, and arriving at a delivered project. Parameterised models can be supplied for various ship types, including cruise liners, ferries, tankers, dredgers, icebreakers, and ro-ro freight ships.

A rule check is always included in any modification - these are built into basic library components and possible parameter ranges, and an automatic update of a generated 3D model is always carried out after each modification. Detail geometry can include all elements, such as windows, doors, false floor, and ceiling, and design reviews can be carried out through the Internet using virtual reality modelling language (VRML).



A typical computer-generated view of a bridge design in its detail geometry version, showing consoles and panels. This is part of Deltamarin's so-called parameterised presentation concept, which is aimed at producing an efficient bridge layout.

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New version of eBrowser from Cadmatic

THE Nupas-Cadmatic software is a joint venture between the Finnish consultancy Cadmatic Ltd and Numeriek Centrum Groningen BV, from The Netherlands. Cadmatic Oy is the software company of the Finnish marine design and engineering company Elomatic. With its Nupas-Cadmatic 3D CAD/CAE/CAM software, Nupas-Cadmatic has secured a significant position among the shipbuilding and maritime industries globally, as well as in Europe, and the system is now used by more than 100 shipyards and design offices in some 30 countries.

Latest product of Nupas-Cadmatic is the eBROWSER, intended for reviewing shared 3D models over the Internet. It has been developed and refined over the last three years for end-users and suppliers of equipment and processes, as well as designers, and especially project management, production installation supervisors, installers and maintenance staff.

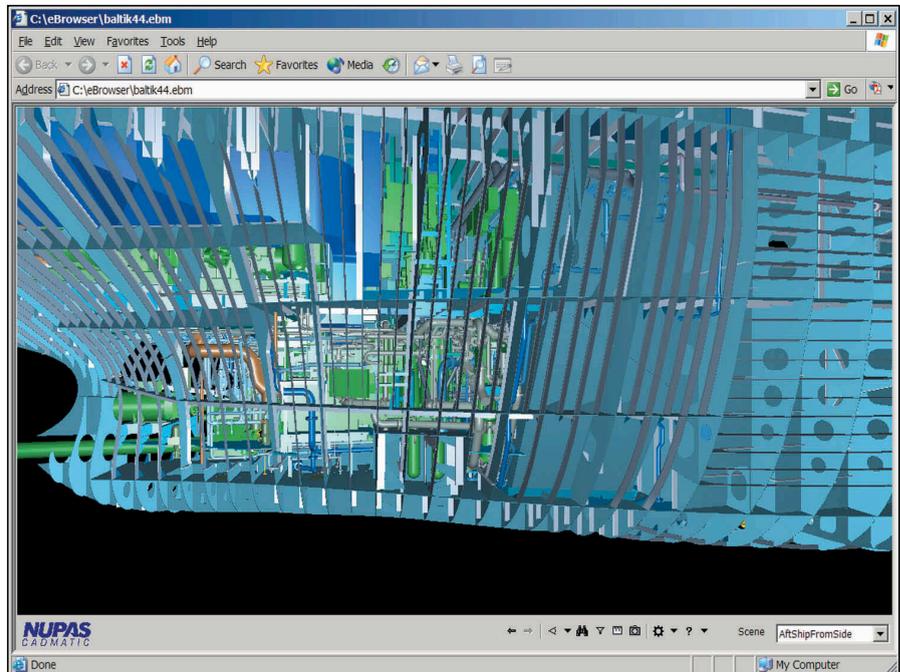
Actual 3D CAD design data is transformed into a lighter 3D file which includes all data necessary for design reviews. The platform for the OpenGL-based eBrowser is Microsoft Windows Internet Explorer. Typical file sizes range from some 100 kilobytes to a few megabytes. The eBrowser file is thus easy to transfer over the Internet anywhere in the world. Reviewing the design in real time means timely comments on projects - especially important, since feedback is an essential feature for designers.

The eBrowser file can, in addition to perusal over the Internet, be viewed from a CD-Rom. Small files can also be sent as an attachment to an e-mail. Viewing of and navigation through the eBrowser model takes place using the computer mouse. Designers can walk around the virtual ship or only view selected individual systems or components. Details of individual components appear on the screen when the object is clicked, and, in the newest upgrade of the software, distances between selected points can be measured.

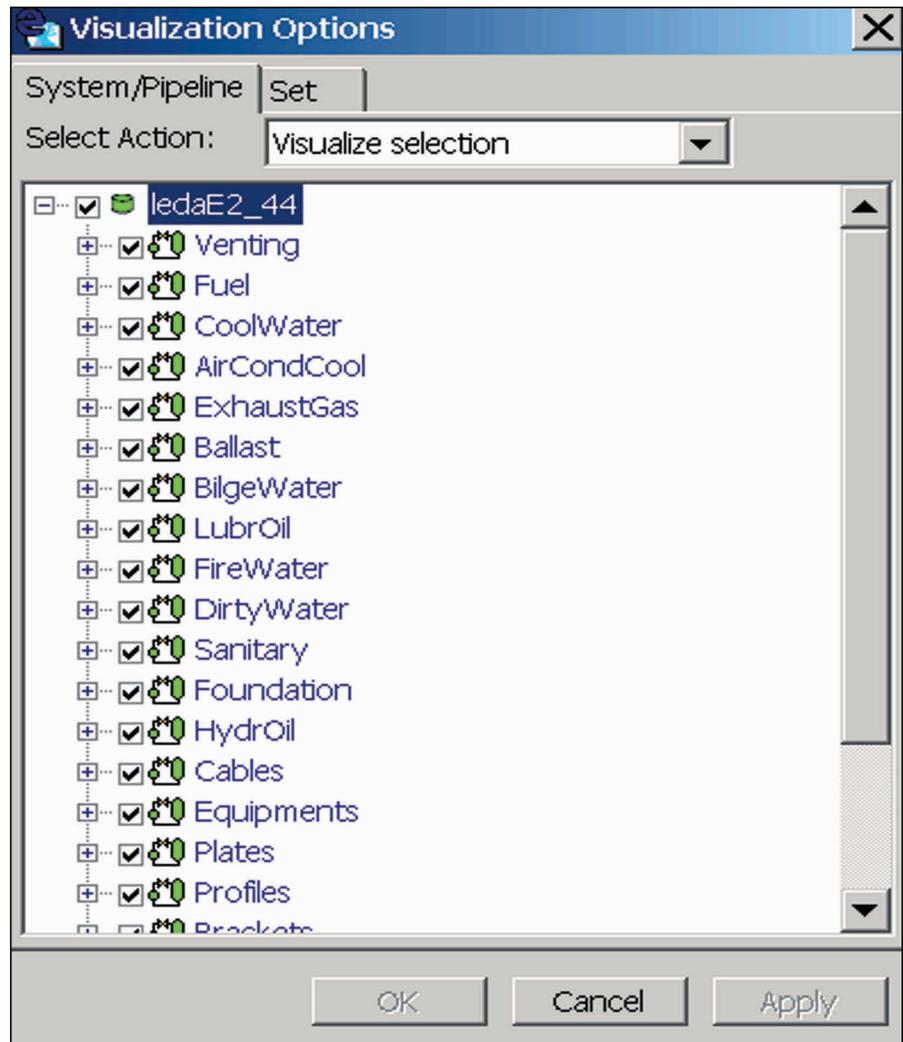
The eBrowser allows users to link the 3D model with external data stored in other systems and documents. Links to, for instance, manuals, structural diagrams, or manufacturers' web sites can be placed in the virtual environment.

A free light version of the eBrowser is intended for viewing only and can be downloaded from the company's web site. One special application is service and maintenance, says Cadmatic. In land-based plants, the eBrowser system has already been utilised for this purpose, in a large paper mill among others, and great possibilities for this software are anticipated in ship maintenance. Ⓡ

A user can select which systems or components are shown, review system details, and, in the newest version of the software, even take measurements.



The latest product of Nupas-Cadmatic is the eBROWSER, intended for reviewing shared 3D models over the internet.



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Kvaerner Masa-Yards Technology covers research and development, concept design and engineering services, shipyard and welding technology, after-sales services, and includes the Arctic Technology Centre (MARC) and the Welding Technology unit.

The subsidiary **Piikkio Works** produces prefabricated cabin and bathroom modules.

Kvaerner Masa Marine, Vancouver B.C., Canada is engaged in marine consulting engineering and marketing primarily in North America.

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Second order for Wärtsilä dual-fuel LNG-tanker engines

An order last autumn for a 153,000m³ LNG tanker by Gaz de France at ALSTOM Chantiers de l'Atlantique has brought another success for Wärtsilä in its penetration of this market. The ship, due for delivery in 2005, will be fitted with a dual-fuel diesel-electric propulsion system, in which one 6-cylinder Wärtsilä 50DF and three 12-cylinder engines will form the heart of the machinery installation. These four dual-fuel engines have a combined output of 39.9MW. The ship will be the largest LNG carrier yet ordered, and will be employed in importing liquefied natural gas (LNG) from either Norway or Egypt, but is also designed for alternative trading on the spot market.

In 2002, Wärtsilä secured an order for four 6-cylinder 50DF engines, with an aggregate output of 22.8MW, for Gaz de France Energy's smaller 75,000m³ LNG tanker, also from Chantiers de l'Atlantique at Saint-Nazaire. Once delivered later this year, this vessel will be the first LNG carrier in service featuring the new dual-fuel/electric propulsion system. The membrane-type vessel will transport LNG from Algeria to France. Service speed is 16knots, which can be achieved with three of the four generating sets. The ship is also designed for spot market trading, such as voyages to the USA.

Until now, steam turbines have dominated as propulsion machinery for LNG carriers for their apparent reliability and the ease with which they can burn the natural gas that is boiled-off from cargo during a voyage. Their low fuel efficiency has however already made virtually all other shipping segments switch to diesel-powered ships. As a consequence, engineers with steam turbine skills are becoming in short supply, which is a worry for many LNG carrier operators. Dual-fuel/electric machinery requires significantly less engineroom space than a steam turbine installation. This enables increased cargo capacity for a given displacement, or alternatively smaller ship dimensions for a given cargo capacity. As a result of both increased fuel efficiency and increased cargo capacity, an LNG carrier with dual-fuel-electric machinery will deliver more natural gas to the offloading terminal even when gas is used as fuel throughout the voyage.

'Wärtsilä has carried out extensive research in order to find the most attractive propulsion solution for LNG carriers', said Mikael Mäkinen, group vice-president, marine division, in connection with the latest order. A number of propulsion alternatives have been evaluated, including machinery installations with conventional diesel engines in combination with a re-liquefaction plant, gas-diesel engines running on a high-pressure mixture of gas and liquid fuel, and dual-fuel engines running on low-pressure gas. 'The advantages and disadvantages of these have been weighed and the most attractive propulsion solution was selected,' says Mr Mäkinen.

The basic propulsion solution for LNG carriers thus uses Wärtsilä's dual-fuel engines for electric power generation. The electric power is



A typical 50DF dual-fuel diesel engine from Wärtsilä. Four of these six-cylinder models will provide primary power on Gaz de France's new 75,000m³ LNG tanker, and a fifth will form part of the plant on a larger 153,000m³ design for the same owner.

supplied to an electric propulsion system, driving a single FP propeller. The Wärtsilä 50DF, derived from the successful Wärtsilä 46 model, is a true dual-fuel engine, using low-pressure natural gas as primary fuel. In order to trigger ignition, a very small quantity of liquid fuel is injected when running on gas. As a secondary fuel, marine diesel oil can be used. Switching from primary to secondary fuel can be carried out automatically at any engine load.

Harmful exhaust emissions are considerably lower than for a steam-powered vessel. Wärtsilä's calculations show that annual earnings of a 145,000m³ dual-fuel-electric LNG carrier sailing between the Middle East and Japan will be several millions of dollars higher than the annual earnings of a steam turbine-powered ship of the same size.

Diesel-electric propulsion enables largely improved flexibility in the machinery layout, resulting in savings in ship construction.

Further developments of the dual-fuel/electric LNG carrier may include locating prime movers on the main deck. Only the electric propulsion motors, sea water intakes with the necessary pumps, as well as the bilge and ballast systems, will still need to be arranged on the tanktop. Added to space savings, this simplifies the arrangements for ventilation, fire insulation, fire extinguishing, and escape ways. Furthermore, dual-fuel generators can be delivered as compact, containerised, fully functional power modules. They can be tested before being lifted onboard, thus enabling savings in installation and commissioning cost and time.

Dual-fuel engines have so far been successfully applied in eight onshore power plants and a number of marine installations, including two FPSOs and two offshore support vessels. LNG tanker operators will be watching with interest when the first ship with Wärtsilä 50DF engines take to the sea later this year. ☎



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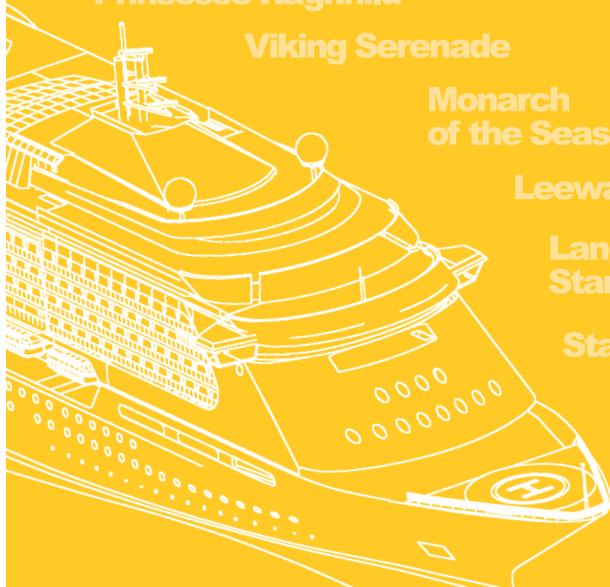
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MAKES THE DIFFERENCE

Azipod propulsion for FESCO icebreaking stand-by and supply ship

ABB Oy has signed a contract with Kvaerner Masa-Yards to supply an Azipod propulsion system and electric power plant for the first Sakhalin icebreaking supply/standby ship, which is already under construction at Kvaerner Masa-Yards for the Russian Far-Eastern Shipping Co (FESCO) for delivery in May 2005. A contract for a second planned ship had not, at the time of writing, been confirmed.

This 4000dwt new-generation design (first discussed in *The Naval Architect* October 2003, page 28) has an overall length of 100m. ABB's delivery includes two 6.5MW Azipods, three main diesel-generators, the main switchboard, transformers, and the bow thruster motors.

The vessel - planned for operation in the very demanding conditions of the Okhotsk Sea, where temperatures can plunge to -40°C, ice ridges up to 20m deep are formed, and solid ice can reach more than 1.5m thickness - will be built utilising Masa-Yards' DAS (double-acting ship) principle, which means that the ship breaks thick ice by going astern. Several ships have now been built to this innovative concept, including the two 110,000dwt tankers *Tempera* and *Mastera* (featured in the newly published *Significant Ships of 2003*). The new vessel will be classed with Det Norske Veritas to Icebreaker Ice 10 standards.

Originally, the Azipod was developed particularly with the needs of icebreakers in mind. Since the launch of the first Azipod system in 1990, a total of 122 units, ranging in power up to 20MW, have been ordered. Many of them are fitted on cruise liners.

Azipod propulsion reaches 1 million running hours

The total operating experience with Azipod systems crossed the 1 million-hour milestone last month. The prototype 1MW installation was fitted in 1990 on the Finnish waterways service vessel *Seili*, followed by two 11.5MW retrofits



An artist's impression of the new heavily ice-strengthened supply/support ship being built by Kvaerner Masa-Yards for the emerging Sakhalin field in the Russian Far East. The vessel will be built to Masa-Yards' innovative double-acting principle, whereby the ship breaks ice by going astern (as shown here) and by turning its Azipod propeller units (two for this particular ship) through 180deg.

on the icebreaking tankers *Uikku* and *Lunni*, also on some new icebreakers. A key breakthrough was made in 1997 with the installation of two 14MW units on Carnival Cruise Lines' liners *Elation* and *Paradise*. As of today, a total of 122 Azipod units have been contracted.

The Azipod concept was originally developed by ABB in cooperation with Kvaerner Masa-Yards. ABB Azipod was acquired by ABB in 1997 and currently forms the propulsion units division within ABB's Marine operations. Since then, ABB has launched two new Azipod concepts: the modular Compact Azipod for lower outputs power and a CRP Azipod (featuring a

conventional mechanical propeller adjacent) for larger, high-power vessels. The Compact Azipod concept (launched in the year 2000) has already won orders for 38 units for a variety of vessels, including megayachts, offshore supply ships, survey vessels, and drilling semisubmersibles. Two prototype CRP Azipod propulsion units will be delivered this year for a pair of Japanese fast ro-pax ferries to be built by Mitsubishi for Shin-Nihonkai Ferry (*The Naval Architect* June 2003, page 6). This concept has also been promoted for large container ships and additionally features in the new Finnish ENVIROPAX ferry project discussed elsewhere in this issue. Ⓜ

Evac's latest orders for cruise, ferry and naval projects

THE Finnish specialist in the design, manufacturing and marketing of environment-friendly vacuum toilet systems, Evac, has received some major orders recently, including those for prestigious passenger ships under construction at Finnish shipyards. A total of 988 (Evac 900 model) wall-mounted vacuum toilets has been ordered for the 33,000gt 1800-passenger Birka Line cruise ship under construction at Aker Finnyards. The system includes all necessary valves, vacuum collecting units, and separation tank; it will serve the 738 passenger cabins and 200 crew cabins.

Evac will also supply vacuum toilet equipment for Color Line's new 75,000gt cruise-ferry *Color Fantasy*, under construction at Kvaerner Masa-Yards' Turku yard. Evac will supply, in all, 1268 toilets including auxiliary systems to serve the 968 passenger and 248 crew cabins. The system

includes three vacuum collecting units, each with a volume of 16m³, a grease-separating grey water tank, two grey-water dilution units, a grease trap for pre-treating galley grey water, a marine sewage treatment plant (MPS) for sewage only, with grey or sea water for dilution, two MSP X-type biological sewage treatment plants, and an automation system with remote operation of the equipment from the engine control room.

Newbuildings commissioned by ro-pax ferry operators are also specified with Evac vacuum toilet systems, among them Brittany Ferries' 39,300gt 2250-passenger ship *Pont-Aven*, nearing completion at Meyer Werft in Germany, for delivery in spring this year (1600 vacuum toilets) and the two 1300-passenger ferries ordered by Enterprise Nationale de Transports Maritimes de Voyageurs (ENTMV), of Algeria, for delivery this year from IZAR's Sevilla yard.

A Corsican Ferries conversion project (the yard is yet to be decided) also calls for the installation of a vacuum toilet system.

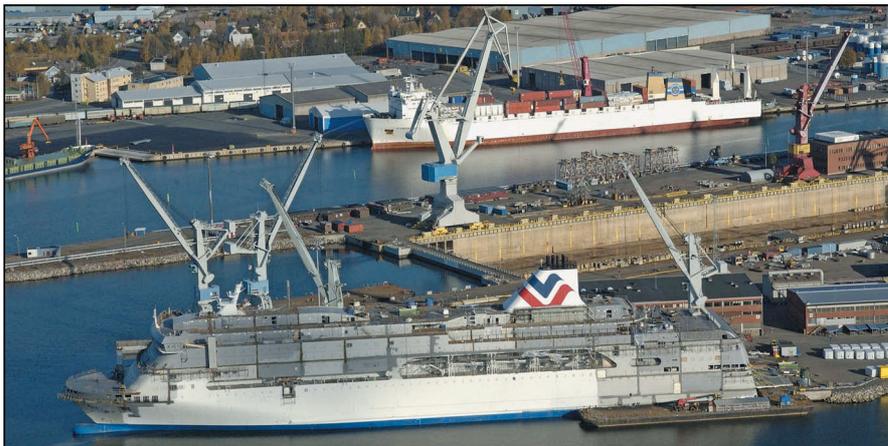
Current Evac commitments in the cruise shipping sector range from mini cruisers to large newbuildings. Evac's vacuum toilet system is ordered for a river vessel building in The Netherlands for a Bulgarian owner, for Royal Caribbean Cruise Line's 160,000gt Ultra-Voyager ship under construction at Kvaerner Masa-Yards (2600 units), and Carnival's newbuildings at Fincantieri: Cunard's *Queen Victoria* (1300 units), and *Carnival Liberty* (2000 units).

Finally, on the naval front, Evac's references will be strengthened by recent orders for vacuum toilet systems for an aircraft carrier commissioned from Fincantieri, and for eight DDG frigates building in the USA. Ⓜ

Merchant/naval mix continues at Finnyards

PRIME business areas today of Aker Kvaerner Finnyards remains ferries, cruise liners, small naval craft, and multipurpose icebreakers. Deliveries during the last three years have included a large cruise-ferry for Ireland (*Ulysses*) with 4101 lane-metres of ro-ro space, the fastest ro-ro ferry on the English Channel (the 25knot *Seafrance Rodin*), and three ferries for the Orkney and Shetland Islands services in Scotland (*Hjalmland* and two smaller half-sisters). The current commercial order book includes a second cruise-ferry for Tallink (a modified version of *Romantika*, delivered in 2002); *Victoria*, as she is named, will sail between Stockholm and Tallinn when delivered in the Spring of this year. She is more environmentally friendly than her predecessor, being equipped with exhaust-gas catalysers. Compared with *Romantika*, the interior design of the bars and restaurants have been changed and the number of luxury-class cabins and suites has been increased. More than 400 people can be seated in the conference area, with the largest room for 250. In all, 2500 passengers can be carried, and accommodated in 740 cabins.

Planned for delivery in the Autumn of this year as a companion for *Birka Princess* is a new cruise liner for Birka Line; *Birka Paradise* is claimed to be the most environment-friendly ship in the Baltic Sea. She will fulfil Det Norske Veritas' new Clean Design criteria and the Comfort Class notation for a noiseless and vibration-free vessel. Catalysers, closed sewage treatment plant, and



Victoria, the new ferry for Tallink, (a virtual sister to the 2002-built *Romantika*) is seen here alongside Aker Kvaerner Finnyards' outfitting quay at Rauma. She will be delivered this coming Spring.

atoxic antifouling paint have all been specified. Her hull has been optimised to avoid wave formation and bottom suction in the sensitive Swedish/Finnish archipelagoes.

An interesting third project for the shipyard is a new contract from Silja Line for upgrading the pioneering gas turbine-powered ferry *Finnjet*, built in 1977 by the then Wärtsilä Marine. Although today featuring part diesel-electric propulsion in the interests of reduced fuel consumption, she appears to be still operating successfully. Over a period of six weeks, Finnyards will modernise much of the technical

equipment, while the passenger spaces will be improved in association with Partner Ship Design. When re-delivered in June this year, the 30knot ferry will transfer to a new route between Rostock, Tallinn, and St Petersburg. This contract is worth some €10 million. Finnyards has already converted other Silja Line ships - *Wasa Queen*, *Silja Europa*, and *Silja Festival*.

Meanwhile, in the military sector, last December the shipyard signed a new contract with the Finnish Navy for a third *Hamina*-class fast surface combatant, for delivery in Autumn 2005, with an option for a fourth vessel. ⓘ

An artist's impression of *Birka Paradise*, the new 1800-passenger cruise liner under construction at Rauma for Birka Line. She is mainly designed for Baltic cruising and feature a high standard of 'green' technology.



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Vision-guided robots 'open up new shipbuilding era'

TOWARDS the end of last year, Aker Kvaerner Masa-Yards signed a cooperation and licence agreement with the Finnish welding automation specialist Pemamek Oy for the former's newly developed automatic vision-guided robot welding system. These new vision-guided robots are claimed to open up a new era in shipyard production: in fabrication and welding of hull parts and subassemblies, current pre-programming times are now reduced to zero, and no CAD models are needed. The new technology is also claimed to allow unmanned production, for example, in night shifts.

Amongst other amazing claims are world record levels in arc and utility time ratios, with resulting improved and stable quality and productivity. The new applications are universal and can be used for most types of ship structures.

Work on this subject has been carried out during 2001 and 2002 with Pemamek, also in association with Master Automation Group Oy and Lappeenranta University of Technology, while applications and training were financially supported by TEKES, the National Technology Agency of Finland. The actual agreement covers a state-of-the-art robot welding system controlled by an advanced machine vision-guided programming system, instead of off-line or pre-programmed systems. The equipment is based on highly advanced computer software applications which acquire their input from machine vision.

Several patents are pending for new applications of joining inner hull parts and accommodation structures for cuttings, welding and finishing of the structural elements and components. These new advances are said to eliminate strict CAD/CAM integration request in the areas of hull parts fabrication and subassembly. Ⓡ



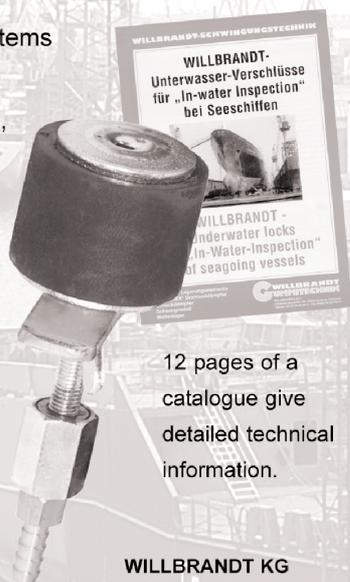
Latest-generation Pemamek welding robots at work in the new Portsmouth yard of the VT Group (formerly Vosper Thornycroft).

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1000 Metos galleys delivered to South Korea

I^N August last year, the Finnish galley producer Metos delivered its 1000th galley to South Korea since deliveries began to that country in the early 1980s. Since then, growth has been at a steady 100 galleys annually, and today, the orderbook extends to end-2005.

Galleys are mainly ordered for cargo ships of different types, and the average price for each delivery is around €40,000. The net sales of Metos, most of whose products are for land-based use, was €198.4 million in 2002.

Principal clients of the company's marine division are the large Korean shipyards, such as Samsung, Hyundai, and Daewoo, also operators of ships in the Baltic. Today, development of new markets in China and Russia are of special interest. Global spare part and services is also an important line of business - Metos sells its galleys directly to the end-client.

During the 1980s and 1990s, Metos was active delivering galleys and restaurants for cruise ships, but today is concentrating on cargo ships, where galleys for large classes are typically dimensioned

for a crew of 20 people. They differ from land-based installations mainly regarding safety equipment and electrical connections, based on different regulations. Ⓡ

I^N mid-January, the board of Aker Kvaerner Masa-Yards appointed Aker Kvaerner Finnyards' current president, Mr Yrjö Julin as the new chief executive officer of the Finnish shipbuilding company; he takes up his position this month. Mr Julin has been head of Finnyards since May 2002. The current Masa-Yards president, Jorma Eloranta, resigned in November last year to head Metso Corp, although he will remain on the board of Masa for the time being.

As a result of Mr Julin's new appointment, cooperation between Finland's two leading yards - Masa-Yards and Finnyards - will be further strengthened. Ⓡ

Ultra-Voyager: a super-giant for RCCL

A GIANT cruise liner that, in gross tonnage terms, will eclipse even Cunard's newly delivered *Queen Mary 2* is currently under construction at Aker Kvaerner Masa-Yards' Turku site. This is a circa 160,000gt hull of a so-called Ultra-Voyager class for Royal Caribbean Cruises - she will be 15% larger in space and passenger capacity than this owner's five-ship *Voyager* class, headed by *Voyager of the Seas* (*Significant Ships of 1999*) and completed by *Mariner of the Seas*, which was delivered at the end of October last year. More than 3600 passengers (double occupancy) will be able to

sail in her, which is 500 more than the earlier type, and the economies of scale are expected to be great. A huge crew of 1400 will be carried.

The hull will have a length of 339.00m and a breadth of 38.60m, and the service speed will be 22.00knots. Royal Caribbean estimates that the all-in costs are around US\$200,000 for each passenger berth. An option exists for a second ship.

HVAC package from Koja Marine

One of the important contracts secured by a subcontractor for this large ship is that won by

Koja Marine. The company will supply the complete heat, ventilation, and air conditioning (HVAC) package and electrical design for the ship plus all the equipment, such as airconditioning units, machinery space cooling units, and cabin fancoils, as well as all cabin supply and exhaust units, also all public room and galley air equipment. In addition, all relevant pumps and heat exchangers, demisters, electrical, and automation components will be provided. This contract marks a major breakthrough into passenger ships for Koja Marine. 

Engine production to cease at Turku

A FURTHER sign of the difficult times being experienced in Europe was the January announcement by Wärtsilä that it will discontinue engine manufacture at its Turku factory. The building of the large models will now be switched to Trieste (the former works of GMT but for several years now part of the Wärtsilä empire), while

Turku will concentrate on service and maintenance activities only. A reduction in the workforce is inevitable, from 680 persons at present to some 200 after this restructuring.

Production of the Wärtsilä 46 medium-speed engine will now be shifted to Trieste, to where all manufacturing previously

carried out in The Netherlands has already been moved. R&D and manufacturing at Vaasa will continue in their present form. Last September, Wärtsilä announced a plan to reduce its workforce by some 400-500 worldwide, but with the new plan, personnel will now shrink by some 1100 employees from its total at the end of 2003 of 12,100. 

Rolls-Royce to transfer Vancouver azimuth thruster manufacturing to Rauma

FOLLOWING a decision by Rolls-Royce to transfer the manufacturing of its azimuth thrusters in Vancouver, Canada, to Rauma, Finland, production volume at the latter unit will increase by one third. At present, production volume of integrated azimuth thrusters has been around 50-80 units in Vancouver and some 150-200 units in Rauma. All manufacturing of the company's new-generation azimuth thrusters will, through this,

be concentrated at its Finnish plant in Rauma, which now employs around 100 people in production.

'The value of azimuth thruster contracts signed in December alone exceeds €14 million, with deliveries to Spain, Russia, South Korea, and China,' Mr Kari Välimaa, manager of Rolls-Royce's Rauma plant, told *The Naval Architect*. One single contract comprised a total of 21 Ulstein Aquamaster units to Damen shipyard in

The Netherlands for eight tugs and, it is believed, the new TESO double-ended passenger ferry. In addition, azimuth thrusters were ordered for two road ferries and a barge in Sweden.

Rolls-Royce in Rauma, Finland, is a subsidiary of Rolls-Royce Plc. Rolls-Royce Oy Ab exports more than 90% of its production throughout the world. The Rauma unit, earlier known as Rauma-Repola and Aquamaster-Rauma, employs some 270 people in total. 

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Color Line's new cruise-ferry giant building at Turku

ALTHOUGH recent years have seen the cruise-ferry concept extensively applied and refined in Mediterranean and northwest European waters, the generic type has its roots in the Nordic maritime industries, and found initial expression on trans-Baltic routes. The Nordic sector is taking the technology an important step forward through Color Line's 74,600gt newbuild project at Kvaerner Masa-Yards' Turku complex - home of this owner's earlier ship, the 1987-built *Kronprins Harald*.

Described at the time of ordering as 'the world's largest cruise-ferry', the Norwegian owner is now seeking to underscore the distinctive nature of its project by alluding to the vessel as a 'cruise ship with car decks'. In fact, the nascent *Color Fantasy*, as she will be named, represents the pivotal element in a bold strategy aimed at fostering major growth in tourism and leisure business. In addition, the ship and associated terminal plus envisaged, adjacent hotel facilities could form an integral part of the proposed Fjordbyen scheme, aimed at re-development and re-vitalisation of the Oslo waterfront.

Color Fantasy promises to set a new benchmark in ferry design, offering a cruise standard to 2770 passengers in conjunction with a capacity for 750 cars and 1270 lane metres of trucks and trailers. *Color Fantasy* is scheduled to be ready for the 2004 Christmas season on the route linking Oslo and Kiel. The project and onboard standard which she will embody has been shaped to a large extent by Color Line's strategy of targeting the German market, and attracting more German tourists to Norway and to the company's own, growing network of hotels and leisure facilities.

The €302.5 million contract is by far the largest investment in the company's history, and among the highest-value, single-ship orders ever placed by the Norwegian shipping industry. Tourism is the fastest growing industry in the world, and it is felt that Norway offers significant scope in this respect.

The company acknowledges that the success of its Oslo-Kiel operation is dependent on the line's

TECHNICAL PARTICULARS COLOR FANTASY

Length, oa.....	223.90m
Length, bp.....	202.66m
Breadth (waterline), moulded.....	35.00m
Depth, to deck 3.....	9.5m/9m.7m
Depth, to deck 7.....	21.90m
Draught, design.....	6.80m
Draught, scantling.....	7.00m
Deadweight (approx).....	5000dwt
Gross (estimated).....	74,600gt
Passenger capacity.....	2750
Passenger cabins.....	968
Car capacity.....	750
Trailer lane metres.....	1270m
Main engines.....	4 x Wärtsilä 8L46B
Output.....	4 x 7800kW
Speed (90% MCR, 15% sea margin).....	22.10knots



A special feature on the new ship will be this circular observation lounge on the very top deck forward, from where spectacular views of the Oslo Fjord will be seen.



The Cosmopolitan à la carte restaurant will be one of the many attractive passenger amenities on board.

attractiveness in a demanding and quality-orientated market. Color Line accordingly took the view that it needed to offer passengers the same onboard attractions and standards that can be found in the latest generation of cruise ships. The goal is that the new ship should become an attraction in its own right, and not simply a transportation conduit.

While the contract secures work at the Turku yard for the equivalent of 1200 man-years, the technical sophistication, scale and outfitting-intensive nature also has important implications for the wider maritime industrial infrastructure. It

is expected to generate subcontractor activity equating to a further 1200 man-years or thereabouts, and a still greater level of work for suppliers of materials and components. The agreement with KMY includes an option on a second vessel.

Internal promenade

One of the key features of the nascent cruise ferry will be a three-deck, 9m-high promenade extending some 120m through the 224m-long vessel's passenger spaces. Innovative Kvaerner Masa-Yards introduced the revolutionary idea of

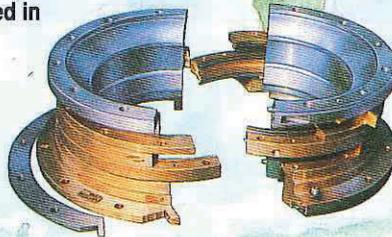
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The Royal Institution of Naval Architects has published the fourteenth edition of its annual *Significant Ships* series. Produced in our usual technically-orientated style, *Significant Ships of 2003* presents approximately 50 of the most innovative and important commercial designs delivered during the year by shipyards worldwide. Emphasis has been placed on newbuildings over 100m in length, although some significant smaller cargo ships, fast ferries and offshore vessels have been considered. We have included a cross-section of ship types, with each vessel being either representative of its type or singularly significant. Each ship presentation comprises of a concise technical description, extensive tabular principal particulars including major equipment suppliers, detailed general arrangement plans and a colour ship photograph.

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A typical Color class passenger cabin. All cabins have been prefabricated by Masa-Yards' Piikkiö works.



A standard integral wet unit for the new cruise-ferry, also supplied by Kvaerner Masa-Yards' Piikkiö factory.

such a huge internal space in ferry design some years ago, applying the concept for the first time in the 58,400gt Silja Line sisters *Silja Serenade* and *Silja Symphony*, delivered in 1990 and 1991, respectively. Color Line also examined closely the Voyager class cruise-ship class from the Finnish shipbuilder during the concept evaluation phase for its new vessel. These ships also feature an internal promenade.

Color Fantasy will include a spa centre, a water park, casino, cinema, show lounge, several discos and restaurants for different age groups and preferences, a conference section and exhibition area. Two leading Nordic interior studios with many references in the cruise-ship sector, Tillberg Design and Falkum Hansen, have been retained for the project. Prefabricated cabins, with integral wet units, will be supplied by Masa-Yards' Piikkiö factory.

The drive-through vessel's ro-ro spaces comprise the lower hold for trailers (deck 2), the main cargo deck for trailers, buses, cars and other vehicles (deck 3), a hoistable car deck (deck 4), and an upper garage for cars and campers (deck 5). Transfers between the main deck and the tanktop, or lower trailer deck, will be made by a

lifting platform, incorporating a watertight hatch. The upper deck 5 will be reached by ramp from the main deck level, and also directly by a shell door. The full shipset of access equipment, including the bow and stern doors and ramps, has been contracted from MacGregor.

Investment in the freight transportation role of the service, complementing the cruise standard of passenger facilities, is underscored by 1030lane metres of capacity for commercial vehicles and units on the main deck, plus 240lane metres for trailers in the cellar hold. The hoistable car deck sections provide a total area of 3100m², and a linear capacity for 2500lane metres of cars. The design arrangements are such that the aft car deck panels can function as hoistable access ramps, while two panels in the midship area will be hinged in a way that facilitates use as ramps, offering tilt in either direction.

MacGregor's scope of supply has also involved a total of 19 elevators, including three scenic elevators of the MiniSpace type, and the refrigeration plant for the provisions stores and catering areas.

Color Fantasy will employ a straight diesel-mechanical propulsion system, based on the use

of four engines of the Wärtsilä 46-series. The maximum power output of the plant will be 31,200kW. Two pairs of eight-cylinder 46B engines, individually turning out 7800kW at 500rev/min, will each drive a Kamewa Ulstein CP propeller through a Renk twin-input/single-output reduction gear; a power take-off shaft on each gearbox will drive a 6000kVA ABB alternator. The contractual service speed is just in excess of 22knots at 90% maximum continuous rating, and a top speed of around 23knots is anticipated. Auxiliary power will come from a genset plant, comprising four Wärtsilä 6L26B prime movers coupled to ABB alternators each of 2450kVA.

The Rolls-Royce group's input to the project will also encompass a considerable array of tunnel thrusters, comprising three 2200kW bow thrust units and two 1000kW stern thrusters, all from the Kamewa Ulstein range.

The newbuilding is due to replace the 36,000gt, 1981-built *Prinsesse Ragnhild*, which underwent a €10 million overhaul and modification programme at Blohm + Voss during 2002. The Hamburg yard's remit included the installation of a 350tonne ducktail at the stern. 

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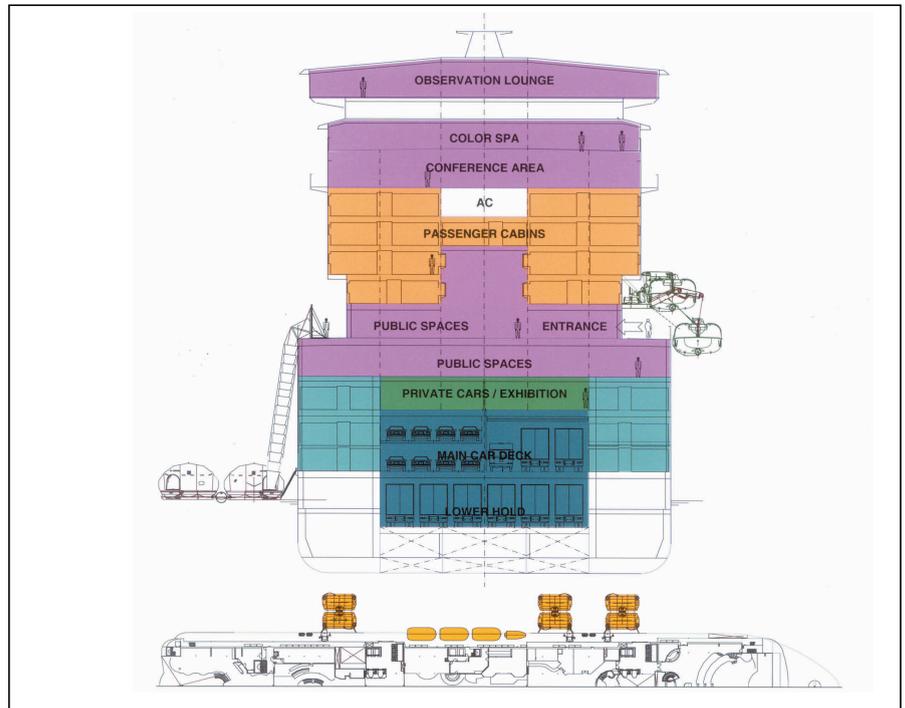
'Cruise liner with a car deck'

COLOR Line's giant new 74,600gt cruise-ferry under construction at the Turku complex of Aker Kvaerner Masa-Yards includes a number of interesting technical layout features. *Color Fantasy's* theme has been based on a modest volume of ro-ro space not extending over the hull's breadth, the inclusion of a interior promenade (first seen on the *Silja Serenade* in 1990), and with all passenger cabins in the superstructure, including some facing the promenade. The main vehicle deck (with hoistable platforms for holiday periods) is the bulkhead deck, as normal, but the relative narrow width has allowed crew cabins to be fitted in casings on each side - a rare feature. A separate garage deck for private cars or for use as an exhibition area is installed above, just one level below the lower public space deck; access is only provided through a door in the starboard shell, which links to a fixed shore ramp.

As can be seen in the accompanying illustration, the lower hold is very modest - partly a reflection of the large amount of machinery and HVAC plant needed in a ship for 2750 passengers and 968 cabins, plus a crew of 250 with 248 crew cabins. Indeed, the new vessel is described by Color Line as a cruise ship with a car deck!

The main passenger amenities for food/drinks, shops, and entertainment are located on two decks immediately above the upper car deck and are grouped along the indoor promenade - the focal point onboard. All passenger cabins are in the superstructure above, where more public amenities are situated.

A special feature will be an observation lounge on the very top level, from where



Cross-section through the new Color Line ferry, showing the arrangement of the vehicle decks and passenger spaces, also the position of the lifeboats and vertical escape chutes.

passengers should be able to enjoy superb views on voyages between Oslo and Kiel. Passengers should be able to find their way around the ship very easily, since there is a large main hall fore and aft, complete with lifts.

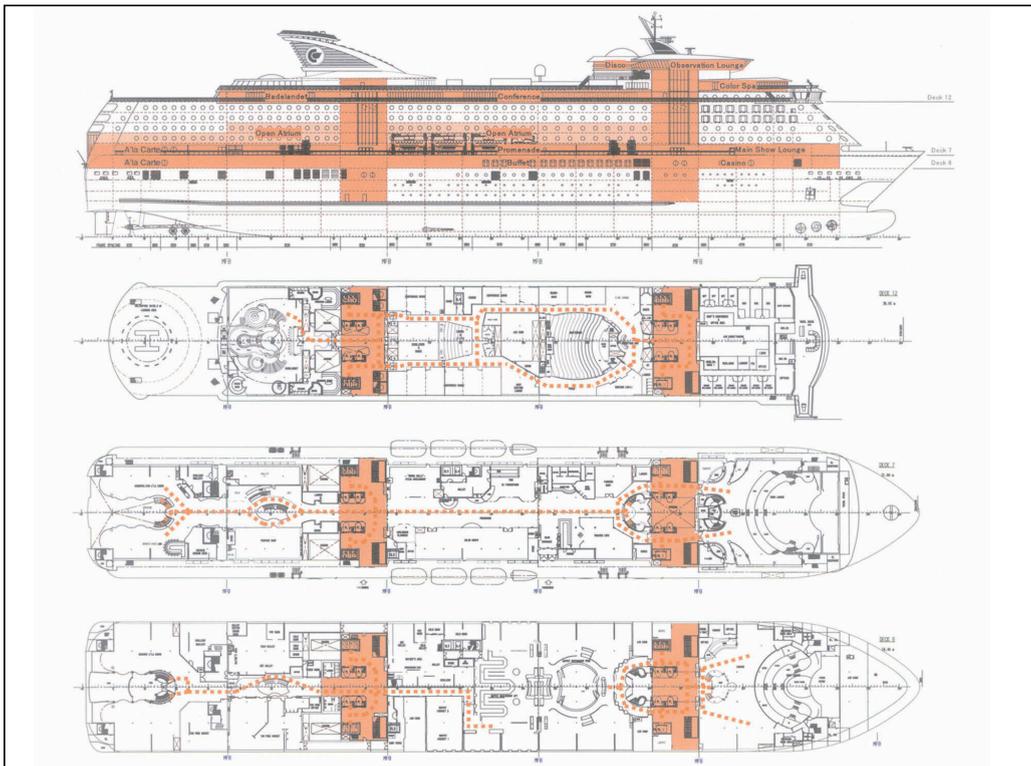
Despite the narrow main vehicle deck and a row of central pillars, drive-through space is provided for six lorry lanes. Four-lane hoistable

platforms for cars are provided to both port and starboard. The lower hold is only served by a lift and is intended for semi-trailers. Space is also provided here for provision and laundry trailers, with access ramps to storerooms. Four service lifts - two forward and two just aft of midships - allow stores to be transferred to the passenger areas.

New regulations dictate that all escape stairways on ferries must not lead through than two deck levels, up or down, before reaching a muster station or an open deck. In a large cruise-ferry, accommodation spaces can be on more than 10 levels above the bulkhead deck. This means that escape routes must be arranged in a different way than in large cruise liners. On the new Color Line ferry, the boat deck is the upper of the two main public-space levels, and on each side of the hull are three lifeboats and three vertical chutes.

Today, Color Line is carrying around 600,000 passengers annually on the Oslo-Kiel route, but with the introduction early in December this year of the fine new ship, this figure is expected to rise significantly. An option exists for a sister. ⚓

Profile and some deck plans showing the principal passenger flow routes centred on the large stairway halls fore and aft.



Hi-Fog fire protection for new Brittany Ferries ship

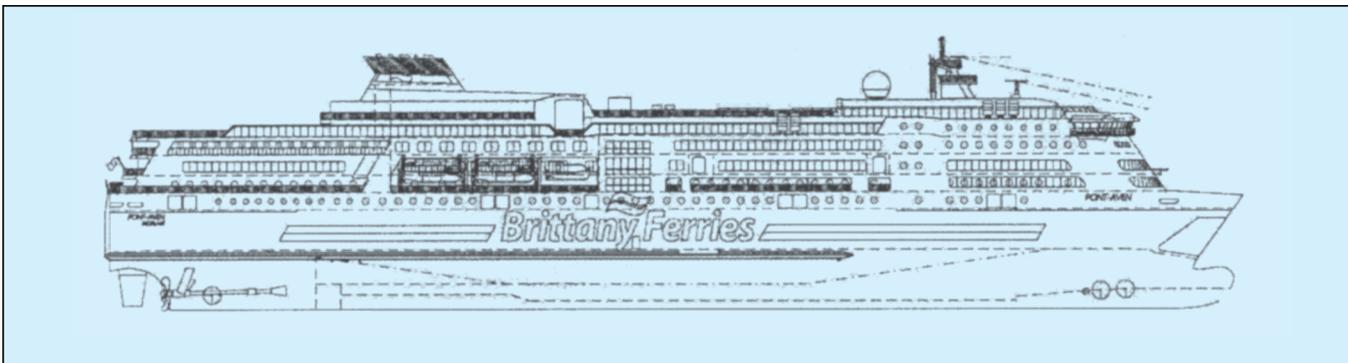
BRITTANY Ferries' brand-new ship *Pont-Aven*, which is due for completion soon by Meyer Werft, will be a further example of how a Marioff Hi-Fog total fire safety concept can be utilised to the benefit of both owner and yard. A Hi-Fog installation will provide complete protection,

covering all accommodation areas, deep-fat fryers, galley ducts, as well as total flooding and local application protection for the machinery space.

Thus, one system instead of five independent ones will significantly reduce the capital and installation costs. In addition, equipment weighs

less, requires less space, and reduces the volume of project, training and service work. Additional savings have been made on *Pont-Aven* by using the Hi-Fog 2000 system in accommodation areas, resulting in a saving of some 20% in the number of sprinklers. 

Profile of Brittany Ferries' new *Pont-Aven*, scheduled for completion soon by Meyer Werft. She is fully protected by a Marioff Hi-Fog water-mist firefighting system.

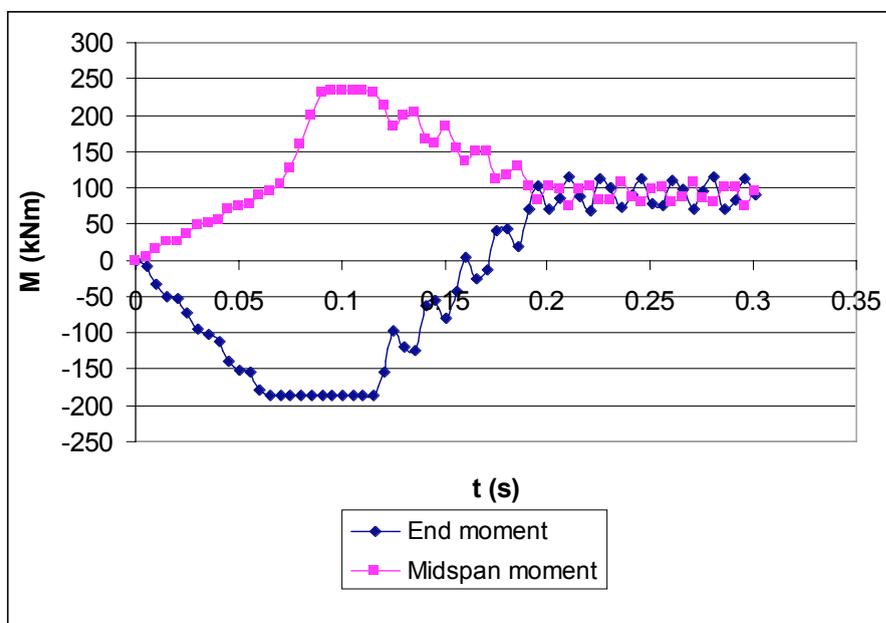


New software analyses complex beams under impulsive loading

ANALYSIS of beams subject to blast loads, wave slam, and vehicle impact, for example, is often a straightforward hand calculation exercise. However, if complications of initial loading, non-uniform cross-section, or plastic yielding are introduced, analysis by hand becomes significantly more time-consuming and difficult, and a more advanced computer analysis is necessary. To help with such calculations, a program to analyse complex beams under impulsive loading, EC-DYABLO, has been released by the UK company Electronic Calculus Ltd.

There are a number of general-purpose structural analysis programs available with facilities for complex beam dynamics problems, but these can be expensive and cumbersome for everyday use, such as for beam design. There is a need therefore for a method of dynamic analysis, intermediate between the usual simplified equivalent single-degree-of-freedom methods and the general-purpose structural analysis program approach, specifically for complex beams. EC-DYABLO has been developed to meet this need.

EC-DYABLO performs a direct numerical integration of the beam-column equations of motion in finite-difference form. The forcing function is a generalised impulsive load superimposed on a given static equilibrium state. The maximum total deflections, bending moments, and shear forces are determined as the integration proceeds. EC-DYABLO also includes a non-linear static analysis option for determination of the initial conditions prior to dynamic loading and an option for a time-history dump. The main analytical capabilities of EC-DYABLO are as follows:



This figure illustrates the elastic-plastic dynamic response of a fixed-end steel beam subject to a short triangular impulse load uniformly distributed along the span. Formation of plastic hinges and development of residual moments can be observed clearly. The new program EC-DYABLO can help to solve problems related to beam loads.

- variable cross-section properties along the beam length
- generalised end conditions
- intermediate fixed and/or elastic supports
- initial loading, including an axial load
- variable impulse load distribution
- generalised impulse shape with positive and negative phases
- elastic-plastic bending, including strain rate effects. 

Guide for ergonomic design of navigation bridges

A PRACTICAL guide that addresses the role of human factors within marine safety has recently been released by ABS, entitled *Guidance Notes on Ergonomic Design of Navigation Bridges*. This classification society recognises that the vast majority of shipping accidents involving collisions and groundings stem from activities on the navigation bridge and that when bridge activities rely on interfaces that are awkward for the mariner, human errors relating to judgment and vessel control can occur.

The new guidance notes build upon ABS' work from its 1998 *Guidance Notes on the Application of Ergonomics to Marine Systems*. This latest addition provides practical criteria for the effective ergonomic design and layout of interfaces located within the navigational bridge area. Criteria include general ergonomic design guidance for navigational bridges, specific bridge design guidance, incorporating information from international sources such as IMO, and a process to identify individual vessel bridge requirements to guide the application of ergonomic design principles.

In an effort to reduce the potential for human error, the criteria is aimed at providing designers and engineers with practical guidance and work processes to use from the concept stage for effective integration of ergonomics and engineering. Effective ergonomic design and layout integrates personnel with systems and their interfaces.

For instance, human-system interfaces include controls, displays, alarms, video-display units, computer workstations, labels, and overall workspace arrangement. ABS believes that without consideration of personnel during design, interfaces may not meet the needs and expectations of personnel and human errors may result. By targeting guidance to the specific area of a vessel where mariners exert the greatest influence over operations and safety, the potential for reducing human error is magnified.

A&P promotes newbuilding hall

IN an interesting move, UK shiprepairer the A&P Group has reached an agreement with the Cammell Laird Waterfront Park to promote and use the former Cammell Laird yard at Birkenhead for shipbuilding. The covered construction hall there, built in the 1970s, was, at the time, one of the most modern sites in Europe.

Although unused for building since the collapse of the UK shipbuilding industry, the hall has been used for fabricating modules and sections for other UK builders and repairers. A&P took over the repair facilities of Cammell Laird in 2000. The covered facility was to have been part of the local 'waterfront' development, which includes a snowdome facility. However, under the terms of this new agreement, A&P Birkenhead will be the 'preferred' user of the facilities to explore the shipbuilding market. Ⓡ

Sections in this guide include: maintenance by bridge watchstanders, personnel safety, facilities, detailed design, design of alarms and warnings, as well as:

- bridge arrangement and layout: this part specifies the basic function and design requirements. It ensures safe navigation through preventing confusion arising from bridge layout, design for ease of device access and use, and reducing workload and human fatigue
- console and workspace design: specifies the design and use of consoles and workstations on bridges

- work environment: this section addresses task performance design considerations associated with the navigational bridge work environment, including vibration, noise, lighting, device and instrument illumination, and heating, ventilation, and air conditioning
- ergonomic design and evaluation: this appendix presents a basic ergonomic design process that can be performed during the initial design of a new navigational bridge. It also presents a series of processes for improving the interface design of existing bridges.



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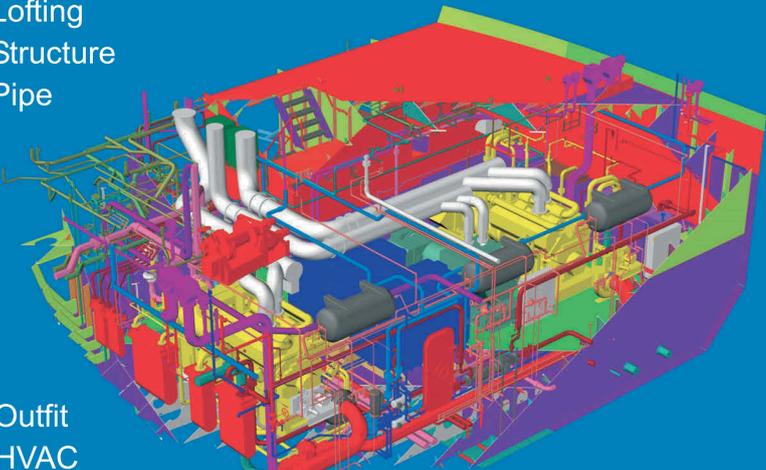
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Ship Hydrostatics and Stability

By *Adrian Biran*. Butterworth-Heinemann, Linacre House, Jordan Hill, Oxford OX2 8DP, UK. Softback. 344 pages. Price: £40. ISBN 0 7506 4988 7.

The author is adjunct assistant professor at TECHNION, the Israeli Institute of Technology, and his book is based on a course of ship hydrostatics delivered over some 25 years. The book is aimed primarily at undergraduates in naval architecture and ocean engineering, although practising naval architects will find some sections valuable for reference.

In this they will be aided by the layout adopted for the book. Each chapter ends with a summary of the matter covered, which will help reinforce the lessons learnt by the student and refresh a more experienced reader's memory, with the ability to refer to the main body of the chapter if more information is needed. Some of the important points in the text, and the corresponding index, are presented in French, German and Italian, besides English.

The author acknowledges the part his students, over the years, played in shaping the book. Their feedback has helped to make the presentation clearer and more complete to cover questions raised by students in the past. This is reflected, for instance, in the attention given, in early chapters, to definitions of hull shape and to the proof of Archimedes' principle. The treatment is more rigorous than that to be found in most textbooks and does lead to a better understanding of the principles involved.

As one would expect, much of the book reflects the traditions associated with such a long-established activity. However, the author includes the results of much recent research and includes the latest stability regulations from around the world, and devotes a complete chapter to parametric resonance. An extensive bibliography directs the student to the sources of information discussed and provides means of following up any point in more depth.

As an illustration of the author's thoroughness, he covers the stability regulations of IMO, the US Navy, the British Royal Navy, and the German Federal Navy (GFN) for both intact and damage stability. The regulations for the GFN are singled out as the only ones, as far as the author is aware, to include parametric resonance, that is the effect of waves on a ship's stability and, in particular, longitudinal and quartering seas - the so-called Mathieu effect. This effect is thought to explain why some ships have been lost in a seaway when they meet all the requirements of intact stability in still water.

The text contains a number of worked examples and each chapter ends with some set exercises. Sometimes hints are given to assist the student in tackling these exercises. In some of the examples, use is made of computer methods based on Excel or MATLAB. A website is quoted from which more information on the use of MATLAB files for hydrostatic and stability calculations can be accessed.

Although not specifically covered by the book's title, one chapter is devoted to the linear response of a ship in waves. The final chapter deals with computer methods including various ways of representing and fairing the ship's hull.

I found the book to be a thorough, well-referenced treatment of those areas of naval architecture it set out to cover. The subject matter is developed in a logical way as the reader progresses through the book. It will be very useful to those taking a degree or practising in the field. Seagoing engineers and masters will find much of interest and will be able to pass over the more advanced treatments of some aspects of the subject.

Eric Tupper

There Go the Ships

By *Marshall Meek*. *The Memoir Club*, Whitworth Hall, Spennymoor, County Durham, UK. Hardback. 273 pages, 29 illustrations. Price: £17.50 from *The Royal Institution of Naval Architects* bookshop (RINA members: £15.50). Post and packing: £2.50 (UK); £3.50 (Europe); and £7.50 (rest of world). ISBN 1 84104 045 2.

This book makes very interesting reading. Marshall Meek, as a professional naval architect, has had a very varied experience and has tackled many fascinating problems. He speaks his mind, giving his views upon many of the events and the great names in the industry over the last 60 years. He is not afraid of being controversial but gives the reasons for his opinions. Not everyone will agree with all his assessments but, as he says, this is how he saw things. Not many would disagree with him when he says that the rapid decline of the UK shipbuilding industry was due to negative attitudes of the unions with their demarcation disputes, coupled with poor management unable to adapt to the changing world around them. He also notes the unwillingness of the industry to employ reasonable numbers of graduates.

As Lord Greenway says in the foreword, Marshall's career spanned 'a period during which shipping underwent a revolution every bit as far reaching as when steam replaced sail'. That career began as an apprentice in the drawing office of the Caledon shipyard in Dundee.

Anyone who served in shipyards in the 1940s and 1950s will remember the bowler hats and recognise the 'types' mentioned in the early part of the book. Somehow, there seemed to be many more 'characters' around in those days.

The book is a blend of personal reminiscences, including his family and religious beliefs, and matters of great national and international importance. As such it will interest not only naval architects but also all involved with shipbuilding and shipping in the 20th century and the social historian. Reading it gives an insight to life generally in that period. Non-technical readers will find the book easy to follow because Meek has the knack of explaining ship terms and design processes in a way a layman will find easy to follow.

The author's career covered building, design and research; it included merchant ships and

warships. It involved visiting major shipyards all over the world and designing ships for a wide range of cargoes. His career was clearly very absorbing and satisfying. The 'best bit' was the 25 years he spent with Blue Funnel Line (in its various incarnations) including responsibility for cargo ships and then for the first purpose-built container ships and later for chemical carriers. Now that container ships are so firmly established, it is difficult to appreciate what a major change they represented and the uncertainties involved. Later he played significant roles in the inquiries into the *Herald of Free Enterprise* and *Derbyshire*, and into the vexed questions of short fat ships and how to achieve cheaper warships.

Over the years Meek was associated with all the major maritime institutions and became president of both The Royal Institution of Naval Architects and the North East Coast Institution of Engineers and Shipbuilders. He was appointed a Fellow of the Royal Academy of Engineering and a Royal Designer for Industry. In recent years there has been some debate within The Royal Institution of Naval Architects on 'what is a naval architect?' and what is naval architecture? I venture to suggest the answers might be that they are what Meek was and what he did.

I have known Marshall over some years, principally through his work with The Royal Institution of Naval Architects and, in particular, when he was president but reading this book has given me a more rounded picture of the man. His experiences show what a fascinating career one can have in the maritime field. To quote his own words, Marshall was 'striving not just to record my own modest part in the nation's maritime affairs, but also to paste my experiences on to the more extensive maritime scenario.' I would say he succeeded very well in his aim.

Eric Tupper

EU Parliament vote on ship pollution

LAST month, the European Parliament voted on a new EU directive aimed at combating pollution. Under the new rules, it will be a criminal offence to cause marine pollution from ships. Sanctions will be applicable to any person or organisation which has caused or contributed to illegal pollution intentionally or through gross negligence - this includes the master, owner, operator, charterer, or classification society.

Parliament members also inserted a clause on voyage data recorders with a speeded-up timetable for their installation on different types and sizes of vessels. Further amendments were adopted on the definition of illegal discharges and on the development of information and warning systems. A majority of members also called for a European coastguard to carry out spot checks on all coastlines. In a separate vote, members supported a proposed regulation strengthening existing rules on the transfer of ships between EU registers. Ⓡ

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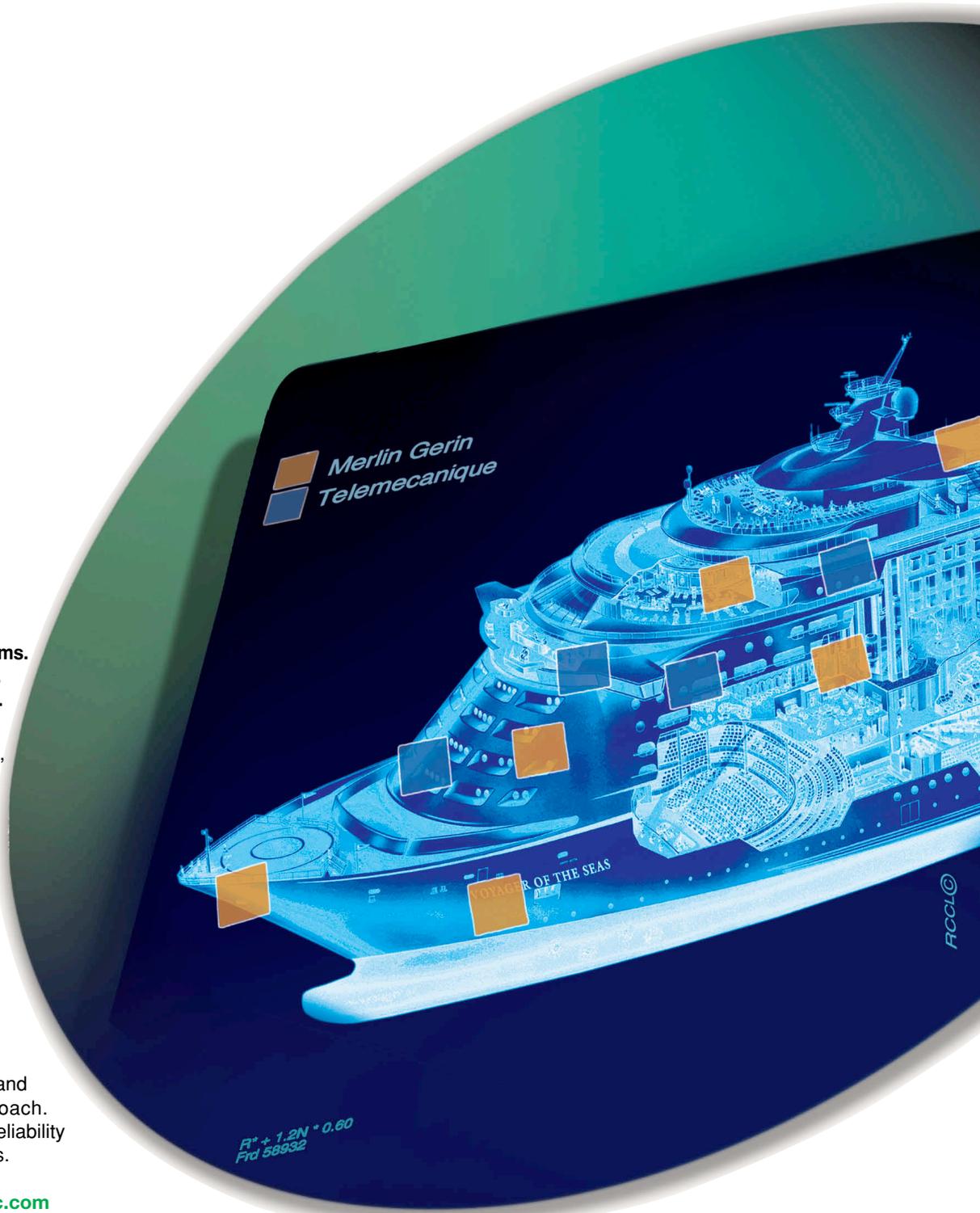
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Developments in water-lubricated bearing technology

At the MARI-Tech Conference, held on May 28-30 last year, John Shaw, PEng, from Canadian company Thordon Bearings Inc, a manufacturer of elastomeric polymer water lubricated bearing technology, discussed the latest developments in such technology, and highlighted the development of new-generation water-lubricated bearings as a viable alternative to oil-lubricated stern tubes for the commercial shipping industry. This includes the evolution of a hydrodynamic water-lubricated bearing design, featuring the ability to remove the bearing elements without removal of the tailshaft, recently installed and proven on the latest series of Princess Cruises and Disney cruise ships.

NOT normally thought of as a lubricant, water does not exhibit the high viscosity and lubricity associated with a recognised lubricant such as oil. However, water does possess finite viscosity and density and is therefore capable of supporting a hydrodynamic film. The problem that must be overcome is the speed range from 0rev/min to the point where the shaft rev/min is sufficient to produce a hydrodynamic lubricating film separating shaft and bearing.

A superior water-lubricated bearing would therefore be based on a bearing material with good self-lubricity characteristics, excellent wear resistance, and a design that encourages the rapid generation of a hydrodynamic film. Convinced that significant improvements could be achieved in the performance of water-lubricated propeller shaft bearings, Thordon Bearings studied the principles affecting bearing performance and found that the most important variable is the early build-up to a hydrodynamic film in both oil and water lubricated bearings. This can be illustrated by a typical 'Stribeck curve' which plots the coefficient of friction against the hydrodynamic parameter Zn/P is shown in Fig 1 and is divided into three main lubrication regimes (Ref 1).

In the first (Boundary) regime, direct contact exists between the shaft and the bearing resulting in high friction values. In this region of the curve, high bearing self-lubricity is of significant benefit. As the shaft speed increases we move into the second (Mixed film) regime of the curve where the hydrodynamic film starts to build and effectively 'lifts' the shaft from the bearing surface. The result is less shaft to bearing contact and friction drops rapidly. Further increases in speed take us into the third (Hydrodynamic) regime where the hydrodynamic film builds sufficiently to eliminate all direct contact. As speed continues to increase, friction begins to increase because of the increasing shear resistance imparted by the viscosity of the lubricant.

The transition between lubrication regimes during operation of a bearing depends on lubricant properties, velocity and load. The curve profile and definition of transition points will depend on the bearing geometry, clearance ratio, self-lubricity of the bearing material and surface finish.

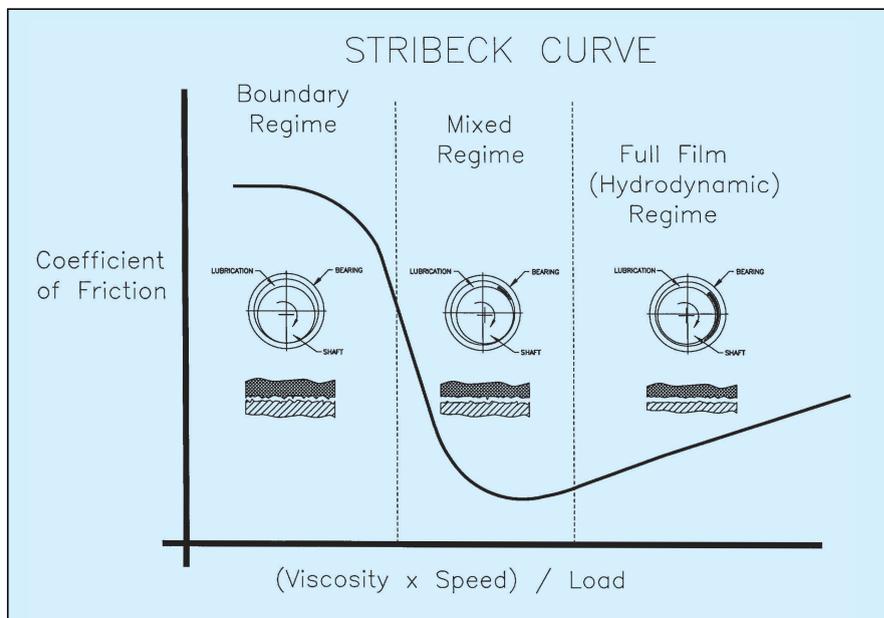


Fig 1. The Stribeck curve, illustrating the build-up of hydrodynamic film.

A higher viscosity lubricant results in the generation of a hydrodynamic film at a lower shaft speed and effectively moves the transition points to the left. Increasing the viscosity, however, also increases the minimum operating coefficient of friction. Lowering the coefficient of friction of the bearing material results in decreased friction at shaft speeds below the point where full hydrodynamic operation occurs. The geometry of the bearing, and in particular, whether the bearing is grooved also affects the curve. A continuous bearing surface without grooves allows the hydrodynamic film to build to a higher thickness than one with grooves (Fig 2). Hydrodynamic calculations show that the film thickness of the lubricant for a conventionally grooved marine bearing is 25% of that for an ungrooved bearing. As a result, there is a greater chance of contact between the shaft and the bearing when a grooved design is used.

Historically, water-lubricated marine propeller shaft bearings have almost always been grooved. Lignum vitae was the common material used and, due to its size limitations, bearings were designed using long staves, dovetailed or locked into a housing with water grooves between them. To reduce the pressure on the bearings and provide more area to build hydrodynamic film, the aft bearing was normally designed at a 4:1 length to diameter (L/D) ratio and the forward bearing at 2:1. As other materials became available to replace lignum vitae, they were designed into the same housings according to the same low-pressure values and incorporating water grooves. However, the full potential of these new materials was not being utilised.

An elastomeric polymer produced by Thordon Bearings was one of the 'new' generation of bearing materials introduced to the marine market in the 1970s. Although able to support higher

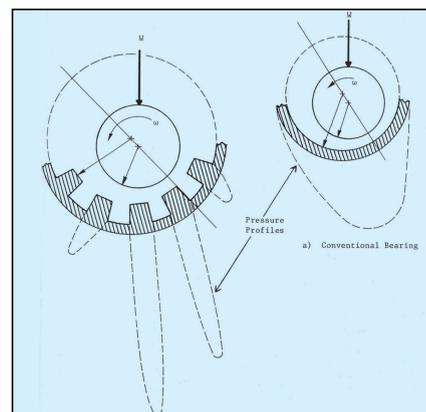


Fig 2. Contrast in build-up of hydrodynamic film pressure in a grooved and ungrooved marine bearing.

pressures and demonstrating a significantly lower coefficient of friction, elastomeric polymer bearings were caught in the inertia of the existing designs and were specified in either stave or fully grooved tube configurations at 4:1 L/D ratios.

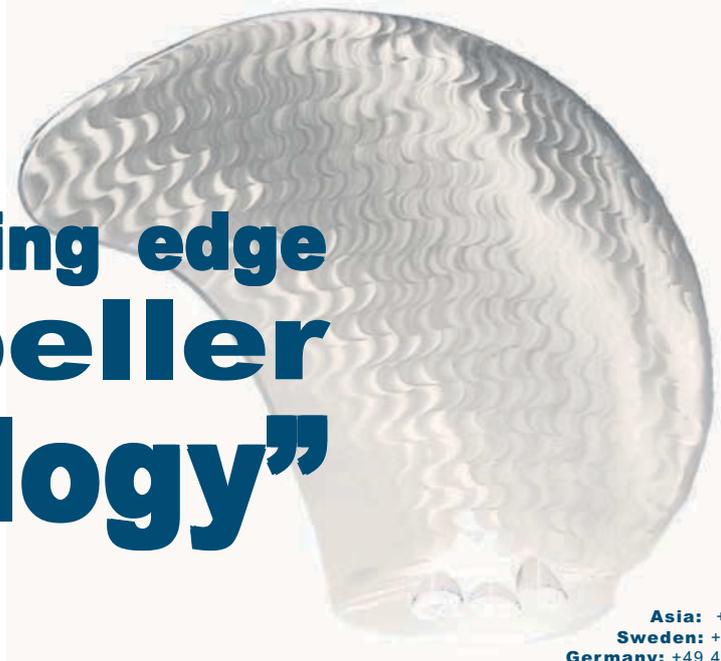
Recognising the benefits of applying the principles previously presented in this article to marine propeller shaft bearings, a research project was started. Based on the benefits calculated for an ungrooved bearing versus grooved bearing, a configuration with a plain lower half and grooved upper half was selected. The plain lower half facilitated optimum build-up of a hydrodynamic film, while the grooved upper half allowed adequate water flow through the bearing to maintain the hydrodynamic film and cooling.

The next variable investigated was the bearing length. Due to the significantly higher load carrying capability of elastomeric polymer

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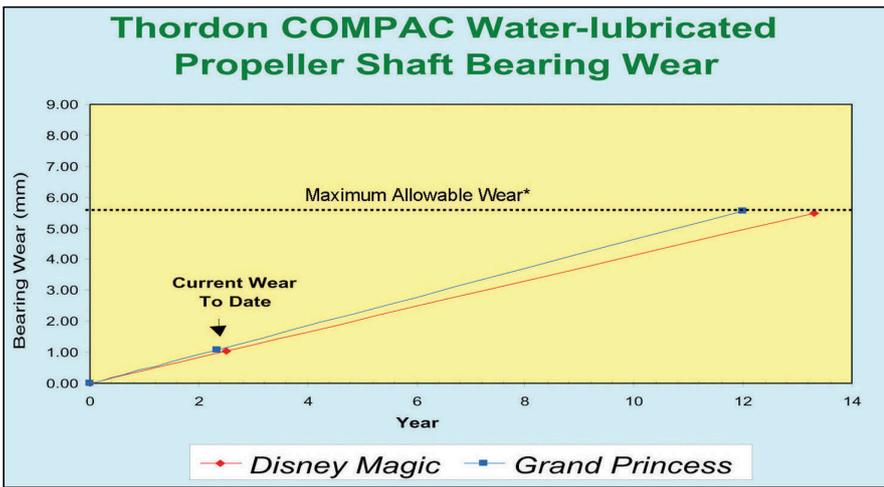


Fig 3. Bearing wear measurements taken from cruise ships, *Disney Magic* and *Grand Princess*, both fitted with elastomeric polymer water-lubricated bearings.

bearings compared to other materials, tests were conducted comparing Thordon XL elastomeric polymer bearings run at 4:1 and 2:1 L/D ratios. The applied load was identical for both bearings and resulted in a pressure of 0.24MPa for the 4:1 design and twice that for the 2:1 bearing. There was a substantial reduction in friction with the 2:1 design. The other operating characteristics of the two bearings were similar except for the differences in friction. The decreased friction for the 2:1 bearing resulted from the additional shearing action imposed on the water in the forward half of the 4:1 bearing.

The next step was to determine the overall effect of the shortened L/D ratio, the removal of grooves from the loaded area and the inherent lubricity of the bearing material. As stated earlier, direct shaft to bearing contact exists when operating in regimes 1 and 2 of the Stribeck curve. In these situations, use of a bearing material with a higher degree of inherent lubricity should result in reduced friction.

A new elastomeric polymer with a higher self-lubricity was developed, and tests were conducted in the 2:1 configuration against a Thordon XL bearing and flat segmented rubber bearings in 4:1 configuration. The new elastomeric polymer in the 2:1 configuration was called the Thordon COMPAC system. The COMPAC system test results show how the Stribeck curve moved, illustrating a reduction in the operational time for both the solid friction and boundary lubrication regimes and decreased friction levels during hydrodynamic operation. Breakaway torque and operational friction were both substantially reduced, translating into smoother operation, decreased wear and increased operating efficiency.

The performance of a successful stern tube bearing application is dependent upon the early development of a hydrodynamic film. This ability will be affected by a number of factors including, the unit load on the bearing, the bearing configuration and the linear speed of the shaft over the bearing.

A question that is frequently asked is 'At what speed will the shaft become hydrodynamic?' The testing completed during the development of the COMPAC bearing profile was conducted at increasing bearing pressures. The measured friction versus shaft speed was plotted for predetermined bearing loadings. From the previous discussion on Stribeck curves, the point of initiation of hydrodynamic operation is the lowest point of the curve. This bottom point will move to the right as the unit loading on the bearing increases. The points at which hydrodynamic lift is achieved can be described in a ratio between the linear speed of the shaft over the bearing surface versus the unit pressure. The ratio is consistent as the pressure range increases and thus can be used as a design tool.

The equation used for calculation of hydrodynamic lift is thus:

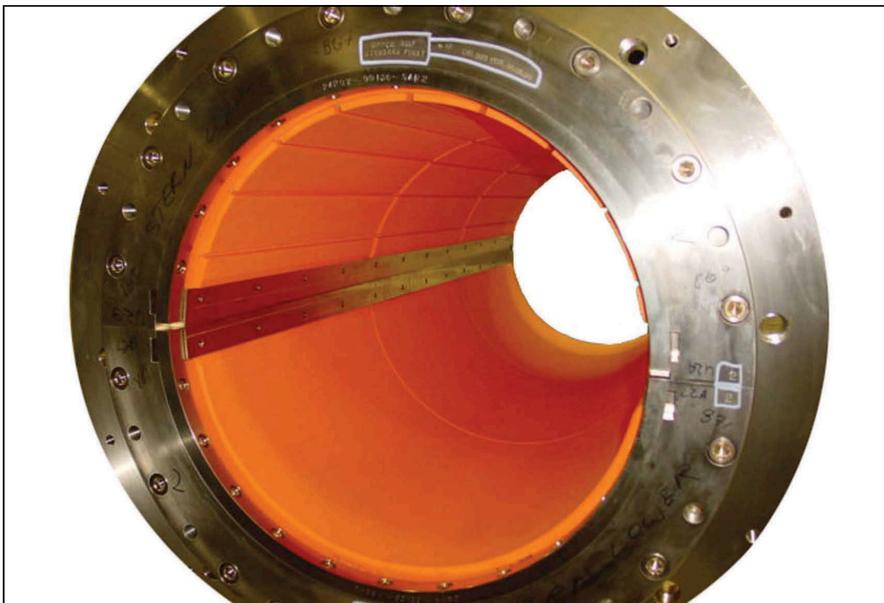
$$V/P = \text{Constant (K)}$$

- Constant
- Plain Bore - 7
- Stave - 14
- SAE 30 wt Oil-3

- V - linear velocity (m/min)
- $V = \pi * D * N$
- D = shaft diameter (m)
- N = rotational speed (rev/min)
- P - pressure (bar).

A major factor contributing to the wear life of a water-lubricated bearing is the quantity and type of abrasives in the cooling water stream pumped into the stern tube. When the shaft operates in hydrodynamic conditions, a layer of water is built up between the shaft and the bearing. The thickness of this layer is dependent upon the linear velocity of the shaft over the bearing material and the unit loading on the bearing. Still, with the improvements in materials and design, the wear life for different operating conditions and water quality was not always predictable. To improve bearing wear predictability and increase wear life to a level approaching that of an oil-lubricated white metal bearing, further study of abrasive and wear parameters was required.

Elastomeric polymer bearing with split housing with keys on either side for the Grand class cruise ships.



Single key design

At the request of ship operators, the means of securing the bearing into the stern tube was examined to provide a method of removing the bearing without having to remove the tailshaft. There were two historical methods of fitting a non-metallic bearing into a stern tube. The first was to fit a cylindrical bearing element into a bronze housing. The bronze housing was then fitted in to the stern tube on the vessel. The bearing element was retained in the housing using the hoop stress developed by fitting into the bronze housing. Second, the housing could also be fit with dovetail grooves, which would be filled with stave elements. Staves could also be fitted into a smooth bore housing and retained by keys at the 3 o'clock and 9 o'clock positions.

These methods allowed for the retention of the bearing material and ease of construction. If bearing elements required replacement because of wear, the tailshaft would need to be withdrawn to gain access.

In the early 1990s, the split housing was developed where the bearing material was



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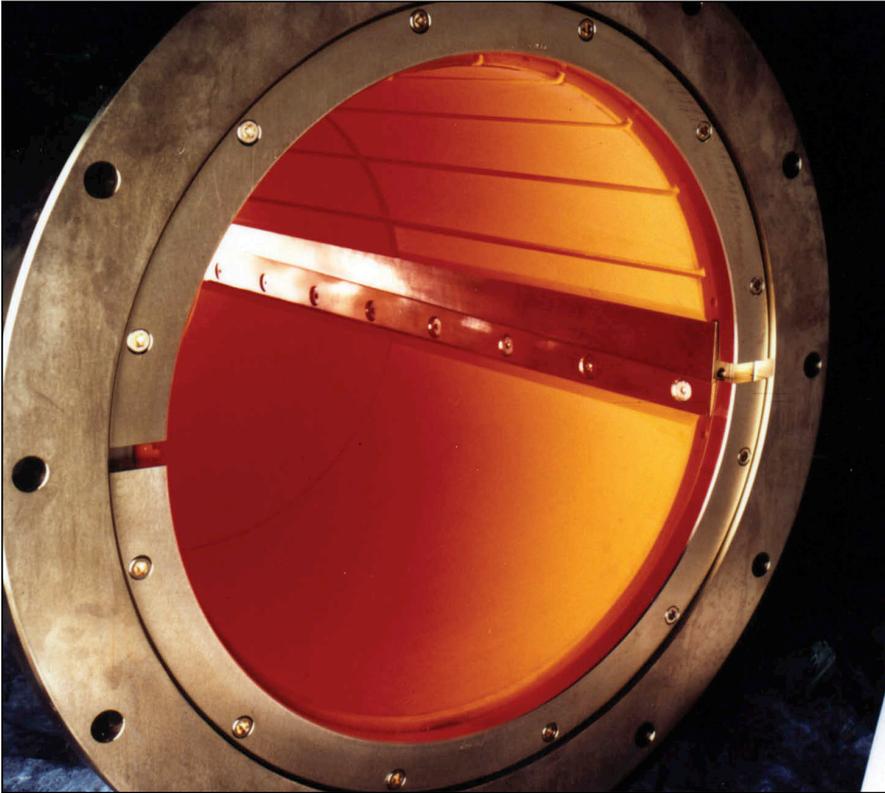
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Single-key bearing design used on *Disney Magic*.

retained with keys on either side. This allowed for the housing to be pulled out for examination of the bearing material. This method was used on Princess Cruises' Grand class cruise ships. In the late 1990s the method of retaining the bearing material was refined to allow for the bearing elements to be removed without removing the bearing housing. The bearing is manufactured in split halves and is retained in the housing using a single tapered key (as shown above). When the key is slid into position, the bearing element is compressed, generating hoop stress in the bearing to retain it in location. Removing the sliding key removes the hoop stress and allows the bearing elements to be removed. This method of bearing

retention has been successfully implemented in the Disney cruise ships and many navies around the world.

To fulfil the requirements of various naval contracts, the ability to remove the bearing with the shaft in place had to be demonstrated. In 2001, *Disney Magic* docked in Norfolk, Virginia and the bearing elements were removed, inspected and re-installed, with the shaft in place over a 4hour period as shown below.

Current developments

Wear in a water-lubricated bearing is typically due to either abrasive wear or adhesive wear. Adhesive wear is the result of excessive contact

Elastomeric polymer bearing removed, inspected and re-installed with the shaft and carriers still in place during scheduled drydock of *Disney Magic* at Norshipco, Virginia, USA.



A sterntube water quality package.

pressure between the bearing and the shaft or slow speed motion of the shaft over the bearing. Adhesive wear can normally be controlled through use of proper materials, design and fit of the bearing. Low coefficient of friction materials will reduce the incidence of bearing material adhering to the shaft and being removed from the bearing surface. The newest grades of materials typically have coefficients of static friction of 0.15 to 0.20.

The second wear factor is abrasive wear resulting from third particles becoming lodged between the bearing and the shaft that physically remove either bearing material or shaft material. Abrasives are found in the cooling water that is fed into the forward end of the sterntube and then flows over the surface of the shaft. The size of the particle that can be trapped is dependent upon the film thickness between the bearing and the shaft and is typically in the order of 10microns. To put this into perspective, 100microns is approximately the size of table salt. Particles smaller than this normally pass through the fluid film with minimal contact of the bearing on the shaft and exit out the aft end of the sterntube.

To enhance the wear life of the bearing it becomes essential to remove particles in the cooling water that are larger than 100microns in size. Thordon has utilised separation technologies based upon centrifugal force to develop a water quality package that can remove particle size to as low as 50microns.

In conclusion, Thordon Bearings is committed to the development of open water-lubricated bearing technologies, which provide similar service life and reliability of oil lubricated white metal bearings. The wear life of water-lubricated sterntube bearings thus becomes much more predictable as evidenced by the expected wear life of the elastomeric polymer bearings fit on *Grand Princess* and *Disney Magic* (Fig 3). Ongoing research continues to improve elastomeric polymer propeller shaft bearing systems providing commercial ship owners with a robust, reliable, non-polluting bearing system. Ⓜ

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1. Juvinal, Robert C, Fundamentals of Machine Component Design. New York: John Wiley & Sons, 1983: 389-391.

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Zeeweed membranes for cleaning wastewater

ZENON, from the USA, a leader in membrane technology for water and wastewater treatment, has recently developed ZeeWeed MBR, incorporating ZeeWeed membranes (immersed ultra-filtration membranes) at the core of the system. This modular, expandable system produces an effluent to near drinking water quality and has a small footprint, which allows vessels incorporating this technology to accommodate travel itineraries within sensitive waterways and regions previously inaccessible for passage. Marine ZeeWeed MBR is claimed to successfully treat any combination of grey and black water.

This system meets USCG, IMO-MARPOL, and Alaskan State House Bill 260 regulations, and requires only minimal operator intervention and training. It has a self-cleaning system, and is adaptable to most ship designs and configurations.

ZeeWeed MBR has a low energy consumption and is unaffected by variations of flow, temperature, or waste strength. It is resistant to fouling and sludging, and produces extremely low sludge yields.

ZeeWeed MBR utilises a simple process for treating grey and black water onboard ships. Wastewater from grey and black water collection tank(s) passes through primary screening to remove plastics as well as larger particulate and debris. The screened waste is then processed by ZeeWeed MBR. The system biologically breaks down the wastewater through aerobic digestion. Solids are kept in suspension through mixing and aeration.

The system operates at mixed-liquor suspended solids (MLSS) concentrations of 15,000mg/litre to 20,000mg/litre, allowing

extremely high recovery rates, smaller tank volumes, lower sludge yield, and longer sludge retention times. ZeeWeed ultra-filtration membranes are immersed in the bioreactor and form a barrier to biomass, solids and oocysts, resulting in a clear effluent regardless of the MLSS concentration or the settling characteristics of the sludge. ZeeWeed membranes reject any particles larger than 0.035µm in size.

Results are said to show biochemical oxygen demand (BOD5) and total suspended solids (TSS) levels near zero every time the system is used, independent of operator efficiency, upset conditions, or sewage temperatures. More information on this concept appeared in our associate journal *Shiprepair and Conversion Technology* 2nd Quarter 2002 page 25. Ⓡ

Class society offers 'green' notation

AS a typical example of the new trend towards 'green' awareness, Lloyd's Register offers (as do other class societies with similar notations) its Environmental Protection notation, a voluntary symbol which indicates that an owner or operator has incorporated ship design, equipment, and operational features which exceed current regulatory requirements for managing environmental risks.

This notation demonstrates to maritime authorities that an owner or operator is environmentally conscious. For example, Stelmar has been awarded the notation for its 70,000dwt panamax tanker *Cabo Hellas*, delivered in November last year; it expects that a further four of its newbuildings (all also 70,000dwt Panamax tankers) - *Cabo Sounion*, *Reymar*, *Reginamar*, and *Reinemar* - currently being built at Daewoo, will also receive the notation.

Stelmar was also awarded in 2001 Lloyd's Register's ballast water management plan (BWMP) notation for every vessel in its fleet. The BWMP notation provides a solution to the potential loss of hull integrity resulting from unplanned loads arising from ballast water transfer and subsequent losses from the interruption of business. It recognises and provides a structured and auditable way of dealing with unique loadings experienced in seagoing ballast operations and gives owners and ports confidence that the operational and environmental risks are being adequately addressed.

The core requirements of the notation cover:

- oxides of nitrogen (NOx) and sulphur emissions (SOx)
- refrigerants and firefighting agents
- oil pollution prevention

- garbage handling and disposal
- sewage treatment
- hull antifouling systems
- ballast water.

Optional modules, with more stringent requirements, include:

- hull antifouling
- ballast water management
- grey water
- NOx emissions
- protected oil tanks
- refrigeration systems
- SOx emissions
- vapour emission control systems.

Following the assessment, Lloyd's Register carries out regular surveys and audits to help ensure that high levels of environmental performance are maintained. Ⓡ

Baby bilge water separator launched

A HIGH-SPEED centrifuge for separating oil from bilge water down to 5ppm has recently been launched by Westfalia Separator. The WC 2 can treat up to 1m³ of oily water per hour. Bilge water regulations stipulated by IMO and MEPC require oil content in effluent discharge at sea to be below 15ppm. However, in some territorial waters limits of 10ppm or 15ppm are required.

WTC 2 separates oil, water, and solids, allowing oil to be sent to a waste collecting tank for disposal. Solids are also collected for disposal, and clean water can be discharged to sea. The unit's intelligent control and oil monitoring system ensures only water with oil content below 15ppm can be sent overboard.

When there is a high proportion of emulsified oil in the water phase, or when ever cleaner water is required, WTC 2 can be

equipped with a dosing system to breakdown emulsions. This can further reduce oil content to less than 5ppm.

This system can be supplied as a single compact unit, which included separator, pump, and control unit, all mounted on a single skid base. Under normal conditions, and without the use of chemical dosing or absorption filters, WTC 2 can provide clean water with a residual oil content of 10ppm-12ppm. Ⓡ

Oil-free stern tubes for new US-built tankers

FOUR 185,000dwt Alaskan-class tankers that will soon be carrying oil along the US West Coast, will be installed with Thordon COMPAC water-lubricated propeller shaft stern tube bearings (for more details of these bearings see article in another part of this feature). These vessels, currently being built in San Diego, USA, by NASSCO, are BP Shipping-owned

and feature the latest innovations in safe-ship design. The first vessel is due for launch in Spring 2004.

During the design phase of the vessels, BP was determined to leave to minimise the risk of oil leakage. This included building in multiple redundant systems, and eliminating the use of oil wherever possible. Traditionally,

propeller shaft bearings on commercial tankers are made of white metal lubricated by oil. Although these systems work well, keeping the oil and water separate can be a challenge.

To ensure a steady supply of abrasive-free seawater to the bearings, Thordon also supplied its integrated water quality package. Ⓡ



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MARPOL: new and pending emission regulations

The International Maritime Organisation (IMO) exists to develop a range of Conventions, Codes and Guidelines which member countries then incorporate into their domestic legislation. The fundamental principle underpinning this activity is the understanding that a uniform approach on a worldwide basis to such matters as maritime safety and environmental protection is essential to the smooth functioning of international trade, writes Andy Wright, senior engineering specialist, ABS London. Pollution controls are primarily effected through the workings of the MARPOL Convention and its associated Annexes, the functioning of which is overseen by the IMO Maritime Environmental Protection Committee (MEPC).

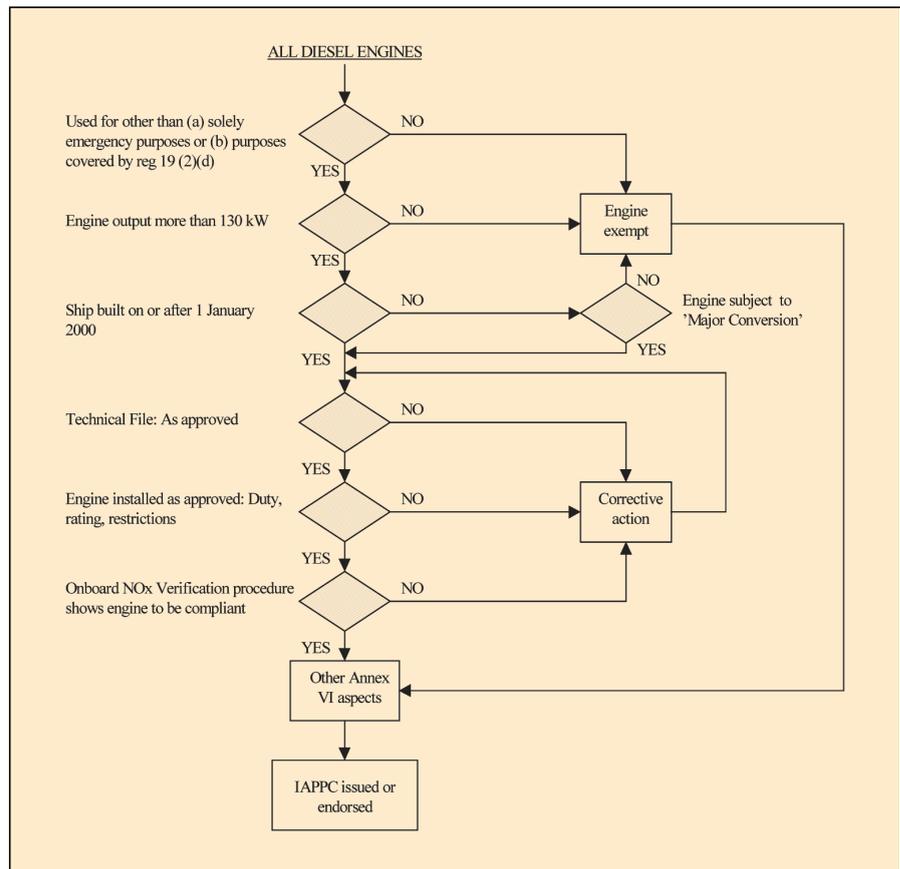
MARPOL Annex VI, 'Regulations for the Prevention of Air Pollution from Ships', was adopted by the 1997 Conference of the Parties to the MARPOL Convention. The Annex will enter into force, for all MARPOL Convention signatories, 12 months after attaining the required level of ratification. This ratification requirement is a minimum of 15 states which control a combined merchant gross tonnage of not less than 50% of the world total. At the time of writing, the ratification process was still awaiting the signatures of three more states.

In terms of exhaust emissions, the Annex VI controls will apply, to a greater or lesser extent, to the oxides of nitrogen (NOx), and the oxides of sulphur (SOx). Furthermore, there are requirements, partly related to the SOx controls, which will cover certain aspects related to fuel oil quality and supply arrangements. In addition, but outside the scope of this paper, the Annex also covers such aspects as the prohibition of new systems using certain ozone depleting substances (for example, halons and freons as used for firefighting and refrigeration), the design and operation of onboard incinerators and the design requirements for tanker vapour emission control systems.

The basis of these Annex VI controls is statutory. Compliance is therefore to be demonstrated to the administration of the ship's flag state which ultimately is the entity which

The NOx emission limits are related to engine rated crankshaft speed

Engine speed (n) rev/min	NOx emission Limit g/kWh
Less than 130	17.0
130 - 1999	45 x n-0.2
2000 and above	9.8



NOx Emission survey flowsheet.

will undertake the necessary approvals and issue of certification. Therefore, it is totally separate matter to the ship's classification. However, where so authorised, the ship's classification society may undertake all or part of these statutory functions, but as a recognised organisation on behalf of the flag state.

Annex VI, prior to entry into force date

Prior to the entry into force date, the various provisions of Annex VI cannot be enforced, except where a Flag State decides to enact those requirements on the ships under its control. However, in the case of the NOx controls, this initial 'voluntary' compliance over the intervening period will be an essential precursor to eventual mandatory compliance (in view of the extreme difficulty in obtaining post installation certification) and therefore, this must be seen as a highly qualified 'voluntary' compliance. A failure to take these steps now could render a ship uncertifiable in the future. In terms of the SOx controls, these too will not be enforceable over this period. Nevertheless, for those ships which will intend to operate on

residual fuel oils on a worldwide basis, there are essential preparatory steps which will need to be taken in order to retain operational flexibility thereafter.

NOx controls

The NOx controls as given within the Annex will apply to diesel engines (boilers and gas turbines are not covered) over 130kW which are not used solely for emergency purposes and which are installed on ships built (ie, keel laid) on or after January 1 2000 or, subject to 'major conversions', as defined, on or after January 1 2000. For the purpose of this regulation a 'major conversion' is where an engine is replaced by a new engine built on or after January 1 2000, or output of an engine is increased by more than 10%, or is 'substantially modified', as defined.

The 'major conversion' clause is extremely significant, since it potentially extends the scope of these controls to engines which would otherwise be exempt, ie, those installed on ships built prior to January 1 2000. In the case of engines installed on ships built before January 1 2000, 'substantially modified' means any

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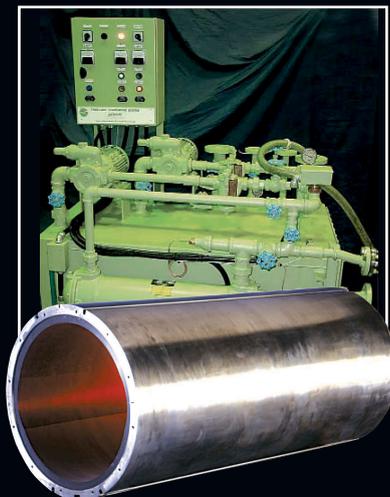
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operational or technical modifications which are made after that date which could increase NOx emissions, as defined. Such modifications may include changes to fuel injection timing, fuel injection equipment, the charge/scavenge air systems or combustion chamber profile.

An engine's duty cycle weighed emission values (since it could be rated for more than one cycle) are given at reference conditions (covering such aspects as fuel type, inlet air temperature and humidity and primary coolant temperature). Consequently, these controls focus on engine design rather than 'end of stack' emission rates.

In this it is important to recognise that, in terms of NOx certification, an engine is specifically approved only for those duty cycles and rating (power and speed) which are given in its certification. Underpinning the whole of these NOx emission controls is the NOx Technical Code which, as a mandatory document, defines the procedures and means by which an engine is to be certified and compliance demonstrated over its service life.

Over this interim period between January 1 2000 and the entry into force date, the essential points in respect of those engines which will fall within the scope of Annex VI are:

- engines, either installed on newbuildings or supplied new, are to be in compliance with the NOx Technical Code
- for all engines, where changes to duty, ratings, restrictions, components or settings which could affect NOx emissions are undertaken, the necessary steps are taken to demonstrate either: that those changes do not affect the status of the subject engine relative to the Annex requirements and any existing NOx certification; or that the engine as modified is, and will thereafter be, demonstrably compliant with the relevant emission limit and is so certified
- an original copy of the technical file as approved by, or on behalf of, the flag state of the ship on which the engine is installed is to be supplied with the engine. The technical file, which is engine specific, defines the engine in terms of rating, application, performance, limitations and NOx critical components and settings, the emission test report relevant to that engine and the means by which that engine is to be subsequently surveyed in order to demonstrate compliance. Three survey options, the onboard NOx verification procedures, are given in the NOx technical Code: parameter check, simplified measurement, and direct NOx monitoring.

The outlines of the first two of these options are defined in the NOx Technical Code. The Guidelines for the direct monitoring method were developed later and were finalised at MEPC 49 in July 2003 as Resolution MEPC.103(49).

- Engines are installed in accordance with the application and restrictions as given within the Technical File. This covers such matters as rated power, speed and duty (main engine; constant or propeller law

speed, auxiliary engines; constant or variable speed). The design requirement is that the engine is to be compliant when operating with 25°C sea water temperature.

- Although the Statement of Compliance with the NOx Technical Code for an engine demonstrates that it was in a compliant condition as manufactured, shipowners may require that a survey be undertaken following installation to confirm that the status of the engine has not been compromised.
- Over the period up to the Annex VI entry into force date, those engines to which this regulation applies will either need to be maintained in a (voluntary) compliant condition (including the ongoing completion of the engine record book, for those intending to demonstrate compliance by means of the parameter check method, in which all changes to NOx critical components or settings are to be recorded) or capable of being put back into such a condition when compliance becomes mandatory.

Over this period, shipowners should also consider whether:

- the onboard NOx verification procedure as given within the Technical File is compatible with their operating requirements
- can the engine survey, when required following the entry into force, be undertaken along with other statutory and classification surveys
- will the given survey regime require specialist services to be provided
- the implications in respect to the supply of spare parts are acceptable.

SOx controls

In order to limit SOx emissions, Annex VI will introduce a maximum limit of 4.5% m/m (mass/mass, ie, sulphur by weight) sulphur for all marine fuel oils, irrespective of fuel grade or the type of combustion machinery in which they are to be used. From the MEPC sulphur monitoring programme, which has operated since 1999, covering some 232,000 fuel deliveries to date, the number of deliveries of residual fuel oils to ships with sulphur contents in excess of 4.5% m/m has been less than 1.0% each year, the overall average sulphur value being 2.6%/2.7% m/m.

Consequently, while this 4.5% m/m limit does not represent any significant restriction on current fuel supplies, a yet lower limit will apply within designated SOx emission control areas (SECA) which inevitably will have a much wider effect.

Within a SECA, the requirement will be either a maximum limit of 1.5% m/m sulphur content to the fuel oil as used, or 6.0g/kWh maximum SOx content of the exhaust gas stream. In practice, it is expected that the majority of ships will seek to comply with the SECA requirements by means of the primary control option of limiting fuel oil sulphur content. Whether in practice this will be achieved by the use of low sulphur residual fuel oils, gas oils (which inherently have sulphur

contents below the limit value) or by onboard blending of unrestricted residual fuel oil (other than by the global cap value) and gas oil will depend on such factors as a ship's projected operating profile, bunker tank and transfer systems and the price differentials between the various grades.

Consequently, there will be those ships which will never enter, or alternatively never leave, a SECA. For those ships, the future situation will be relatively straightforward; the respective fuel oil sulphur content limit will apply without exception. The complication arises for ships which use residual fuel oil and operate, or may operate, for only a portion of their time within a SECA, since outside the SECA, such ships will utilise fuel oils of sulphur content typically around 1.5%-3.5% m/m. In these instances, it will be necessary to ensure that those ships will have both the necessary segregated bunker capacity and the means to change over to the lower sulphur content fuel prior to entry into a SECA.

Annex VI, after entry into force date

From the entry into force date, compliance in terms of both the equipment and operational requirements of Annex VI will be mandatory for all ships engaged on international voyages and to which the MARPOL Convention applies. In the case of ships of 400gt and above, compliance will be indicated by the issue of an International Air Pollution Prevention Certificate (IAPPC) following an initial survey by, or on behalf of, the responsible flag state. For ships under this tonnage limit, it is for the individual administrations to set up schemes appropriate to such vessels to ensure compliance.

For ships completed after the entry into force date, the IAPPC will need to be issued prior to entering into service. However, for ships in service at the entry into force date, the IAPPC initial survey is to be undertaken no later than the first scheduled drydocking thereafter, although in all cases, it must be satisfactorily completed within three years of the entry into force date.

Thereafter, a system of annual, or intermediate and unscheduled, surveys will apply with a periodic (renewal) survey every five years. These statutory surveys will be undertaken by, or on behalf of, the relevant flag state and are to be harmonised with the other MARPOL Annex surveys. Additionally, there will be port state inspections, which may be either random or targeted in terms of the particular ships checked.

In addition to the specific Annex VI requirements, shipowners will also need to ensure that the various operational requirements of the Annex are implemented and verifiable. Consequently, those ISM procedures covering refrigeration, firefighting systems, incineration and bunkering will need to have been updated, as necessary, in addition to those required to cover aspects of the NOx and SOx controls.

NOx controls

The NOx controls within Regulation 13 form the major part of Annex VI in terms of

complexity, implications for the shipowner and survey. Any diesel engine falling within the scope of these requirements will need:

- valid engine certification
- technical file
- Installed in accordance with the duty, rating and restrictions as given in the technical file
- in the case where the onboard NOx verification procedure is to be based on the parameter check method, the engine record book will need to be accurately maintained
- to be in a demonstrably (ie, surveyable) compliant condition.

Consequently, any engines installed between January 1 2000 and the entry into force date, which were modified from their initial NOx compliant condition or to which spare parts have been fitted, which do not enable the onboard NOx verification procedure, as given in the technical file, to be applied, will need to be re-instated to their 'as approved' condition.

SOx controls

All fuel oils for use onboard will need to be ordered, and verified from the bunker receipt on delivery, as having a maximum sulphur content

of 4.5% m/m. The exception to this is where ships are to operate within a SECA with compliance through primary, rather than secondary controls. In those instances, the fuel oils to be used within a SECA are to be ordered, and verified, to have a maximum sulphur content of 1.5% m/m.

Where a ship enters a SECA it will be necessary that the fuel oil service system is fully changed over and flushed of all fuel oils exceeding 1.5% m/m prior to that entry into the SECA. Consequently, it will be necessary to have onboard, prior to entering such an area, an adequate quantity of 1.5% m/m maximum sulphur fuel oil. However, this requirement will not be applied to vessels entering a SECA during the first year after the entry into force date or, where such areas are declared after that date, the first year after their designation. Nevertheless, in such cases compliance will be required following the first port call within that SECA.

Fuel oil quality

Although entitled fuel oil quality, the relevant requirements only cover some of the commercial aspects which so often affect supply. These requirements are essentially operational in nature. From the entry into force date, it will be necessary to ensure that:

- marine fuel oils are only supplied by companies registered with the appropriate authority of the country in which they operate
- bunker receipts are only accepted from the supplier if they are fully in accordance with the required scope (given in Appendix V of Annex VI), particularly the statement as to the actual sulphur content. Additionally, the bunker receipt must include the required composition clause in order to indicate that the fuel is free of certain deleterious materials
- for ships of 400gt and above, the bunker receipt is to be kept onboard for a minimum period of three years from the date of delivery. Individual administration may extend this requirement to ships below that tonnage limit
- for those ships which are required to keep their bunker receipts onboard, as above, a retained sample of all fuel oils as supplied is drawn in accordance with defined guidelines, MEPC.96(47), at the ship's receiving manifold, sealed and signed on behalf of the supplier and the master or ship's officer in charge of the bunkering operation. Ⓡ

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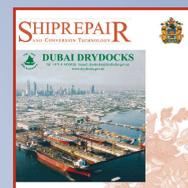
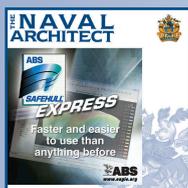
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Comprehensive waste-handling systems for galleys and cabins

WASTE-handling issues onboard vessels have in recent years been taken much more seriously, and consideration is now given in the newbuilding stage. Uson Marine, with 20 years marine waste experience, has a number of systems that can be used, in a number of different types of vessels.

Chute systems can be used in smaller cargo vessels, yachts, and larger cruise ships. Chutes are available in different sizes, and may be used for general waste, aluminium tins and cans, glass, and dirty linen. Major benefits of a chute are fast disposal, less man-hours required for waste handling, less risk of smell in connection to public areas, and no risk of cross-contamination.

A chute is cleaned with high-pressure water and rotating brushes. The control systems applied to the chute and its accessories ensure that personal safety and fire safety is maintained as prescribed by SOLAS II requirements. Uson's prefabricated modular chutes require no further outer panelling. Noise reduction solutions are also applied to ensure a pleasant passenger environment.

Different solutions are used beneath the chute for volume reduction. Depending upon fraction and amounts, everything from smaller shredders and compactors, to larger custom-made combined systems can be utilised.

Dry waste fractions can also be handled in more local manners. Compactors are used onboard most vessels; a multi-chamber compactor reduces space requirements onboard and at the same time allows for separated waste fractions prior to recycling. The number of chambers is adjustable depending upon number of fractions. Different shredders are also used for different fractions.

Food waste

Food waste may cause problems if not considered properly. Several different solutions are available in the market, but those requiring least maintenance and offering the most cost-efficient solution are food waste disposers installed where the waste is generated, ie, in galleys, bars, pantries, and preparation areas.

Food waste disposers are installed in a table top or beneath a sink, and grind the food waste to small pieces using fresh water. Since no



Uson Marine's food waste disposers can be installed in a table top or beneath a sink. The unit grinds food waste to small pieces using fresh water.

chemicals are used and the small pieces are fulfilling MARPOL requirements, food waste slurry can most often be disposed of directly to sea. Cruise vessels may have special food requirements giving difficult food remains, such as larger bones or fish skins that require shredding before any further treatment.

Food packaging is often contaminated and then cannot be disposed of as food waste, but still may cause odour problems. This refuse can be compacted and simultaneously refrigerated in Uson's refrigerated sack compactors that are installed in galley areas. Other waste generated in galley areas is greasy and oily galley water, so water is separated from the grease with a 99.5% efficiency in a grease separator.

Living quarters

Centralised vacuum cleaning systems are often used on large cruise vessels, as well as cargo

vessels. Units are used for floors in accommodation areas, and may also be used in case of leakage from toilets, or for cleaning machinery areas and tanktops. The advantages compared with local hoovers are said to be significant. A central system means all dust is collected in one place, it allows an allergen-free environment, it has a longer system life-time, sound is kept away from passengers, and no storage space is required for small hoovers.

One of the most recent Uson Marine deliveries was for *Mayflower Energy*, where a comprehensive waste handling system was installed. Units included: three different chute systems for general waste, plastic, and metal; a multi-chamber compactor with three chambers for different fractions; a food waste system with dewatering unit; a baling press for cardboard; and a glass crusher. Ⓡ

First orders for new oil spill recovery system

JLMD Ecologic Group, which created a pre-installed system for preventing oil pollution (*The Naval Architect* September 2003, page 128), has recently signed its first three orders for a total of 14 ships - eight of which are to be delivered to companies based in the Persian Gulf, and six to a French company. Remarkably, these orders have been placed with JLMD after a marketing campaign of merely six weeks. Other potential orders are awaiting confirmation from shipowners and oil companies. These very positive contacts suggest that JLMD is likely to secure contracts for 100 ships over the next two years.

The confirmed orders for a total of 14 ships have come from Qatar Navigation (two new ships), Qatar Shipping (six new ships), and Jet's Cargo Bulk, a French company established in Greece (six ships, with five new units and one retrofit). The retrofit unit should be fully fitted with the JLMD System by February or March 2004.

In addition, the French government, through the Department of Maritime Affairs at the Ministry of Transport, has officially confirmed its support for a presentation of the JLMD System to IMO at the next

meeting of the Marine Environment Protection Committee (MEPC), in March this year. The concept will be demonstrated as part of an international drive towards effective regulation of the shipping and oil sector.

Although primarily designed for containing cargo oil, the JLMD equipment is said to be equally effective in bunker tanks on ships of all types, to better prevent environmental disasters. JLMD Ecologic Group is currently seeking financial and/or manufacturing partners worldwide. Ⓡ

Emissions clubs will bring environmental gains

ALLOWING syndicates of ships to work together to achieve collective emissions reduction goals could represent an important part of a future marine environmental emissions reduction 'industry' that delivers massive short and long-term benefits. BP Marine's Don Gregory claims that the principle of offsetting is essentially quite simple. Groups of ships calculate the emissions that they would expect to make in order to comply with the fuel sulphur limits. Then one or more of the ships takes the necessary steps to reduce emissions below their individual target level.

This could mean that some vessels are fitted with abatement technology that help them to exceed individual targets, while others not converted fall short. However, because they can offset the 'over target' against the 'under target', the net result is positive and the cumulative group target is achieved. Any extra emissions saving could also be 'banked' and used in a future year.

These syndicate groups would all work under a standard operating framework. This framework would include rules, procedures, monitoring devices and reporting mechanisms. Such a uniform approach may also allow some additional inter-club trading or offsetting where this was appropriate and beneficial.

Gregory, who is also a committee member of SEAAAT (Shipping Emissions, Abatement and Trading organisation), which has been working to produce the evidence, arguments and methodology for an offsetting arrangement system in the shipping industry, suggests that effective offsetting cannot just happen overnight, the conditions for its success need to be considered and developed. In the early stages, syndicates will have the best chance of operating effectively where there are ships with a diversity of abatement opportunities and costs, so that operators can look at and select the lower cost options before the high investment and higher risk options, Mr Gregory believes.

Within this broad framework, a number of variations are possible, such as:

- ships within a single fleet may find that offsetting abated and unabated ships is a satisfactory option
- ships which regularly use a particular port harbour or route may find that they can develop an instrument which allows trade between both local ferry trade and international liner trade that delivers air quality benefit in that area
- general syndicates where owners see the benefit in cooperating with other owners.

Measurement and controls would require official and independent verification, and all documentation would need to be clearly 'auditable'. It is also possible that as expertise grows, service companies may enter the market to take on these tasks and act as an intermediary with regulatory authorities.

SEAAAT is helping the marine industry demonstrate to legislators that it is willing and capable of taking responsibility for self-regulation within given governmental targets and is confident that offsetting will gain both industry and government support. It argues that a basic sulphur cap on fuels used within EC waters, as proposed by European legislators, would impose major problems on both the shipping and fuels supply industry. But that does not mean that it is wrong. If this were the only option then capping would clearly be the focus of everyone's attention.

The EU has accepted an amendment to its proposed sulphur emissions control to provide for the use of offsetting, providing it states that; it can be demonstrated that in doing so these vessels collectively exceed the requirements of the directive by 10% initially, rising to 25% by January 1 2007. SEAAAT considers these expectations are likely to be too great to encourage participation and may act as a strong disincentive. The preferred position is that offsetting, particularly at the start, should not be expected to exceed what was otherwise expected simply by using low-

sulphur fuel. It is very much in the capability of offsetting and abatement to deliver continuous improvement and some broad targets could be set, but they must remain realistic.

- Options such as offsetting/emissions trading do exist. It would be unreasonable not to explore the viability, benefits and deliverables of each. But if the best solutions to meet environmental targets are to be realised they need to have incentives. Logically the best solutions would be those which offer the highest return, and the best sustainability. They also need to be capital efficient, providing a framework for early investment, innovation and further technology improvement.
- There is a significant body of evidence and opinion that says that removing emissions at the point of application can be much cheaper, more efficient and overall more environmentally beneficial than removing the undesirable substances during the refining stage.
- Why do not all ships simply fit onboard emissions reduction equipment so that we can enjoy a massive and immediate environmental benefit? Certainly that would be an extremely good position to be in. Unfortunately however, it is totally unaffordable in the short or medium term. The necessary level of investment would be well out of reach of many owners and probably outside the scope of any public subsidy. In a free and international market such as shipping such investment needs be made attractive through some form of incentive, such as the ability to trade off some of its cost over time, by exchanging surpluses in emission level targets with other ships within an offset agreement club.
- The EC has already seen some positive benefit in the concept of offsetting; it commissioned National Economic Research Associates (NERA) to report on the potential of market instruments to support the possibility of an offsetting arrangement. 

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Phase-out of single-hull tankers: impacts and implications

Lloyd's Register clarifies the latest changes to the regulations surrounding single-hull tankers and assesses the impact of these changes on the tanker market from both a commercial and a technical point of view.*

SINCE the sinking of the single-hull tanker *Erika* off the coast of France in December 1999 and the resultant oil pollution, tanker hull structures have been the focus of many heated debates, both within the industry and without, particularly the wider political realm encompassing the International Maritime Organisation and, most significantly, the European Union (EU).

Following the *Erika* incident, IMO's Marine Environment Protection Committee (MEPC) at its 46th meeting in May 2001 considered proposals for the accelerated phase-out of single-hull tankers, which had been made by some EU member states as a consequence of the *Erika* casualty. The result of the meeting, as is now well known, was the amended Regulation 13G of Annex I of MARPOL. Under this regulation, Category 1, 2, and 3 tankers were to be phased out according to a timetable dictated by their dates of delivery, deadweight tonnage and pre- or post-MARPOL status. In addition, it introduced the Condition Assessment Scheme, or CAS, for Category 1, or pre-MARPOL, tankers of 25 years of age after 2005 and for Category 2, or post-MARPOL tankers, after 2010.

In addition, the EU put forward its *Erika* I and II packages of legislation in a bid to minimise the risk of future pollution incidents in European waters.

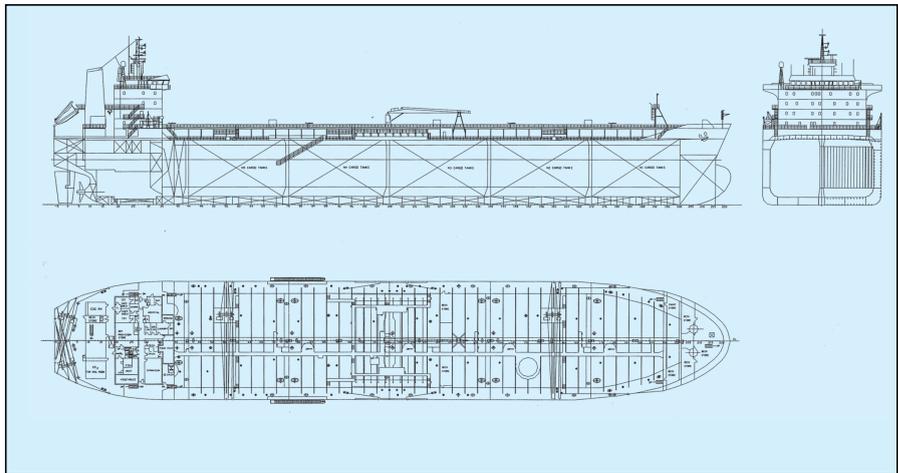
Erika I requires:

- increasing port state control inspections in EU harbours
- strengthening the existing EU Directive on Class
- accelerated phase-out of single-hull tankers, as per regulation 13G.

Erika II, meanwhile, requires:

- establishment of the European Maritime Safety Agency, or EMSA
- fitting of automatic identification systems onboard vessels to better enable maritime and port authorities to monitor vessel traffic.

Throughout this time, the industry fought hard to ensure that a compromise was reached and that



A typical modern double-hull tanker, the 47,000dwt *Troitskiy Bridge*, lead ship of a new series ordered by Sovcomflot from Admiralty Shipyards, Russia. Despite current concern over single hulls, work is currently proceeding at American Bureau of Shipping, Lloyd's Register, and Det Norske Veritas on a new set of unified rules for double-skin tankers of more than 150m length. These are expected to be implemented in 2005 and might change the detailed design of such vessels. The aim is to ensure that double hulls do not run into trouble, too.

the resulting legislation would be enacted on an international level, by bringing the debate into IMO.

Then the *Prestige* happened. The *Prestige* was, in many ways, *Erika* redux: a similar cargo spilt under similar conditions and most importantly, the break-up of a single-hull ship. The debate surrounding single versus double hulls for tankers was re-ignited, and the EU acted swiftly. At the 49th session of MEPC in July 2003, the EU attempted to push through its proposed acceleration of the phase-out of single-hull tankers, resulting in a number of draft resolutions.

The key features of the EU's proposal were the acceleration of the phase-out of single-hull tankers, the expansion of CAS to single-hull tankers of 15 years of age, and the restriction of the carriage of heavy oils to double-hull tankers.

MEPC agreed to an early phase-out of Category 1 tankers by April 2005, thereby rendering CAS superfluous for this ship type, and supported in principle the extension of CAS to so-called Category 2 and 3 tankers, provided that the Scheme could be used as a compromise to enable 'teenage' single-hull tankers to trade internationally beyond their phase-out date, up to the age of 20, 23, or 25 years of age (to be finalised), but not beyond 2015.

The EU, however, wished to retain the paragraph in regulation 13G which permits a state to deny the entry of Category 2 and 3 oil

tankers to its ports and offshore terminals after the phase-out date, raising the ire of industry representatives who countered that a tanker that has cleared CAS should be allowed to trade internationally without potential denial of port entry.

The outgoing IMO Secretary-General Bill O'Neil and the industry were further piqued by the unilateral introduction of a ban on single-hull tankers in European waters, ports and anchorages which was brought into force by the EU on October 21, 2003. Industry representatives from the Far East expressed dismay at the two-tier system that this would give rise to, sending single-hull tonnage deemed unfit for European waters into the Asian trades.

The unilateral ban alarmed many in the industry who perceived it to be a further blow to the primacy of IMO, while others criticised the regulation for being technically unfounded, as double hulls are thought to provide the greatest protection in the event of low-energy collisions and groundings, and not in conditions such as those in which *Prestige*, or indeed, *Erika*, struggled prior to its break-up and eventual sinking. With owners still fuming over the perceived violation of UNCLOS by Spain and France, the unilateral ban on single-hull tankers in European waters, ports and anchorages simply fuelled the already fiery debate between the shipowning community and European regulators.

*This article is based on a speech delivered at the Marintec China conference, held on December 2-4, 2003 in Shanghai, by Alan Buckland, marine business director, Lloyd's Register Asia.

Readers are also referred to the article on IMO activities that appears elsewhere in this issue, which discusses events at MEPC50.

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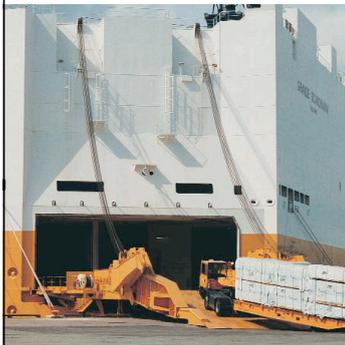
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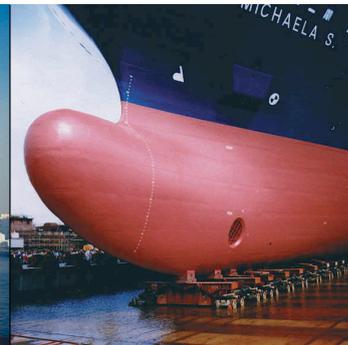
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Regardless of the merits on both sides of the argument, the fact remains that the EU's ban is now in force, with the regulation stipulating the following:

- all EU-flag Category 1 oil tankers are to be phased out, dependent on the date of delivery, not later than the anniversary of their date of delivery in 2003 up to 2005. Category 1 tankers irrespective of flag will not be permitted to enter or leave ports or offshore terminals or anchor in areas under the jurisdiction of an EU member state according to the same schedule
- all EU-flag Category 2 and 3 oil tankers are to be phased out, dependent on the date of delivery, not later than the anniversary of their date of delivery in 2003 up to 2010. Category 2 and 3 tankers irrespective of flag will not be permitted to enter or leave ports or offshore terminals or anchor in areas under the jurisdiction of an EU member state according to the same schedule
- with effect from October 21, 2003, no single-hull oil tanker of 5000dwt or above carrying heavy grades of oil, irrespective of its flag, will be allowed to enter or leave ports or offshore terminals or to anchor in areas under the jurisdiction of an EU member state. Oil tankers of 600dwt or above but less than 5000dwt are to comply with this requirement no later than the anniversary of the date of delivery of the ship in the year 2008.
- until October 21, 2005 an EU member state may, in cases where ice conditions require the use of an ice-strengthened vessel, allow ice-strengthened single-hull oil tankers carrying heavy grades of oil, equipped with double bottoms not used for the transport of oil and extending over the entire length of the cargo tank, to enter or leave a port or offshore terminal or anchor in an area under the jurisdiction of that member state, provided that the heavy grades of oil are transported only in the vessel's central tanks
- irrespective of its flag, a single-hull oil tanker above 15 years of age shall not be allowed to enter or leave ports or offshore terminals or anchor in areas under the jurisdiction of an EU member state beyond the anniversary of the date of delivery of the ship, in 2005 for Category 2 and 3 ships, unless it complies with the Condition Assessment Scheme (CAS).

As noted above, the EU decided to proceed with its own unilateral regulations in October 2003, in spite of the likelihood that IMO would accept its proposals in December 2003 at MEPC 50. It now remains to be seen whether the EU will amend its existing Directive to bring it into line with the IMO requirements.

Tanker market impact

What will the impact of these regulatory changes be on the tanker market? It is believed by many that the EU did not fully assess the consequences of the phase-out before putting it into force. Let us look at the fundamentals.

Global demand for oil, products and chemicals is growing, albeit slowly, supported by the improving world economy. Freight rates in 2000-2001 were very good, but 2002 saw rates fall below breakeven levels, as a result of decreased demand and the delivery of many new ships. However, everything changed in the winter of 2002-2003, mainly due to winter-time stockpiling, the war in Iraq, problems in Venezuela, and knock-on effects of the *Prestige* accident.

Rates have since eased as the effects of these extraordinary events have abated, returning us to market fundamentals. The question is: what will be the impact of the accelerated phase-out on the market?

It was originally expected that the revised IMO MARPOL 13G phase-out of single-hull tankers would have *some* effect on the market, but fears about the stability of the tanker market were largely laid to rest when owners took early action by ordering a substantial amount of double-hull ships. Towards the end of 2002 and throughout 2003, we saw a mini-boom in tanker ordering, as a result of the expectation, now fulfilled, that IMO would adopt the EU proposals put forward at MEPC 49.

From a global tanker supply perspective, the EU-proposed amendments to MARPOL will have a limited effect on the larger tankers. Some trade will inevitably shift to non-regulated areas of operation, and modern double-hull tonnage may be able to achieve better rates, perhaps further promoting a two-tier market. However, from a global viewpoint, there is enough capacity in the market to deal with this. This could change if local governments, in particular in Asia, should decide to respond to the EU's unilateral action.

The impact on smaller tankers will probably be more profound, as only a small proportion of the global fleet is fitted with double hulls. These ships are often engaged in local trade, and the scope for shift in trade is limited. Given the deadline set by the EU in 2008 for the banning of very small tankers from carrying heavy grades of oil in single hulls, one has to ask whether this will create a sudden rush of orders before the deadline and whether it will actually be possible to obtain enough small tankers into place to continue local supply lines without significant disruption. As the trade flows for these tankers are not as well documented and as transparent as the main global supply routes, it is likely that this will need to be taken into consideration, and Asian yards in particular might be interested in monitoring the situation.

The impact of the recently agreed amendments to MARPOL will be difficult to predict as it will be determined by how widely the right to deny entry is exercised, both in terms of the carriage of the heavy grades in single-hull tankers and the continued operation of Category 2 and 3 tankers after 2010.

The best-case scenario assumes that *only* EU member states will choose to exercise the right to deny entry and that heavy grades of oil will continue to be carried in single-

hull tankers for as long as possible under the new regulation 13H. In this scenario, the additional impact would be negligible, although the effects on the tanker market of regulation 13H still require further analysis to be fully understood. It is expected that it will create some shift of trade, but that the market will be capable of absorbing the change.

The worst-case scenario assumes that *all* countries will fall in line with the EU's approach. This would create major disruption, as an estimated extra 450 Category 2 and 3 tankers would need to be scrapped in 2010. In fact, the large number of ships to be phased out over such a short time period will certainly cause problems for owners, shipyards and scrapyards. It is not unreasonable to believe that most of these ships will be traded until their drop-dead date.

Despite the fact that shipyard capacity is increasing, it will simply not be possible to meet the sudden increase in replacement demand, let alone find the scrapyards capacity to dispose of the obsolete vessels. The most likely outcome of such a situation would be a steady build-up of tanker capacity up to 2010, as most owners would not want to risk waiting to place their orders. This could in turn create a very volatile situation in terms of freight rates in the years leading up to 2010.

Commercial impact on the tanker owner

Owners will obviously be concerned about the commercial impact of these regulations. As with any investment, a judgement needs to be made about future earnings, operating and maintenance costs and, not least, how long the asset can be expected to remain in service. The latter will have an impact on the viability of the project, whether the owner decides to run the ship until it is scrapped or sells it on after a given period of time.

From the political side, it has been decided that the scrapping of single-hull tankers should be done earlier than might have been originally anticipated by an owner investing in a ship. In terms of the EU requirements, this means that tankers could be considered obsolete at an age of as low as 14 years.

From a commercial perspective, this is obviously highly unfortunate for the individual owner. This is now reflected in the high price differential between similarly aged single and double-hull tankers, to the extent that conversions from single to double hull may be considered financially viable. Again, this will require an investment not originally envisaged when the tanker was purchased and is as such unfortunate from a commercial perspective.

It is widely recognised that the introduction of double hulls will offer better protection against low impact groundings and collisions. The most important elements related to achieving good levels of safety are, however, related to how ships are operated and maintained. The phase-out is evidence of a determined ageism which discriminates against older tonnage,

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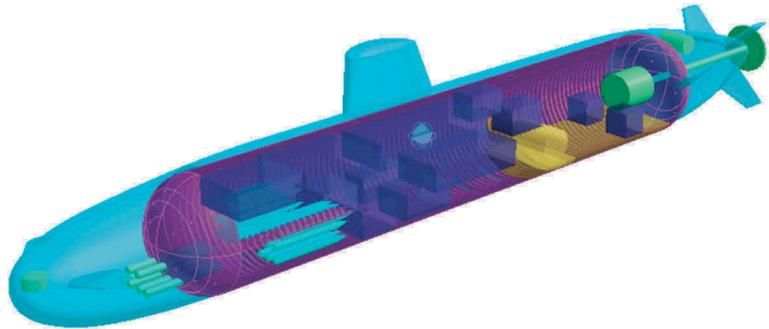
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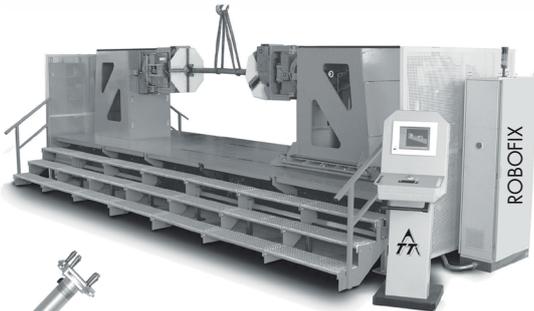
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regardless of how well maintained and operated it is, which clearly has a negative impact on earnings.

Faced with the prospect of an asset that is less attractive to the market and has a limited trading life, the accelerated ban may well discourage owners from investing in maintenance. In spite of the good intentions behind the phase-out, it may well create new risks which the industry will have to take into account.

Technical impact

The technical impact of the heightened focus on tanker structures has been profound. More attention is being paid to the Condition Assessment Scheme (CAS), permanent means of access (PMA), and the maintenance and construction issues surrounding double-hull tankers than ever before.

Technical impact - CAS

CAS is a statutory requirement for tankers over a certain age, and the latest amendments to MARPOL adopted by IMO extend the scheme to single-hull tankers of 15 years of age and older.

The International Association of Classification Societies (IACS) has recently moved to harmonise the survey requirements of CAS and the Enhanced Survey Programme (ESP). The survey requirements for ESP of a tanker at the age of 15 years are therefore now identical to CAS, with the only differences being those of documentation and control.

The additional requirements for ESP under this regime involve extensions of close-up surveys. For the third and subsequent special surveys, close-ups are now required on all the web frame rings in one cargo wing tank, and additionally, will be required on a minimum of 30% of all web frame rings in each remaining cargo wing tank. Similarly, instead of one deck and bottom transverse in each cargo centre tank, a minimum of 30% of deck and bottom transverses in each cargo centre tank is now required.

As a result of the accelerated phase-out timetable proposed by the EU and the documentation-and-planning-intensive nature of CAS, ie, the requirement for owners to advise the flag administration eight months in advance of the survey commencing, classification societies have already seen the first applications for CAS. In the amended regulation 13G, CAS is also seen as a condition to allow tankers to operate beyond the stipulated phase-out dates.

The difference of this approach from the application of CAS to tankers of 15 years of age is in the timing. For tankers of this age to be able to trade beyond the phase-out dates, CAS needs to be carried out prior to the relevant date and repeated at five-year intervals. The validity of the statement of compliance has been extended to five years and six months in order to give administrations sufficient time to review the final CAS report and to issue the statement of compliance.

Further, the possibility of CAS for double-hull tankers has recently been raised, and it is not inconceivable that the EU might attempt to introduce such a measure, especially if a double-hull tanker were to cause pollution in European waters.

Technical impact - permanent means of access (PMA)

Another recent rulemaking which follows directly from the *Erika* incident deals with the installation of permanent means of access (PMA) in the cargo spaces of oil tankers. The idea to enhance SOLAS emerged from the Bahamas.

IACS responded to IMO's Ship Design and Equipment (DE) Committee's invitation to IMO members and industry to submit proposals for technical provisions for means of access. IACS produced a document that satisfied the intent of the then draft regulation and at the same time allowed for flexibility by permitting rafting in lieu of permanent means of access. Underdeck and vertical structures could be inspected by rafting, if certain safety requirements were met such as the depth of the structure and the availability of access in each bay to allow escape of a surveyor.

However, some IMO member states saw rafting as a means of evading the fitting of permanent means of access, ie, ladders and walkways, and this provision was eventually removed altogether.

The amendment to SOLAS [new regulation II-1/3-6] was adopted in December 2002 at the 76th session of IMO's Maritime Safety Committee (MSC). The regulation will enter into force on July 1, 2004 for all tankers of 500gt and above constructed on or after January 1, 2005.

It was realised by industry and class that these technical provisions were in need of interpretation to produce practical requirements which would meet the intent of the regulation. For this reason, IACS (the International Association of Classification Societies) and industry - shipowner and shipyard representatives - formed a joint working group to produce these interpretations with the intention of submitting the unified interpretations in December 2003 to MSC 78, which is due to take place in May 2004.

Work on the interpretations is at an advanced stage and IACS hopes to present a paper to IMO. Over 70 pages of interpretations with technical background will be presented to the IACS council for adoption. They address both regulatory and technical provisions.

It must be said, however, that 70 pages of interpretations are the indication of a flawed regulation. In recognition of this fact, Greece has submitted a proposal to IMO containing draft amendments to the regulation and its technical provisions. These amendments are based on the interpretations drafted by IACS and industry mentioned above.

The Greek proposal garnered considerable support at the 23rd IMO Assembly, where it was decided that the DE Committee should examine the amendments at its meeting in March 2004 and submit the results for approval

to the 78th session of IMO's Maritime Safety Committee (MSC) in May 2004, with the aim of achieving adoption in December 2004.

However, in spite of these efforts, the fact remains that the current regulation has already been accepted and will enter into force on July 1, 2004. The draft amendments, if adopted, would not enter into force until July 2006. The current regulation will begin to be applied from January 1, 2005, which means that owners and operators have a year and a half to comply.

An interim solution may well be the application of the IACS/industry interpretations; alternatively, IMO may devise a different mechanism to allow its member states to apply the amended version of the regulation in lieu of the current one from the outset. The situation will hopefully be clarified at MSC 78 in May 2004.

Technical impact - double hulls

In the past, regulators have focused almost exclusively on single-hull tankers. But what about double hulls? More than one person in the industry has asked the question: what happens if and when a double-hull tanker has an accident and causes a serious pollution incident? It is unlikely that all tanker-related legislation will cease when the last single-hull tanker finally goes to the scrapyard.

Indeed, the EU appears to be trying to get to grips with the issues surrounding double-hull tankers, having recently held a 'closed seminar' in Brussels at which industry participants offered viewpoints on the design, construction, operation, maintenance and survey of double-hull tankers, as it considers that these will become of critical importance for maritime safety in the years to come.

At the request of the industry, ABS, Lloyd's Register and DNV are currently working on a set of common rules for scantlings for double-hull tankers of more than 150m length. These will be implemented in 2005. Furthermore, these harmonised rules will be submitted to IACS with a view towards adoption by all IACS members. This work was undertaken to ensure that societies do not compete on standards for new construction, as a result of pressure from either yards or owners. This will be good for the industry, but the importance of proper maintenance and operation should not be forgotten.

Conclusion

In conclusion - it is clear that we are still seeing the knock-on effects of *Erika*, as well as those arising out of the *Prestige*, and may do so for some time to come. As a result of these accidents leading to unacceptable pollution of coastlines, the tanker industry has been faced with a range of issues, including the accelerated phase-out, as well as increased inspections and requirements.

Despite all this, it should not be forgotten that tanker safety has improved markedly over the last few decades. This is an achievement that the industry should be proud of, considering the vast quantity of oil being transported by sea. We may congratulate ourselves on this continuously improving track record, but complacency is not an option, and further improvement should always be sought. Ⓣ

Expansion expected to make China world leader in shipbuilding

The Chinese shipbuilding industry has embarked on a period of unprecedented expansion, which will probably soon make it Number One in the world. George Bruce recently visited some of the major yards for *The Naval Architect* and reports on progress, with a particular accent on production and productivity.

CHINESE shipyards have expanded rapidly in recent years, and are continuing to do so at an accelerated rate through the development of new docks and associated facilities. Major engine builders now account for a significant proportion of the world total kilowatts produced; however, the total proportion of equipment supplied from Chinese sources is low compared with Korea and Japan in particular. Shipyards in both the CSSC and CSIC groups, in Dalian and Shanghai, made this point. They indicate that local supply in

Korea and Japan is typically around 90% of the total equipment for a ship. In China, the proportion is much lower, with the highest estimate given being around 60%; others suggest it is lower still.

These shipyards also state that the proportion of engineers and other technical staff among their employees is around 10% compared with 20% in Korea and Japan. There is therefore a need to develop the education and training infrastructure, to supply sufficient staff to meet the growing needs. These needs arise from expansion and from the need for more comprehensive management and technical systems.

In the field of management information systems, Chinese yards also identify a weakness compared with their two major competitors. Whereas the major Japanese and Korean shipbuilders have comprehensive systems for management of all activities from design through procurement, and planning production

to delivery, those in China are more fragmented. Thus the need to develop software is also seen as important.

Procurement is seen as particularly important at Dalian, to ensure materials are available as they are needed in production. Once again, the ambitious expansion plans make this requirement more urgent. Linking the financial and management information systems to ensure good financial control is also a priority.

Apart from those management areas which need to be improved, the attitude of the workforce also needs to be changed, according to some management leaders. The transition from planned to market economy requires a more disciplined workforce, and comparisons with Korean and Japanese yards which managers had visited, are made.

The long-term objective at several of those shipyards visited by *The Naval Architect* is stated to be parity with Japan and South Korea in terms of output – perhaps by the year 2015. 

Economic growth apparent at CSSC

CHINA State Shipbuilding Corp (CSSC) is one of the two major shipbuilding groups in China, having been formed in 1999 when the original company split into two. CSSC owns the southern shipyards, based primarily in the Shanghai area and Guangzhou. Overall, the company has 52 enterprises including marine engines and industrial equipment as well as shipbuilding and repair. In common with the other major group, CSIC, CSSC has ambitious plans for building expansion, primarily to meet domestic shipping needs.

The main yards in the group are Jiangnan Shipyard, the 'greenfield' Shanghai Waigaoqiao Shipbuilding, and Hudong-Zhonghua Shipbuilding (two sites united), all three of which were visited recently by *The Naval Architect*. Others include Guangzhou Shipyard International and Shanghai Shipyard; additionally, there is a machinery plant at Lüzhou, as well as research and development centres.

Economic growth in China is currently creating an enormous demand for energy. A long-term agreement with Australia for the supply of gas is in place, and this has led to the development of the country's first designs and two contracts, for two and three LNG carriers respectively, at Hudong-Zhonghua. These will most probably be built in the large new dock at the Hudong site (*The Naval Architect* February 2002, page 22). The chosen design is the membrane type, although CSSC has also studied Moss spherical models. Technical assistance will come from a cooperation agreement with GTT, France, for the supply of LNG technology, and a 147,000m³ design has been made jointly with ALSTOM Chantiers de l'Atlantique.

Need to relocate

CSSC believes that the development of China's shipbuilding industry will serve the rapidly growing

domestic demand for new tonnage. Thus the main driver in ambitious plans to expand its yards is the growth of the Chinese economy. A strategy for expansion is well advanced, fuelled apart from the increased demand for ships by pressure on waterfront land in both Shanghai and Guangzhou. As a result, there are plans that at least some of the Shanghai yards will be relocated on to a greenfield site on an island in the Yangtse river, some 30km from Shanghai itself. At the time of our visit, plans to move the Jiangnan shipyard were underway.

Shanghai is due to host EXPO 2010, and the city-centre land on the Huangpu River waterfront earmarked for this exhibition is currently occupied by the Jiangnan Shipyard, so the need to relocate and maintain continuity of production is pressing. Similar local developments at Guangzhou are also causing pressure on yards there to relocate. The need to make the changes in such a short timescale is seen by CSSC as the major difficulty facing the group. Although shipbuilding as a proportion of GDP is relatively small, it is an important sector of industry in the two regions, and a major employer (around 90,000 people in the CSSC group).

Portfolio and research

For the present and immediate future, CSSC is generally focussing on relatively straightforward ships (despite the highly interesting LNG tanker contracts) but including latest-generation mega container liners, and includes some standard designs in its portfolio. Apart from vessels for domestic inland and coastal traffic, CSSC does not have plans to enter the cruise or ferry market, although it has built some smaller vessels for domestic use.

Research and development is important to the group and there are nine institutes, including the leading Marine Design & Research Institute of

China (MARIC) and Shanghai Merchant Ship Design & Research Institute (SDARI). Facilities include towing tanks, an ocean basin, wind tunnel, and cavitation tunnel.

The focus is on developing new ship designs for the market, mainly conventional types, including bulk carriers and container ships. To date, CSSC has orders for container designs up to 5668TEU and has plans for 8000TEU-plus in the pipeline. Other development projects include offshore engineering, including FPSOs.

CSSC places a lot of emphasis on quality assurance, and has a total quality control (TQC) programme in place. All those Chinese shipyards visited by *The Naval Architect* echoed this point, and it is clear that the industry is making considerable efforts to be seen as progressive by using state-of-the-art methods. Construction times for ships are typically around 20 months from contract signing to delivery, but varying according to ship type. CSSC is planning to improve on these.

Expansion is not expected to increase the labour force. Developments will aim to increase capacity fourfold and at the same time improve productivity. The average age of the workforce is only 30 years, so the problems of an ageing workforce, which concern European, Korean, and Japanese shipbuilders, do not exist here.

To date, most building work has been carried out at the yards, but increasingly, CSSC is following current practice and out-sourcing many activities which are seen as non-core. The move from a command to a market economy in China demands that industrial companies operate in a commercially viable way, and already CSSC is understood to be making a profit. 

New 'greenfield' site for China's oldest yard

CHINA'S oldest shipbuilder is believed to be Shanghai-based Jiangnan Shipyard. It was established in 1865 during the Ching Dynasty, initially as an arms manufacturing factory. Today, it is one of the country's leading lights in the construction of both commercial and military vessels and is poised for a new era in its history - relocation to a brand-new 'greenfield' home.

Current output is around 700,000dwt annually, but it is intended that this figure will rise dramatically, as the result of a decision to relocate the yard. The orderbooks are currently full through to 2006.

Jiangnan's city centre location places a complete block on any expansion, so to be able to participate in the future development of Chinese shipbuilding, Jiangnan will be moved to a completely new 'greenfield' site. The move is also necessary because the current site is earmarked as the site of EXPO 2010. As a result, a brand-new facility will be built on Changzang island, located in the Yangtze River opposite the Shanghai Waigaoqiao Shipyard (SWS), which is already partly managed by Jiangnan.

This move will create ample room for future growth, since it will create some 6 million m² as against the current one million m². The future complex is planned to have an eventual capacity of 4.5 million dwt annually. This will be based around two shipbuilding divisions, the smaller of which will build ships of up to Panamax size and will recreate the current capability for specialised vessels. The larger division will be based around three, perhaps eventually four, large drydocks, which is similar in concept to the plans of other Chinese shipyards visited by *The Naval Architect*.

The new docks will be suitable for ships up to VLCC size. Although overall planning is in hand, the yard's design has yet to be completed. The future product mix will continue with the current programme of Panamax bulk carriers and smaller chemical tankers as well as the larger ships. An ability to build large, new-generation container liners and LNG tankers is also an objective.

Disposal of the current site to the Shanghai government will be the basis of the move. A timescale for transfer of the facilities is set, and the existing site must be clear by 2008 to allow EXPO construction to begin. Land reclamation at



An interesting completion at the end of the 2002 by Jiangnan Shipyard was the new train ferry *Yue Hai Tie I Hao*, to serve a new rail link across the Qiongzhou Strait (12.5 miles) to the southern island of Hainan. This 5700dwt vessel can load up to 40 x 80tonne freight wagons or 18 x 18tonne passenger wagons on the main deck, plus 50 lorries and 40 cars on the open weather deck. Space is available for 1360 passengers. Two Wärtsilä 6L32 engines driving Rolls-Royce Kamewa CP propellers give a service speed of 15.00knots. An option exists for a second ferry. Further details appear in the newly published annual *Significant Ship of 2003*.

the new site started in 2003 for completion in May this year, and a new access tunnel to the island from Shanghai is scheduled for completion in 2007. As the site is developed and facilities are brought into operation, the move will be phased to ensure continuity of operations.

The current workforce is around 10,000, but as at other shipyards, Jiangnan is keen to improve productivity, and operational changes are planned. This will include outsourcing where possible (an interesting contrast to Waigaoqiao where the stated intention is to control as much work as possible within the shipyard) and investment in more automated facilities.

Initial plans have been influenced by observations of Japanese shipbuilding practice, and state-of-the-art technology from around the world will be applied. Further study of the world's leading shipyards, and feedback from the experiences at SWS will also influence layout and operating systems to create a modern and efficient shipyard.

As part of this new development, the president, Mr Chen Jin Hai, has indicated his determination to use modern management techniques, including ERP (enterprise resource planning) and computer-integrated manufacturing (CIM), adapted to the shipbuilding industry's specific needs. Jiangnan is already using Tribon Solutions CAD packages.

New industrial culture

As at some other shipyards in China, the president places considerable emphasis on the need to develop a new industrial culture. Ability to adopt effectively the planned new technology is an essential component of the planned move. The currently increasing price of steel and the expectation that future demand will keep prices high was also mentioned as a problem. Cutting costs where possible is a management objective but Mr Chen is anticipating an exciting future for Jiangnan. 

RT-flex engines for Chinese tankers

ORDERS for Wärtsilä's Sulzer RT-flex low-speed engines with the new common-rail technology for fuel injection and valve operation are steadily rising. Amongst the most recent newbuildings to be equipped are four 110,000dwt Aframax product tankers contracted at Dalian New Shipbuilding Heavy Industries, China, by Danish owner A/S Dampskibsselskabet Torm.

The ships are for delivery between the first quarter 2006 and the second quarter 2007. They will each be propelled by a Sulzer 7RT-flex58T-B engine with an MCR rating of 14,875kW (20,230bhp) at 105rev/min. The

four engines will be built under licence from Wärtsilä Corp by the nearby Dalian Marine Diesel Works.

These vessels follow on from a series of 15 similar Aframax tankers built at New Dalian for various owners since 1999. The earlier vessels are powered, however, by Sulzer 7RTA62U low-speed engines having traditional camshaft-based systems. Developed by Wärtsilä Corp at the Sulzer works in Switzerland, the RT-flex concept gives unrivalled flexibility in the way engines operate, to deliver benefits such as smokeless operation at all speeds, lower fuel

consumption, reduced maintenance costs, and lower steady running speeds for better manoeuvring.

The above orders bring the total number of the RT-flex engines in service and on order to 47, amounting to an aggregate power of 1.89 million kW. These include four engines already at sea. The first series-built RT-flex production engine, a Sulzer 6RT-flex58T-B model in the bulk carrier *Gypsum Centennial*, has now exceeded 11,000 running hours since September 2001 (*The Naval Architect*, February 2002, page 46). Three ships were

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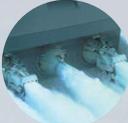
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completed last year, the Aframax tanker *Sea Lady* in Japan with a Sulzer 6RT-flex58T-B engine, the reefer *Carmel Ecofresh* (*Significant Ships of 2003*) in Portugal with a 7RT-flex60C engine, and the multi-purpose carrier *Wladyslaw Orkan* in China, also with a Sulzer 7RT-flex60C engine.

Sulzer RT-flex engines have been, or are currently being, manufactured in the works of five licensees in Japan, Korea, and China, as well as in Wärtsilä's own low-speed engine factory in Trieste, Italy. In China, RT-flex engines are being

built by both Dalian Marine Diesel Works and Yichang Marine Diesel Engine Plant and now Hudong (see below).

- Since the above text was written, further Chinese orders have been secured, particularly RT-flex60C engines to power eight 1574TEU container ships placed by Peter Döhle Schifffahrts at the Jiangsu Yangzijiang yard. Each seven-cylinder engine, to be built at the Hudong engine works in Shanghai - the first RT-

flex models to be built there, will have a maximum continuous rating of 16,520kW at 114rev/min. The ships are expected to work in the North Atlantic trades, and Wärtsilä reports that the reason for the choice of this engine model is its capability for running at lower, steady speeds than traditional camshaft-equipped machinery. This will allow better ship control while manoeuvring and during the long port approaches and river passages planned for the new ships. Ⓡ

Safety and quality key focus at Dalian

LOCATED in the northern city of Dalian, Dalian Shipyard is one of the oldest of the larger Chinese yards, having celebrated its 100th birthday in 2001. Since April 2002, this yard has been a limited liability company, with the China Shipbuilding Industry Co Ltd (CSIC) as its holding company. Most ships on order at the end of last year were for export.

In addition to commercial activity, Dalian also builds naval vessels, and over the years, 815 have been completed, including both combatant and support vessels. The yard also has some shiprepair capability, although this is small. Two floating docks are available, one of 15,000tonnes lift capacity and the second of 5000tonnes lift capacity.

For newbuilding, the yard is limited to ships of 80,000dwt on the largest of its three slipways, until a new dock (currently under construction) is commissioned. This dock, which will have a length of 400m and a width of 96m, was due to have been completed at the end of 2003; it will be used for ships of over 100,000dwt, with container ships and tankers as the target domestic markets.

The building berths have cranes of 150tonnes and 200tonnes lifting capacity but for the new dock, two 600tonne gantry (Goliath) cranes were due to be commissioned early in 2004. They will be supported by one jib crane of 120tonnes lift and three of 40tonnes. The smaller jib cranes will also service the adjacent outfitting quay of 300m length. Block storage and outfitting space is alongside.

A high level of block painting and outfitting was noted, mainly in open areas adjacent to the berths, with blocks also having staging in place before erection. Until the new dock is working, the shipyard has some limitations on space, hence the need for the new developments.

Facilities at Dalian include modern plasma cutting, a panel line, a new block painting shop, and a pipe shop. In addition, outfitting facilities will provide the required capacity to prepare blocks for the new dock as well as the berths.

Safety and quality

The shipyard appeared to be safety-conscious. Warning notices about protective equipment were seen around the yard, and the workforce were well equipped with helmets. All scaffolding around the ships was fitted with safety nets.

The shipyard has also implemented a quality assurance system to ISO 9001 standard which is accredited by DNV. For military



Conventional building berth at Dalian Shipyard contrasts with the open spaces of the newer yards; however a new construction dock has recently been opened. This 72,000dwt product tanker is being built for Stena Bulk.

shipbuilding, there is a separate QA certification to Chinese military requirements. The yard has a technical and development centre which has almost 1000 staff members, including a high proportion of engineers. CAD systems in use are Tribon Solutions and CADDSS5.

The president of Dalian, Dong Qiang, stated that the key to quality assurance is the effective operation of systems which are in place. He acknowledged that there are some complaints from superintendents and surveyors during the production process, and that there is a need to update production methods at the detail level. Considerable use of manual metal arc welding in outside areas and a large numbers of workers observed confirm this point. On the other hand, he stated that this has no impact on final product quality, as testified by the acceptance of ships by classification societies and owners.

The president's view is that these problems are for the shipyard, in that rework impacts

both on cost and schedule, but he repeated that final ship quality is not an issue. This is borne out by observation of the final outfitting of blocks and the ships near final stages of construction. Time did not permit a detailed look at any one ship, but the samples of blocks appeared to be complete, with staging and safety nets and rails also in place prior to erection.

The acceptability of ship quality is also testified by the list of owners who have had ships constructed at Dalian. These include A P Möller/Maersk with four 32,000dwt product tankers and Stena with four 72,000dwt product tankers. Chemical tankers have also been delivered. Domestic owners include COSCO, Nanking Shipping Co, in Wuhan, and China Shipping Corp. The success of the shipyard is also apparent in a full order book through to 2006. Once the additional capacity is fully operational, Dalian is confident of securing new orders. Ⓡ

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Hudong-Zhonghua to build China's first LNG tankers

CSSC founded Hudong-Zhonghua Shipbuilding (Group) Co Ltd in April 2001. This interesting union was created by the merger of two well-established shipyards in central Shanghai: Hudong, established in 1928, and Zhonghua, across the Huangpu river, two years earlier in 1926. The combined company, which also produces steel structures, builds propulsion diesel engines, and carries out shiprepair; it has a workforce of 13,000, of which 9000 are engaged in ship construction.

The shipyard has a similar product mix to most of the larger Chinese shipyards, that is, large container ships and Panamax crude and products tankers. However, future plans include the construction of Aframax tankers. Current production involves large container ships of 4100TEU and 5600TEU for Chinese interests. Plans are in hand to develop designs for much larger, new-generation container liners of 7500TEU and 8100TEU, but perhaps the most exciting news is that the company has won China's first contracts for LNG tankers, for three and two ships respectively. These have been ordered by a domestic owner.

The president of the yard, Mr Ma Guo Dong, told *The Naval Architect* that these are a particular source of pride. They are seen as prime opportunity to develop engineering capabilities but will, of course, also be a huge technical challenge. The vessels, of 147,000m³ capacity, will be built to a design developed jointly with the French yard ALSTOM Chantiers de l'Atlantique. Design work started in March last year. A licence agreement has been signed with GTT, of France, for the membrane cargo containment system. Further assistance has been received from classification societies.

The first LNG tanker is expected to be delivered in early 2007. Notwithstanding strenuous efforts by a number of industry leaders to change propulsion systems for this class of vessel, the new ships will have steam turbine propulsion, supplied by Mitsubishi or Kawasaki, of Japan. There is an expanding demand for LNG in China, so more ships can be expected in the future, and along with other shipyards, Hudong-Zhonghua is keen to participate in construction of further ships.

Probably the most important asset is a new building dock for ships up to VLCC size, which was completed on the Hudong site late in 2001. This is supported by shipbuilding slipways at both yards, one of 120,000dwt, one of 70,000dwt capacity, and three for ships of 20,000dwt to 30,000dwt. The total combined site area is 1.35 million m², including all the company's engineering and non-shipbuilding production facilities. There is also a floating dock, which is used for shiprepair. Two 600tonne capacity Goliath cranes serve the building dock, and there are various jib cranes of 100tonnes and 150tonne lifting capacity.

Ambitious targets for the future

Hudong-Zhonghua has steadily increased both the size of ships that can be built, together with



Hudong-Zhonghua is scheduled to complete this year the last of a quartet of 4100TEU container ships for China Shipping Line, an example of which is seen here. However, also under construction today are an even larger series - four hulls of 5618TEU for China Shipping Container Lines. These are the largest yet built in China to date, but the yard has ambitions to construct giants up to 8000TEU in the future.

their sophistication. Several groups of staff have visited Japan, Korea, and the European Union to study ship design methods, production systems, and management methods.

In line with government intentions that China will be the No 1 shipbuilding nation in the future, Hudong has extensive future production targets. Current output is around 1.5 million dwt annually, and this is intended to rise, by 2010, to 2.2 million dwt, with a further rise to 3.5 million dwt by 2015.

Diesel engine production is planned to rise in parallel, from one million kW in 2003 to 1.8 million kW in 2010, and 2.9 million kW in 2015. This will reinforce Hudong's position as the largest manufacturer of marine engines in China - its factory for diesel engines is a large, relatively modern building with an extensive range of cranes.

During a brief tour of the shipyard, it was apparent that Hudong has adapted much of the modern shipbuilding technology seen on overseas visits. The new dock was in use for the construction of 4100TEU and 5168TEU container ships for China Shipping, with blocks

and units alongside the dock substantially outfitted and painted. In common with the other Chinese shipyards, there was a still much staging compared with South Korea, so more work than is ideal is still being completed at the assembly stage.

Health and safety is important, and safety helmets were universally worn. The shipyard is also developing a 'green' policy, bearing in mind its sensitive location close to central Shanghai, but there are, at present, no plans to relocate the shipyard, unlike the more central Jiangnan yard.

Hudong-Zhonghua claims to be the largest Chinese shipyard at present, but there is a need to reduce costs by increasing productivity. This is to be managed by use of new technology and by improved organisation and management. Management is also trying to establish an enterprise culture, and to increase the workforce's motivation. The considerable emphasis which Mr Ma placed on health and safety, environmental issues, and competitiveness clearly indicates a company which is determined to become a leader in its field. 

An interesting Chinese completion at the beginning of last year was the 26,737dwt bulk carrier *Cinnamon*, built by the Wuhu Shipyard. She is another product of the prolific design stable of G T R Campbell/Algoship and is of the Fortune Mk 2 class; she has been specially conceived to trade up the St Lawrence River in Canada, through the Seaway system, and into the Great Lakes. Thus her hull has different dimensions from usual (177.00m length bp and 23.70m breadth, on a St Lawrence draught of 7.92m). *Cinnamon* is owned by Navarone SA, of Greece, and operated by the Canadian company Canafore Navigation. Despite the beam restriction, the class has extra-wide hatch openings, closed by end-folding, box-type MacGregor hatch covers. Four 40tonne MacGregor-Häggglund jib cranes are installed. A hold-washing system, coupled to tank storage, avoids discharging dirty water into the St Lawrence Seaway. Further details can be found in *Significant Ships of 2003*.



CSIC widens portfolio: 4 million dwt annual capacity by next year

CHINA Shipbuilding Industry Corp (CSIC) was formed in 1999, when the former China State Shipbuilding Corporation (CSSC) group was split into two companies. The other continues to carry the name CSSC (whose activities are discussed in another article). The objective of the government was stated to be to promote competition within the Chinese shipbuilding industry. CSIC operates the northern shipyards, based in six Chinese provinces.

The main companies in the group are Dalian Shipyard, Dalian New Shipbuilding Heavy Industry Co Ltd (both recently visited by *The Naval Architect*), Bohai Shipbuilding Co, Wuchang Shipyard, Shanhaiguan Shipyard, and Qingdao Beihai Shipbuilding. In addition, the group includes the Dalian Marine Diesel Works and China Offshore Industrial Corp.

Research and development is important to the Chinese industry, and CSIC includes both the China Ship Scientific Research Centre, at Wuxi, and China Ship Research & Development Academy. There are a number of other R&D centres and in total the group is said to have 30,000 engineers and other technical staff.

CSIC is state-owned, and operates as a national organisation. The total workforce is around 160,000, and annual sales are approximately US\$8.5 billion. In addition to shipbuilding and some repair, CSIC undertakes civil steel structures and bridge fabrication. Total ship production is some 1.8 million dwt annually, including both military and commercial ships. Expansion plans are to increase the total group annual capacity for ship construction to 4 million dwt by 2005.



China's ambition for a widened portfolio will certainly benefit from current construction of the country's largest container ships to date: a series of 5618TEU Post-Panamax designs for the China Shipping Group. These have been ordered from CSIC member yard Dalian New Shipyard and CSSC member Hudong-Zhonghua. One of the first, *Xin Yan Tian*, is seen here recently at the outfitting quay of Dalian New Shipyard. Plans are, however, also being drawn up to build the newest generation of 8000TEU mega-container liner.

Commercial shipbuilding activity is understood to be one third of the Chinese total. From an initial export order in the early 1980s, CSIC yards have now exported ships to over 60 countries. The 10 yards have completed some 1800 ships, including more than 400 for export. Today, export contracts represent 60% of output by deadweight and 35% by number of ships.

In addition to the VLCC capability offered at the Dalian New Shipyard (discussed in a separate article), CSIC claims to be able to build most common merchant ship types including LPG tankers, product and chemical tankers, bulk carriers, container ships, and ro-ro designs. However, Dalian New Shipbuilding is keen to be taking part in China's plans to build its own LNG tankers. 

Impact of shipbuilding and interaction with local communities

THE shipbuilding industry is important to the Chinese national, provincial, and local government, and an opportunity was taken to discuss the future of the industry with the mayor of Dalian, Mr Xia Deren. He informed *The Naval Architect* that a central government decree, issued in October 2003, relates to renovation of the older industrial areas in the north east of China. The decree and the plans associated with it envisage that the area, with a population of 110 million, will be a key growth area along with the Pearl River delta, Yellow River, and Shanghai.

The city of Dalian will be an important element of the developments because of its strategic location. Dalian has slipped from its former place as the second largest port in China after Shanghai in recent decades. Under the new policy the mayor expects it to grow again.

The city has been designated by government as an international maritime centre. Dalian will be a significant centre for logistics, trade, and finance in northeast China. Industrial development is also part of the future planning, and the main sectors included are shipbuilding, equipment, petrochemicals and electronics. Shipbuilding is thus seen as very much a sunrise industry, and pivotal to future development.

The two Dalian shipyards, Dalian Shipyard Co Ltd and Dalian New Shipbuilding Heavy Industries Co Ltd, have a current capacity of around 2 million dwt annually. This is set to grow to around 5 million dwt annually by 2010. In the mayor's view, the overall economic growth in the region will continue, and to support this the city shipyards will produce 10 million dwt by 2020.

The city is supportive of the planned developments, which will include three construction docks of 300,000dwt capacity. Developments on this scale, coupled with major expansion in Shanghai, will make China the dominant force in world shipbuilding. To do so the industry will need to maintain its cost advantage, so the mayor's goal is 'a profitable and professional shipbuilding industry'.

The support policy outlined to *The Naval Architect* includes making harbour area land available to shipyards for expansion at low cost. Central government will support the industry through a tax rebate for export ships, and loans at preferential rates will also be available to the industry.

Further central support will be given through the development of the education and training infrastructure. Dalian has 20 institutes of further

and higher education, including the Dalian University of Technology with a shipbuilding department and the Dalian Maritime University. These two produce engineers and other qualified people for the industry. A planned expansion of the shipbuilding department into a college was stated to be supported by UNDP.

Mr Xia Deren is confident that the shipbuilding companies in cooperation with government will ensure a bright future for shipbuilding. The accession of China to the World Trade Organisation, scheduled for 2005, will result in increased trade, with Dalian a strategically placed port. The policy of supporting maritime industries extends to the port sector.

Control of Dalian port has passed from central government to the municipal government of Dalian. Profits can now be retained to further develop the facilities, and this is the policy that the mayor will adopt. The city has also taken some of the administration and infrastructure functions for which the port company has previously had responsibility. Overall, the message from China is that the shipbuilding industry is regarded as a key growth industry, which will support the rapid economic growth of the country. 

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Optimism and expansion plans at SWS

SWS is the most recent addition to China's rapidly expanding shipbuilding industry. The yard was built on a 'greenfield' site on the Yangtse River, some 30km from Shanghai. It also claims to be the most technologically advanced shipyard in the country.

The yard has an area of 1.44 million m², and has 1.1km of waterfront. This represents only the first phase of construction, which was started in October 1999 and completed in 2002. Initial steel cutting for the first ship, a 175,000dwt bulk carrier, *CSK Fortune*, for Tai Chong Cheang, was in November 2001; the design by a Hong Kong consultancy, Peter Cheng, was discussed in our February 2002 edition, page 13. The ship was launched in March 2003 and delivered two months later. Two further ships have been delivered since then.

A second phase of development is planned, with a further drydock, which will increase the area to 2.1 million m². Current designed capacity is 1.8 million dwt annually, which is expected to be reached in 2007, after which the second phase development will increase the capacity to 2.6 million dwt.

Principal facilities are centred round No 1 drydock, which is 480m in length and 106m wide, and No 2 dock, with a length of 360m and width of 76m. Ships can be built semi-tandem, that is building the stern and machinery spaces of a new ship at the landward end of the dock while completing the cargo section and accommodation of another at the seaward end. On completion and float-out, the new ship after-end is floated along the dock to allow the whole process to be repeated.

Two 600tonne capacity Goliath cranes have been installed, of 185m span for No 1 dock, and 155m span for No 2 dock. Both cranes were designed by Kocks in Germany and constructed in China by the Shanghai Port Machinery Co.

Other significant features are two panel lines of 22.5m and 20m panel block length respectively. These are located in a 30,726m² assembly workshop and are capable of producing eight panel blocks daily. Curved blocks are produced in a separate workshop of 35,432m², with a 2200tonne roll-press from Hugh Smith, of the UK, a 400tonne frame bender, and assembly equipment. Completed blocks are coated in a specialised painting workshop of 16,602m², which is capable of processing 1000 blocks annually. Steel is cut using the latest plasma cutting equipment, in preparation workshops with a total area of 18,850m².

An 11,880m² workshop for pipe production is the other major facility at Waigaoqiao. This has a monthly capacity of 10,000 pipes. Other outfitting workshops are also available and the yard is designed to be capable of sophisticated ship production.

Production target: 1.5 million dwt in 2005

The production targets are to complete 1.2 million dwt in 2004, increasing to 1.5 million dwt in the following year. The order book is already full until the first half of 2007. Three ship types make up the current product mix, 17



Alongside the yard's first ships (Capesize bulk carriers), one of two 150,000dwt FPSOs for CNOOC is seen nearing completion - evidence of SWS ambitions to build sophisticated tonnage.

'green' Capesize bulk carriers, nine 105,000dwt/110,000dwt Aframax tankers, and an FPSO for the China National Offshore Oil Corp (for delivery this year). For designs, SWS is happy to work with design houses in China and also overseas, including South Korea.

During the start-up phase of operations there were some delivery problems, but these are being rapidly overcome, and current ships are expected to have a total production time of 15 or 16 months. In spite of this fairly rapid build time, quality of the ships is understood to be good, and Dr Chen Qiang, president of SWS, stated that the two Capesize ship delivered to date have exceeded cargo capacity and speed requirements.

Quality is seen as a very important issue - SWS has experienced some difficulties with owners over the interpretation of quality requirements although for some projects the company believes the quality it has provided has been in excess of real requirements - and assistance has been sought from Det Norske Veritas in developing production inspection standards. Further assistance in developing and maintaining quality assurance systems is also being received, while extra collaboration with overseas experts is foreseen as a means to improve capabilities.

Productivity close to Japan and Korea by 2015

Not surprisingly, the president identifies Japan and South Korea as the key competitors for SWS. In productivity, SWS expects to be close to, but not higher than, Japanese and Korean

levels by 2015, and certainly better than traditional Chinese yards. This is because as a new enterprise, the company is able to control the intake of labour and maintain a force which closely matches requirements. Of the 5000 workers currently engaged at Waigaoqiao, only 1300 are core workers with long-term contracts. The remainder are on short-term contracts, effectively a probationary period, usually for two years but with a maximum of three.

Over time, some of the temporary workers will join the core labour force, but this will be carefully controlled. This approach will ensure that the workforce is well trained and motivated. Another benefit to SWS is that it avoids the difficulties that state-owned businesses have in shedding labour.

Dr Chen also noted that SWS is not keen to use subcontractors, because of quality concerns. The preference is to do as much work as possible in-house to maintain control of these factors which are critical to developing a good reputation among shipowners.

In a brief tour of the shipyard, it was apparent that the painting and outfitting of hull blocks is very advanced prior to erection. The lessons from visits to South Korea and Japan appear to have been well learned. On the other hand, the quantity of staging around the ships under construction was more than was seen in a recent visit to South Korean shipyards. This may be an indication that organisation of work and supply chain management still require improvement. Relatively few workers were seen in the assembly areas, which seems to confirm that SWS is a 'lean' and relatively efficient operation. Ⓜ

Successful VLCC building programme

DALIAN New Shipyard Heavy Industries Company secured the first VLCC contract for China in August 1999. The building of these five 299,500dwt ships is still in progress – the first was delivered in August 2002. *The Naval Architect* recently had the opportunity to discuss the ships with the National Iranian Tanker Co (NITC).

NITC has placed orders recently with builders in China and South Korea. Careful preparation was needed in deciding to become the first owner to order such large ships in China. Classification societies have provided considerable support, including DNV, for these Chinese-built ships. They are unusual, in that they have been designed for a longer fatigue life than is common. In principle the ships are expected to last for 40 years service, a lifespan which is today becoming a benchmark for quality owners.

The ships also have been designed to comply with current and anticipated environmental and other requirements. The result is vessels which have a more expensive outlay, but which are anticipated to have lower through-life costs. Some of the features are:

- DNV Clean notation
- tin-free antifouling coatings
- a high standard of crew comfort (the ships have a large complement of 53, including berths for 12 cadets)
- crude oil washing
- ballast water exchange
- Mitsubishi Supercargo system, with fully automated loading, discharge and ballast system.

The first requirement was to develop a suitable specification, which was done in collaboration with DNV. Some Chinese staff were used in other countries to gain experience before the work started in Dalian. NITC regarded the Chinese shipyard's bid for the contract as commercially attractive, but potentially risky since they would be the first such ships and had a demanding specification.

Delivery date was less critical, as the cash flow was easier, so the project team has focussed on quality. The changing rules and NITC intention to have ships compliant with the latest requirements also made a slower delivery schedule acceptable. The first of class has been operating for over a year and was said to be very satisfactory.

The first ship had a 24month build period, the second, delivered in February 2003, was completed more quickly. To ensure quality and because of the specification, the first ship had a trials period of over three weeks. The subsequent ships are taking around two weeks which is estimated to be twice the time for equivalent ships in South Korea or Japan. However, the complexity of the systems, new equipment and safety features create a lot of system interfaces, extending the trials period.

NITC has stated that it would return to China for future ships, though currently full Chinese order books mean it has ordered recently in



Work continues at Dalian New Shipyard on the last of the five VLCCs for National Iranian Tanker Co, at the same time as the dock is being extended from 365m length to 550m.

South Korea. Overall, it regards China as capable of producing a high quality product, provided the shipowner is prepared to spend more on preparation, contract management and

supervision. A slower build time is also to be expected but if this is factored into fleet planning, the results should be very satisfactory. Ⓡ

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Dalian New: full order book for two years

THE Dalian New Shipyard was inaugurated in 1981, but in August 2001 the company was reconstituted as the Dalian New Shipbuilding Heavy Industries Co Ltd. It was the first yard in China to construct large commercial ships, that is, vessels over 100,000dwt.

This yard is well equipped with machinery and production equipment, largely of European origin. It has a large technical and R&D centre which focuses on product improvement. CAD systems utilised are from Tribon Solutions and NAPA (for architectural calculation). Production is organised into three flow lines, for different interim product types. These are: flat panel blocks, curved panel blocks, and other structures. In addition to ships, the Dalian New Shipyard builds offshore oil platforms and production vessels. Organisation is based on the use of group technology to identify different product families, each of which uses specialised facilities.

After outfitting of completed steel blocks, they are coated in a specialist paint shop where environmental conditions can be controlled. Outfitting is largely completed in outside block storage areas, prior to being transported to the berth or building dock.

The main ship construction facility is a dock 365m in length, 80m wide, with a depth of 12.7m, which is suitable for ships up to 300,000dwt. A 900tonne lifting capacity portal crane is used to position blocks. There is also a building berth for ships up to 150,000dwt tonnes, served by a 580tonne-lift crane.

Development plans under way

Expansion plans for the yard include lengthening the dock from 365m to 550m, allowing larger ships to be built. Work was in progress during the tour of the shipyard by *The Naval Architect*. An extra 600tonne-lift gantry crane will be installed on the existing crane tracks. The dock is being extended while work continues on a VLCC (the last of a series for National Iranian Tanker Co), and the shipbuilding programme has not been affected. The crane beam was in position at the time of our visit, and the lifting arrangements for beam and legs under construction.

Current capacity of the shipyard is approximately 1.5 million dwt annually, once the current round of development projects is complete. Once the new dock is fully operational, the shipyard has plans to extend its facilities for steel cutting, preparation, and initial assembly. This is likely to be at a new site close to the shipyard, and will increase capacity to 2.4 million dwt by 2006.

Further preliminary plans are to extend the overall capacity of Dalian New Shipyard to 3.3 million dwt by the year 2009. All expansion is to be achieved partly by new facilities, but also by a productivity improvement programme. It is not intended to increase the production current workforce of some 5000 (this figure excludes sub-contractors and there are other, non-commercial activities carried out in the shipyard).



The offshore sector is of great interest to Dalian New Shipyard. Seen here at the end of last year at outfitting quays are a bare semisubmersible hull and, in the background, an FPSO.

Given the modern facilities and hardware, the shipyard recognises that further expansion will also be heavily dependent on the improvements which are planned in productivity. Yard organisation has been adjusted to create three departments, the first to assemble complete ship blocks (including all outfitting and painting) and the other two for dock construction, and slipway construction.

Each department has a schedule to meet, and its performance is judged not only by an ability to meet the schedule, but also by the ability to provide complete interim products for the next stage of production. Thus the berth and dock departments must meet defined milestones, while the assembly department must provide complete blocks to the others at defined times. Block completeness is determined by inspection. As with the shipyard itself, failure to meet quality and schedule requirements carries a penalty in financial terms. On the other hand, the ability to exceed requirements will carry a bonus, as overall capacity will be increased. Essentially, the shipyard is trying to develop a production system which is based on the principle of payment by results.

Current contracts

Current orders are for 1.58 million dwt, and the yard is close to completing a series of four 5618TEU Post-Panamax ships for China

Shipping - the largest container designs yet built in China. The last was scheduled for delivery in January 2004, some five months ahead of contract schedule. This will allow the shipyard to insert an additional vessel into the overall programme, increasing total income.

Other building work includes VLCC ships (mentioned above), building for the National Iranian Tanker Co, which are of a sophisticated design. They should have a fatigue life of 40 years, and incorporate a number of state-of-the-art systems. The success of Dalian New Shipbuilding to date may be judged by the order book which is full until the end of the year 2006.

Product development in particular is a feature of Dalian's technical centre. New designs are under development for Panamax oil tankers, large container ships, and multi-purpose vessels. There are also projects to design LNG tankers for the expected boom in energy demand from Chinese industry. In this case, a collaboration agreement exists with both Aker Kvaerner Masa-Yards and ALSTOM Chantiers de l'Atlantique, and in the event of securing orders, Dalian expects to import spherical tanks.

The shipyard is also developing designs which are more optimised for production. For example, the design of piping systems will run in defined routes, reducing the number of bends and thus the time to manufacture and install the pipes. 

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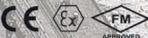
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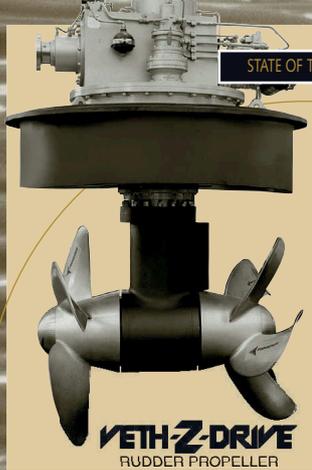
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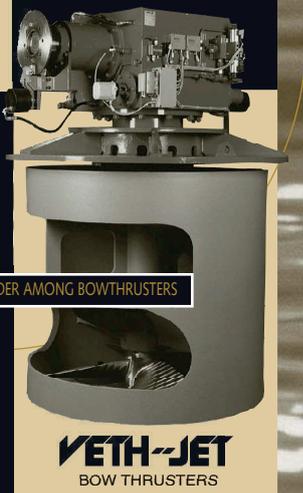


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Hold cooling systems for refrigerated containers

Sir - I write this letter in response to Dr Koelman's comments (January 2004, page 37) regarding my article published in the September 2003 issue of *The Naval Architect*, page 90.

The contents of Dr Koelman's letter have been noted, and in essence, what he is saying is correct. This is true if the container is considered under steady state conditions. We have promoted a 'heat balance' concept instead of only taking the input electrical energy as the new heat load to allow the hold ventilation requirements to be readily calculated.

If a frozen cargo, say lamb carcasses, being maintained at -18°C , is considered, we come to the following conclusions. As the meat is 'dead' it does not contribute any field heat or heat of respiration, nor does it require any air refreshing. Provided it has reached and is maintained at its normal carriage temperature, it will not have any effect on the heat balance. It is considered that in this instance, due to the mass of cargo and its inherent large thermal inertia, the change in enthalpy of the container air, as the container's thermostat cycles on and off, may also be discounted.

The heat absorbed by the evaporator located within the container is equal to the transmission heat through the container's insulated envelope, heat load from infiltration air (for dead cargoes this is limited to air entering through gaps and door seals), and the electrical heat energy from the evaporator fans, drain line heaters and internal lighting if left energised.

This heat absorbed by the evaporator is normally rejected by the container's condenser in a location where it does not matter. However, when the containers are located within the hold this becomes a problem and the total heat rejected by the condenser needs to be established and dissipated to atmosphere. This includes the heat absorbed by the evaporator, the energy equivalent of the work of compression, and any superheat absorbed by the refrigerant suction vapour from the surrounding air. The work of compression per kW of refrigerating capacity is dependant on the compression ratio, which varies with the operating conditions.

Heat rejection factors for various operating conditions are readily available from a number of standard reference books. In addition to the heat rejected at the condenser, further container heat rejection loads need to be considered. These include the heat energy associated with the condenser fans, motor, losses from the compressor drive motor and to a lesser extent the radiated and convection heat from the compressor, pipework and motor. For each container a heat balance needs to be calculated, and the net heat gain to the air within the hold space determined.

It is considered that the effects of heat gains and losses to the air within the hold space, due to external ambient air and sea water/ballast spaces/heavy oil tank temperatures, are separate from the containers' heat gain and we would request that this be calculated separately once the dimensions, layout and scantling of the ship were known.

Cargo	Bananas	Apples	Lamb
External ambient air	38°C	38°C	38°C
Hold space air	45°C	45°C	45°C
Container temperature	14°C	3°C	-18°C
Weight of cargo	21,300kg	27,000kg	20,500kg
Heat absorbed by container's evaporator			
Internal electrical	0.54kW	0.54kW	0.72kW
Air refreshing	1.72kW	0.69kW	N/A
Respiration	2.82kW	0.52kW	N/A
Field heat (pre-cooled)	N/A	N/A	N/A
Transmission	1.30kW	1.90kW	3.04kW
Infiltration	0.34kW	0.43kW	0.29kW
Total	6.72kW	4.08kW	4.05kW
Heat rejected by container's condenser			
Evaporator load	6.72kW	4.08kW	4.05kW
Factor*	1.20	1.28	1.42
Total	8.06kW	5.22kW	5.75kW
Heat rejected to hold space by other means			
Condenser fan	0.54kW	0.54kW	0.54kW
Radiation & convection	0.15kW	0.18kW	0.20kW
Total	0.69kW	0.72kW	0.74kW
Total heat rejection into hold space			
Total	8.75kW	5.94kW	6.54kW
Heat transmitted back into container from hold space air			
Transmission (envelope)	1.30kW	1.90kW	3.04kW
Infiltration	0.34kW	0.43kW	0.29kW
Total	1.64kW	2.33kW	3.33kW
Net heat balance = electrical input energy			
Total	7.11kW	3.61kW	3.21kW

*Work of compressor

Values from the heat balance calculation for three different cargoes.

When 'live' cargoes and those requiring close control of carbon dioxide concentrations are carried, the added heat gains arising from respiration, field heat (if recently harvested) and container air refreshing requirements also have to be considered. To establish the heat balance for different operating conditions, we have computer models to allow the net heat gain to be determined for a number of different cargoes carried under various operating conditions.

Listed in the accompanying table are the values obtained from the heat balance calculation of three different cargoes carried in a standard 40ft container. The ratio between

the heat ingress into the container envelope and the heat rejected into the hold space air can readily be determined.

Whilst we are in agreement on the heat gain concept, it is evident that some form of hold space ventilation system is required to dissipate the heat to the outside of the hold space.

If readers require any further help or assistance please feel free to contact me.

Robbie Sillars
Senior Surveyor
Engineering Systems
Lloyd's Register EMEA
71 Fenchurch Street,
London EC3M 4BS, UK

DNV to cooperate with Russian Register

DET Norske Veritas has signed a cooperative agreement with the Russian Maritime Register of Shipping (RS) that covers the classification of ships and mobile offshore units (both newbuildings and ships in operation), and the certification of material components, consulting, verification, and the provision of third-party services to the oil and gas industry.

Both societies will put resources at each other's disposal, so in practice RS will aid DNV in Russia, and DNV will aid RS in the rest of the world. This gives two possibilities to win service contracts where both Western and Russian oil companies are involved. The agreement offers DNV the opportunity to provide services to the offshore development projects in the important Sakhalin area, and in the future, to the north of Siberia. 

Key machinery for Queen Mary 2

CUNARD'S 150,000gt, 3090-passenger Transatlantic liner *Queen Mary 2* from Chantiers de l'Atlantique - fully detailed in a special publication from *The Naval Architect* - sets a new standard in scale and luxury and provides a powerful reference for CODAG-electric machinery and podded propulsors.

An all-diesel ship was considered at the preliminary design stage but a combined diesel and gas turbine-electric propulsion plant emerged as the favoured solution. Estimates using the speed-power curve of the 1967-launched 70,000gt *Queen Elizabeth 2*, modified for the proposed increase in size of the new ship, showed that around 80,000kW of propulsive power would be required for a maximum speed of 29.5knots.

An optimum diesel-based configuration had initially appeared to be two engine rooms, each with three Wärtsilä 64 medium-speed engines, but since Cunard parent Carnival had no experience with the 640mm-bore design it was decided to revert to smaller Wärtsilä 46 engines with a gas turbine boost component. The owner has considerable experience with this popular 460mm-bore design.

A cruising speed of 23.5knots and the hotel load can be satisfied by four Wärtsilä 46 engines operating at 85% maximum continuous rating. Each engine is rated at 16,800kW MCR, running at 514rev/min and driving Alstom generators supplying electrical power at 11kV/60Hz/3-phase. The diesel gensets are located low down in the hull to enhance ship stability, paired in separate engine rooms.

The engines exploit an EnviroEngine specification developed by Wärtsilä in conjunction with the Carnival Corp for the cruise group's most recent tonnage. A key element, the electronically-controlled common-rail fuel injection system, allows injection pressures to be kept sufficiently high at all engine loads and speeds (including idling) to achieve clean combustion with no visible smoke emissions.

Higher ship speeds are delivered by engaging a pair of GE Marine 25,000kW aero-derived LM2500+ gas turbine-driven gensets to supplement the diesel genset effort, creating a CODAG-electric plant with an overall rating of just over 117,000kW. Mounted on elastic



The two GE LM2500+ gas turbines on board *Queen Mary 2* (one of which is seen here being shipped to France already packaged with its 25,000kW Brush alternator) will provide a further important reference for the US manufacturer's portfolio in the cruise ship sector. Each is positioned at the base of the main funnel. A noteworthy point is a reduction, achieved by GE at the shipyard's request, in the overall weight of each set, compared with previous installations, by 40tonnes. This figure excludes ducting.

supports, the gas turbine-generators are installed in a room immediately aft of the funnel, a location minimising the amount of intake and exhaust ducting and releasing valuable space within the ship. All air intakes are around the funnel and screened by the funnel 'scoop' and deck baffles against noise.

The gas turbine sets can be deployed either alone or in conjunction with the diesel gensets to meet varying propulsion and hotel load demands. It is

anticipated that the gas turbines will mainly be started when a power boost is dictated or when the ship is in a particularly environmentally-sensitive area where stricter emission regulations apply.

Manufactured by GE Marine Engines' Evendale, Ohio facility, the LM2500+ turbines were packaged by Houston-based GE Aero Energy. Running at 3600rev/min, each turbine drives via reduction gearing a 25,000kW/29.411MVA generator supplied by the UK company Brush

In the interests of simple installation and elimination of hydraulic leaks, electrical operation was chosen by ALSTOM Chantiers de l'Atlantique for all the Rauma-Brattvaag (Rolls-Royce group) mooring equipment, including these winches on the covered forecandle deck. Because of the narrow streamlined bow, both windlasses are on the level above. All forward rope and fairlead hatches, also hawse-pipe openings, can be closed by plates to make the forecandle as watertight as possible in mid-Atlantic weather.



TECHNICAL PARTICULARS QUEEN MARY 2

Length, oa.....	345.00m
Beam, waterline.....	41.00m
Draught.....	10.00m
Air draught.....	62.00m
Displacement.....	75,000tonnes
Gross.....	150,000gt
Decks.....	19
Passengers/crew.....	3090/1300
Propulsive power.....	86,000kW
Hotel load.....	16,000kW
Power plant.....	4 x Wärtsilä 16V46; 2 x GE LM2500+
Installed power.....	117,200kW
Speed, max.....	30knots
Class.....	Lloyd's Register

Design and Operation of Trimaran Ships

29 - 30 April 2004, London, UK

Second Notice



The idea of trimaran ships has inspired a tremendous amount of attention, both civil and military. The concept; a stabilised monohull, with small sidehulls adding stability to a slender central hull, has a number of potential advantages. The most obvious are the increased control over stability and greater flexibility in layout, but other advantages include better seakeeping, reduced speed loss in a seaway and possible high speed powering and vulnerability benefits.



The subject has now been thoroughly investigated around the world with a combination of design studies, numerical simulation, model testing and the construction of the large ocean-going technology demonstrator, RV Triton. The trials have proven highly successful and have produced a large amount of data; validating prediction methods and design tools and providing experience of operating a seagoing vessel in all weather conditions.



There is now an increasing move to exploit this new technology, culminating in the recent order of a large trimaran fast ferry to operate in the Canary Islands.

This conference will definitively review the present situation with a selection of papers from civil and defence sources, as well as providing a forum to discuss plans for the future. This conference is planned with the UK MoD to include very significant discussion of the results of the Triton trials programme.

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Electrical Machines. Cooling is effected by air-to-water heat exchangers. Like the diesel gensets, power is supplied at 11kV/60Hz/3-phase.

The packages are reportedly around 40tonnes lighter (excluding any ducting) than previous LM2500+ marine gas turbine installations and contribute to compactness, and low noise and vibration characteristics. The volume and weight of ducting for combustion intake, exhaust and package ventilation are also significantly reduced, claims GE Aero Energy.

Another feature of the redesigned package is a new generation Woodward Micro-Net digital turbine control system, which covers engine fuel management, package sequencing and condition monitoring, and interfaces with other relevant shipboard systems.

All six prime movers on line together can generate sufficient power for the hotel services (16,000kW) and 86,000kW of propulsive effort (yielding a trials speed of over 29knots). The divided generating plant fosters good operational flexibility as well as redundancy in normal deployment.

Exhaust gases from the turbines are passed through an Aalborg waste heat boiler (one for each turbine) to generate 2 x 30tonnes/h of steam for diverse shipboard services. Each diesel engine exhaust line includes a 5.4tonnes/h Rizzi boiler.

Electrical power is fed to four 21,500kW Rolls-Royce Mermaid podded propulsors, the first quadruple-pod installation and reportedly the largest and most powerful pods yet installed; each weighs almost 350tonnes with ancillary equipment. The Mermaid was developed by Rolls-Royce in conjunction with Alstom Power Conversion, which supplied the electric drives for the pods.

The two forward-mounted pods are fixed, while the after pair are fully azimuthing types. Each pod features a four-bladed Kamewa stainless steel propeller, but with different configurations for the forward and aft pairs reflecting the different wake field patterns in which they have to work.

Great care was taken in determining the positioning of the pods (see below) and the tip

clearance between propellers and hull, this being a critical factor for low pressure pulses and low vibration levels.

Special attention was paid in testing to the location/orientation of the pods and to minimising pressure pulses. In early tests it was found that the pressure pulses were significantly higher than expected and would give rise to unacceptable vibration. Consequently, the pod stays were lengthened so as to increase the propeller-to-hull clearance; subsequent testing indicated a dramatic improvement.

MARIN in The Netherlands performed full resistance, self-propulsion and various propeller tests to optimise propulsion. Extensive tests were also carried out by the organisation for harbour manoeuvring and seakeeping.

Four voyage scenarios were used to evaluate the conflict between speed and comfort:

- a 'maximum sustained speed' scenario
- a 'constant speed' scenario (variable power, up to the maximum, to maintain speed under most circumstances)
- a 'just in time' scenario (high speed in the early stages of the voyage, with a lower speed when approaching the destination and recovering delays when necessary)
- a 'comfort' scenario (reducing speed in the event of bad weather causing discomfort).

Performance, including the effects of route and sailing direction, was established in terms of arrival time, fuel consumption, and passenger comfort.

It was demonstrated that the use of constant power gave the lowest fuel consumption; but delays are possible and sailing under 'constant speed' and 'just in time' scenarios secures high reliability in arriving on time with only a slight increase in consumption compared with the constant power scenario. It was also shown that routing between northern and southern tracks had only a minor influence on comfort, but with an 11% increase in distance there was a significant rise in fuel consumption.

The comprehensive study concluded that the propulsive power proposed for *Queen Mary 2* promised an adequate sea margin, and that the ship should be able to maintain her six-day Transatlantic schedule without undue difficulty.

An integrated dynamic positioning system from Alstom is installed to coordinate the efforts of the pods and three Kamewa 3200kW bow thrusters, the ADPO2 system being operable from three locations on the ship. Full joystick control - manual and auto-heading - is offered as well as conventional DP functions such as station keeping, anchor mode, autopilot, transit, auto speed with Doppler log, and 'relaxed DP'. The latter mode offers the additional benefit of fuel savings and reduced wear-and-tear on power generation and propulsion plant.

Passenger comfort is enhanced by four Brown Brothers VM-series folding-fin stabilisers, each with a fin area of 15.63m², maintaining the Rolls-Royce brand's long relationship with Cunard tonnage: fin stabiliser systems from the Scottish company were supplied to the first *Queen Mary*, *Queen Elizabeth*, and *Queen Elizabeth 2*. Rolls-Royce also provided the Rauma Brattvaag deck gear whose frequency-controlled AC stepless drive fosters quiet anchoring and mooring.

Toronto-based CAE Valmarine supplied a complete control systems package, including machinery monitoring, controls and alarms, an emergency shutdown system, and a computer-controlled safety system.

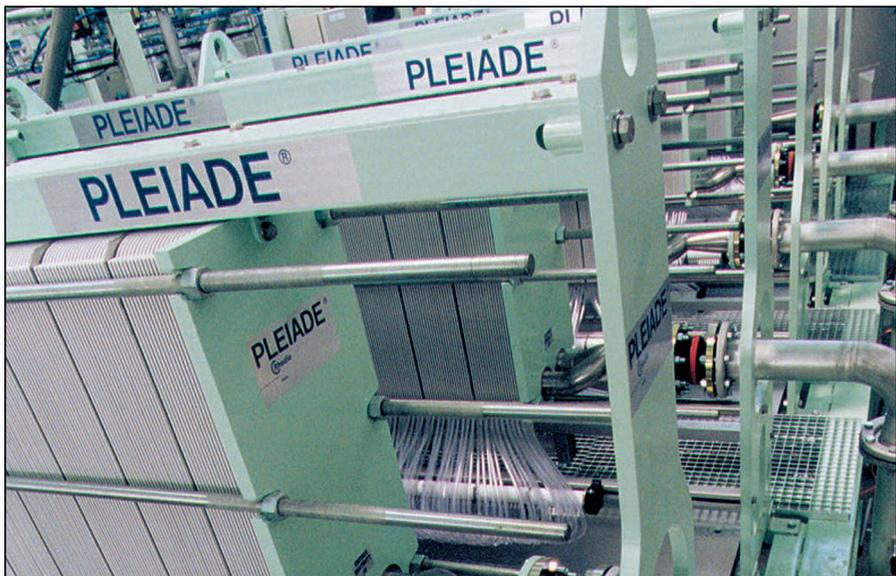
An extensive Marioff Hi-Fog water mist fire extinguishing system protecting the accommodation, service and machinery spaces incorporates over 10,000 sprinklers and spray heads and 58km of stainless steel piping. The system features the Finnish specialist's new compact SPAU 2000 3 pumping unit based on three electric motors, each driving two pumps.

Daily water consumption onboard - from drinking water to showers - is estimated at around 1100tonnes, with most of the supply generated by three Alfa Laval 'multiple effect plate' distillers. Exploiting waste heat from the diesel engines, each distiller is capable of producing 630tonnes of fresh water per day by evaporating sea water. The water produced is reportedly of very high quality, with a salinity of less than 5ppm.

Addressing another challenge for large passenger ship operators - oil treatment and oily waste management - Alfa Laval supplied its S-separator systems to treat fuel oils, gas oil and lube oils. Gas oil burnt by the gas turbines is purified and settled in the main machinery space tanks for delivery via one line to two 4m³ heated buffer tanks near the turbine sets.

Alfa-Laval's fully automatic EcoStream system was specified to separate bilge water into water, oil and a small volume of pumpable sludge. A greatly reduced amount of concentrated sludge translates to lower disposal costs ashore. Black and grey water are treated by a Rhodia Orelis membrane bioreactor plant, refining the waste to what is technically drinking water standard. This is the French supplier's first marine plant, and its specification here could lead to further shipboard contracts. Ⓡ

A typical Pleiade membrane bio-reactor waste-water installation from the French specialist Rhodia Orelis. The installation from this company on *Queen Mary 2* is its first marine venture, but the equipment was very carefully evaluated, and super-high efficiency is expected. Technically, the effluent is of drinking water quality.



Interior features of *Queen Mary 2*

North London-based Designteam was responsible for creating a number of interiors areas of *Queen Mary 2*. One of this company's most exciting designs is the Illuminations theatre and the planetarium, thought to be the first ever on any ship. Along with this, stylish public spaces can be seen in the ConneXions college-at-sea, cleverly positioned under the auditorium seating of the Illuminations auditorium, as well as the shopping area, and the Todd English restaurant.

THE Illuminations theatre spans Decks 2 and 3 towards the forward end of *Queen Mary 2*. It includes the first ever planetarium on a cruise liner and is an impressive spectacle. This domed planetarium in the ceiling of the theatre is a masterpiece of technical gadgetry and innovation.

With the aid of computerised lighting, up to 170 passengers seated under the central area of the auditorium can be given a unique show; since space is only available for a limited number - the seating area is delineated by different colour upholstery (gold), shows will normally last only up to 40 minutes. This feature, which employs six projectors, was not in the original plan, which envisaged the room being used solely as a cinema, for piano recitals, stage shows, and conferences, but was subsequently changed to provide what Cunard calls a 'wow factor' or 'signature space'.

This planetarium can move: the lower segment of the half-globe is lowered down and around the permanent top segment, where it is sealed by a skilful arrangement of flaps which close sequentially, in the form of the ailerons on an aircraft wing, to form a perfect hemisphere. Since

the seating in this central area is raked, the audience will not have to crane their necks at an uncomfortable angle in order to view the almost 180deg 'solar system' but special inclined chairs with quick-flip backs for returning to the upright position (needed for safety reasons) are included at the lower end of the rake. All the chairs were developed and made by the Italian company Poltrona Frau to Designteam's specifications.

The advanced full-colour projection and sound system, which enables viewers to orbit a planet, was designed by the US specialist Skyskan in conjunction with another US company, Nautilus (which provided the lighting and sound effects), and if required, could be re-formatted to provide a virtual space roller-coaster. Dimensions of the planetarium dome are 13m wide, and 7m from 'equator' to apex. All construction work was subcontracted to the French company HMS.

The theatre itself is designed around a strong but simple Art Deco theme, to tie in with the overall theme of the new liner - a contemporary vision of that employed during the 1930s on the first *Queen Mary*. All the two-tone chairs are fitted with side-folding tables and have wireless hand controls for interactive voting in special shows.

To link the Art Deco theme with the planetarium and the mysteries of the constellations, two outsize bronze statues of Roman gods Mercury and Jupiter, 4m high, are positioned by each of the two entrances, with Greek goddess Andromeda in a 4m high niche in the lobby stairwell. All of them are planned to promote a sense of theatre and drama prior to entering Illuminations. Walls of the theatre feature wood veneers on the pillars with suede panels between, designed to be both decorative and to absorb noise. Ⓡ



Queen Mary 2 has an extensive shopping area, believed to be one of the largest on any cruise liner, located on Deck 3 off the atrium second level, which was also created by Designteam. This 480m² space consists of nine shops which sell goods such as top fashion brands, fine jewellery, and watches.

The Todd English restaurant was created with the assistance of the US celebrity chef of the same name, and whose theme is Mediterranean 'fusion' cuisine with a US slant. This is located at the aft end of Deck 8 and includes an outside area and adjacent pool and fine-weather bandstand that can be used for sunbathing at other times. Seating is available inside for 142, with 52 outside.

This restaurant has a circular vestibule entrance area, and decor both here and in the restaurant itself reflects modern interpretations of southern Spain, Moorish, and desert themes, including a 'cobblestone' floor in the vestibule to create an outdoor feel. The restaurant includes a bar with stool seating for 'show cooking'. Other features include a huge wall-to-ceiling mirror and large gilt picture frames with tiny pictures inside. Full-height glazing enables diners to view the outside teak deck area and raised pool. As part of the Todd English dining experience, Designteam has created an open deck terrace, which allows passengers to dine in an informal café-style atmosphere by day, with panoramic views across the aft pool. In the evening, it transforms into an intimate al fresco restaurant.



Energy management cuts air conditioning costs

SUBSTANTIAL cost savings are promised for cruise ship operators by a new energy management programme, Demand Control Systems, which is also said to foster emission reductions, extended equipment life, and lower noise and vibration levels. Applicable to individual ships, the programme has been devised by UK-based independent air conditioning design specialist Giles Consulting, after assessing the air conditioning systems of 120 ships of 30,000gt or more.

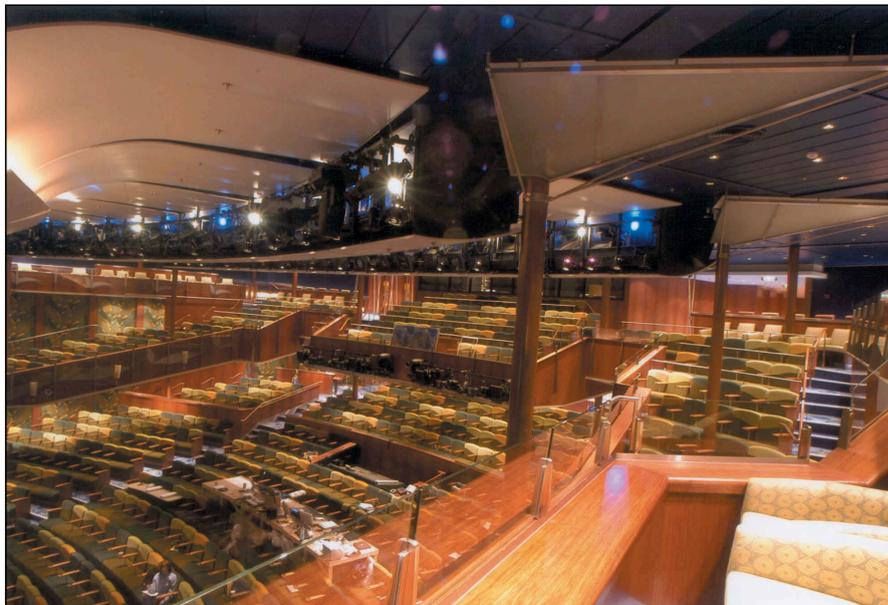
The two-year study was stimulated by the failure of many ships to effectively monitor and manage electrical consumption by chillers and AC systems. The company calculates that the world's cruise fleet annually consumes 1.126 billion kWh in powering AC plant serving public rooms alone, and suggests cross-industry savings of US\$50 million a year are possible.

Demand control design engineering is based on the principle that air conditioning and electricity usage should be designed from the outset as two sides of one energy coin. Power usage is perceived as part of the life-cycle costs.

Shipowners are reportedly commissioning Giles Consulting to carry out onboard surveys, from which the consultant prepares a detailed report and, in most cases, a specification document. The document enables the owner to go out to competitive tender for the work necessary to implement the new philosophy.

Giles Consulting's service extends to supervising the onboard activity to ensure that equipment supply and installation are performed in accordance with the specification document. A training programme is normally required to make the crew aware of the programme's objectives, the capabilities of the technology involved and the importance of procedures for successful application.

Ship operators have a duty of care to passenger and crew and must address the issue of air hygiene, especially hazardous airborne respirable spores (HARMS) which build-up in shipboard systems. According to Giles Consulting, should a heating, ventilating and air conditioning system be found to be contaminated, the shipowner has a liability that may be financial, legal or both.



Over 1.1 billion kWh is consumed annually by the cruise fleet in powering air conditioning plants, serving public rooms alone, such as in the Tropical Theatre on *Serenade of the Seas*, seen here.

This liability will arise mainly because an air hygiene management programme is not in place to provide verification of the system's cleanliness, even though the owner has installed a technical capability to provide it. Negligence claims require proof in four main areas: that the defendant owed the plaintiff a duty; that the defendant breached that duty; that the plaintiff suffered injury or damage; and that this injury was caused by the defendant's action or inaction.

Climate management: the way ahead

Shipboard climate management systems will soon replace traditional ventilation systems for complex tonnage, suggests ABB Automation Technology, Marine Ventilation, the Sweden-based marine air conditioning specialist (formerly ABB Fläkt Marine), whose experience dates back to 1939 when it

airconditioned the liner *Stockholm*. Great potential is foreseen for energy savings and air quality improvements through process optimisation and system supervision. Considerable data has been logged from a pilot climate management system on a cruise ship operating in the Caribbean.

In analysing this data, it is only too obvious that contemporary air conditioning systems still have potential for energy conservation. In addition, new control principles can provide the crew with effective tools to eliminate complaints over poor climate, reports ABB.

Expertise in automation software will transform a ventilation plant into a climate management system which allows the crew to take a firmer grip on the shipboard environment. A pilot climate management system and Monovent air control units from ABB serve the Aker MTW-built cruise ship *AidaVita*. 

Huge potential offered by untapped cruise market

EUROPEAN cruise sale penetration figures compiled by Swedish shipping media house and consultancy, ShipPax Information, show that there is a huge untapped market for cruising in Europe. Although, not surprisingly, the UK has the largest penetration of cruise sales, all other European countries, apart from Luxembourg, are a long way behind.

ShipPax Information believes that all European nations could almost match the UK cruise penetration, which in itself will continue to climb. If so, at an average

penetration of 1.4%, European countries would develop another 3.3 million passengers. In other words, the global cruise market would suddenly jump another 25.6%. This, in turn, would result in starving shipyards instantly being able to fill their order books with some 25 cruise ships.

There are a number of factors which have contributed to the UK's success: home porting ships; building on established cruising traditions; having the right sales channels; or simply a combination of all these elements.

Nevertheless, the question remains: why do not other European countries learn from the UK's winning formula and follow suit?

It is clear that new marketing and booking methods need to be established in continental Europe's cruise industry. Many potential holidaymakers are of the opinion that cruising is beyond their budget. Travel agents all over Europe need to be trained in getting the message across that cruising is value for money, and to be better educated in the cruise product. 

NEW PUBLICATION

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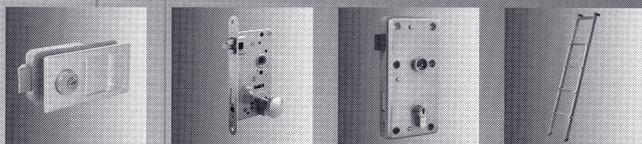
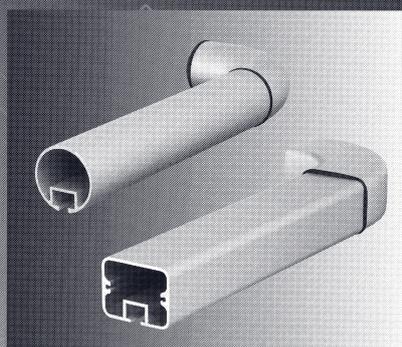
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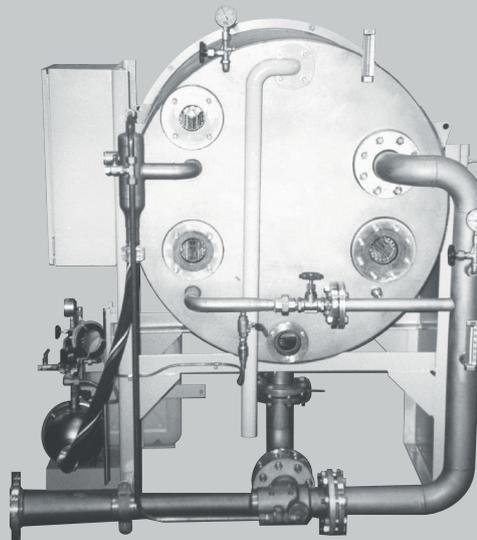
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Passenger capacity increase for Super Panamax cruise ships

A NEW Super Panamax cruise ship concept from Finnish design group Deltamarin promises a significant increase in passenger cabins and other revenue-generating spaces over conventional Panamax tonnage as well as an improvement in functional efficiency. Some 290 extra cabins can be created - taking the total to 1340 - with crew and public spaces expanded accordingly to maintain the standard of service and space per passenger.

Contributing to the capacity expansion are the following design features:

- machinery arranged in a new location in the aft ship
- all services, preparation and store rooms relocated in an open large lower hold on the second deck
- third deck released for passenger cabins and necessary tendering and intakes
- a foldable bow, lengthening the vessel by 11m
- lengthened vessel can carry an additional deck; using alternative constructions and aluminium in the upper structures allows the stability of the 15-deck high Panamax vessel to be managed
- large public spaces introduced to accept increased number of passengers.

Locating the power plant aft close to the largest consumers - the pod propulsor electric motors - releases the whole midships area for other functional purposes. All service, preparation and store spaces are removed to a dedicated area on Deck 1, eliminating all disturbing flows (such as passenger tendering and luggage handling) which typically arise on the third deck.

	Panamax	Super Panamax	Differences
Length, oa	294m	305m	+11
Breadth	32.2m	32.2m	-
Draught	8.15m	8.15m	-
Gross tonnage	90,000gt	99,000gt	+9000
Displacement	48,000tonnes	48,500tonnes	+500
Passenger cabins	1050	1340	+290
Crew	890	1090	+200
Public spaces	15,800m ²	16,300m ²	+500
Outdoor deck	10,000m ²	10,450m ²	+450

Super Panamax versus conventional Panamax cruise ship, according to Deltamarin. An interesting comparison could perhaps also be made with an alternative concept, the Panamax-Max, introduced by Kvaerner Masa-yards and presented with *Costa Atlantica* in *Significant Ships of 2000*.

Completely separated arrangements foster more efficient flows and a better use of space allows some 5000m³-8000m³ of valuable revenue-generating space to be created. The probabilistic damage stability approach enables this type of arrangement to be adopted, the actual survivability of the design being better than that of a conventional Panamax ship of today, Deltamarin claims.

Arranging all services, preparation rooms and stores on Deck 1 allows the creation of a full deck-long uninterrupted and separated space. Service functions, such as tendering and luggage handling, can thus be carried out well below the passenger areas without disrupting other facilities or operations. The third deck houses machinery in its after part, with service intakes in the middle section and passenger cabins/amenities forward.

A key feature is the foldable bow or bow visor, common in ro-pax ferries but not yet applied to cruise ships. The 11m-long visor is turned into its upper position when transiting the Panama Canal, thus reducing the canal passage length and allowing the vessel to be built 11m longer in its hull.

The additional length yields more displacement than that needed for the extra weight and the required additional deadweight; and another full accommodation deck is possible if the stability requirements are met. This 15th deck can be added by applying an alternative design approach to reduce the amount of non-structural secondary steel bulkheads with lighter construction and materials but equivalent fire safety. Aluminium would be necessary for the uppermost full deck as well. ⚙

Royal Caribbean Cruises' 140,000gt *Voyager* class ships from Kvaerner Masa-Yards (*Navigator of the Seas* is seen here) benefit from a system that continually thermally monitors the 11kV propulsion switchgear of the diesel-electric plant, helping to avoid potentially expensive consequences from unplanned power outages.

UK-based QHI-Infrared's ExerTherm system features small, plastic non-contact IR sensors located within the switchgear enclosure to directly monitor key components and identify potential problems at an early stage via ongoing trend analysis. Two individual alarms are provided per sensor, which activate if temperatures exceed customer-defined levels. No power is required by the sensors.

According to QHI-Infrared, the system represents an advance on thermo-graphic scanning which can only provide periodic inspection (and hence not trend analysis) and only of those components immediately adjacent to the external switchgear panel surface.



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Tougher standards challenge wastewater treatment systems

THE increasing size of cruise ships - overall shipboard complements of 5000-plus passengers and crew are now encountered - calls for high capacity wastewater treatment plants capable of satisfying stringent effluent quality regulations from compact installations that are simple to operate and maintain.

High-performance treatment systems for black and grey water are demanded to allow unrestricted operations in particularly sensitive environmental cruising arenas, such as Alaska. Other regions of the USA as well as the Baltic Sea have also tightened legislation.

A market leader in traditional marine sewage treatment plants, UK-based Hamworthy KSE, collaborated with major cruise lines in developing membrane bioreactor (MBR) technology to satisfy the tougher standards.

MBR systems are based on modules - the number depending on the plant treatment capacity required - in which hollow composite membrane tubes are housed in a fibre-reinforced casing. The biomass feed passing through the modules is processed into clean water using the cross-flow ultra-filtration principle; solids build-up is therefore reduced and the need for back washing eliminated.

Wastewater collected in the ship's black water tanks (vacuum collection units) is pumped to an

automatic filter press, while sanitary grey water is collected in buffer tanks and fed to the same automatic screen press.

Each membrane bioreactor incorporates two bioreactor stages contained within a single process tank unit; both stages are fitted with aerators fed from duty and standby blowers. Wastewater passes through the screen press into the first-stage bioreactor, where the active biomass degrades organic material. The digested biomass is pumped through an inter-stage filter, which returns particulate and fibrous material to the primary filter screen press.

Duty and standby pumps transfer the filtered biomass into the second-stage bioreactor, free of any fibres that could cause blockages in the membrane modules.

Second-stage biomass is circulated through the modules, the pumps returning the concentrated wastewater to the second-stage bioreactor. A gravity overflow returns excess biomass to the entry area of the first-stage bioreactor, and clean permeate is taken from the modules through flow control valves and flow meters, allowing monitoring of each module.

Permeate is collected from all the membrane modules into a tank and pumped for discharge by duty and standby pumps. Isolating valves are arranged throughout the system to allow pumps,

membrane modules and other components to be serviced without shutting down the plant. A turbidity meter constantly monitors the effluent and automatically stops discharge in the event of membrane failure.

An MBR system for a cruise ship normally embraces two or three membrane bioreactor units, each typically incorporating 24 membrane modules together capable of treating 240tonnes or 320tonnes of grey and black water daily.

A pioneering project by Hamworthy KSE on *Sun Princess* was followed by retrofit and newbuilding installations on other P&O Princess Cruises tonnage. Radisson Seven Seas fleet members have also benefited from retrofitted systems ensuring full compliance with Alaskan wastewater regulations.

Trials on *Sun Princess* are said to have demonstrated the system's capability to process black and grey water to an effluent quality over ten times better than IMO standards and to well within the significantly more stringent regulations of the Alaskan authorities.

Conversions of existing conventional sewage treatment plants to advanced MBR systems can be executed without disrupting a ship's cruising itinerary, a typical installation time being six to eight weeks, Hamworthy KSE reports. Ⓡ

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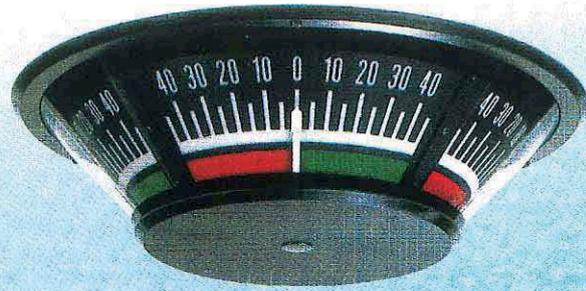
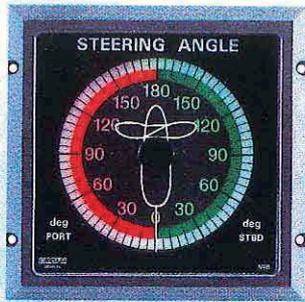




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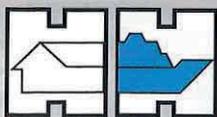
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Taking the problems out of pods

AZIMUTHING electric pods are now firmly entrenched in cruise ship propulsion, following the pioneering efforts of ABB Azipod, whose success stimulated rival propulsor designs from collaborations between other major electric drive and thruster specialists.

Cunard's new 150,000gt liner *Queen Mary 2* gave podded propulsion its most prestigious and powerful reference so far as well as featuring the first quadruple-pod system, with two fixed and two azimuthing Mermaids from Rolls-Royce, each with a rating of 21,500kW (see elsewhere in this report).

A debut installation was logged in 2003 by a rival to the Azipod, Mermaid, and Siemens-Schottel's SSP pods. The Dolphin pod developed by STN Atlas Marine Electronics, of Germany, and Dutch propeller designer John Crane-Lips (now Wärtsilä Propulsion) entered service with the 50,000gt cruise ship *Seven Seas Voyager*. Twin 7000kW models are each driven at 175rev/min by an air-cooled six-phase synchronous motor.

Problems directly or indirectly involving pods may justify the caution of those cruise ship owners still to be convinced of the technology's promise or those awaiting longer term favourable feedback. A swift penetration of the propulsion market has perhaps outpaced a full understanding of pod design, the operational environment and pod/aft hull optimisation.

Designers acknowledge that the pod is not yet a mature product and development potential remains in motor and electric drive technology and cooling systems. Bearing and seal systems are also a challenge in serving fully-rotatable pods which, with ancillary equipment, can weigh up to 350tonnes - more than a Boeing 747 jet on take-off.

New lubricating monitoring systems

Lubrication is a problem with one of the twin 14,000kW Azipods supplied to the Carnival cruise ship *Paradise* by ABB, which successfully responded to running-in problems with larger installations by modifying bearing designs and the lubrication system.

A key improvement addressed the cooling oil, which lost viscosity under high operating temperatures and caused excessive wear to the propeller bearing. A remedy resulted from changing the type of oil and installing an oil temperature monitor; a vibration monitor was also added. No in-service trouble has been reported with Azipods since 2000, ABB claims.

Pod technology, according to ABB Marine, is now seen to be out of the discovery phase and into an era of refinement. This company wants to find a reasonable degree of standardisation, and make installation simpler, for example.



The first-ever four-pod installation. Four Rolls-Royce Kamewa/Alstom Mermaid propulsion pods are seen here on the brand-new Cunard cruise liner *Queen Mary 2*. The forward pair are fixed and the aft pair are azimuthing, and the total output is 4 x 21.5MW.

A legal case brought by Celebrity Cruises against the suppliers of the Mermaid pod, Rolls-Royce and Alstom, cited mechanical and electrical problems with systems installed on its four *Millennium* class ships. Contributing to future trouble-free performance will be MetalSCAN lubrication monitoring systems ordered by Rolls-Royce from GasTOPS, of Canada, for installation and evaluation on each Mermaid for *Queen Mary 2*.

MetalSCANs are installed on the return lube oil lines of the four pods to monitor bearing health, the system detecting and quantifying ferrous and non-ferrous metallic particles passing through the sensor. Such particles carried within the lube oil system indicate hidden or impending damage and trigger maintenance alerts long before component failure. Successful results from this and installations on the four earlier Mermaid-powered ships may see the scanning system integrated as a core component in the pods.

Research and development

Cross-industry acknowledgement that the full potential of pods remains to be tapped inspired the EU-funded OPTIPOD R&D project, which aims to develop guidelines for designing podded ships. The work focused on four different vessel types: cruise ships, ro-pax ferries, product tankers, and supply ships. Studies addressed the environmental impact, operational aspects, effects on general arrangement and cost/benefit evaluations. Structural safety was also examined and information exchanged with an associated EU project, Pods in Service.

Started at the end of 1999, the MARIN-supervised Pods in Service project aims to gather and evaluate operating data influencing the long term integrity and reliability of podded propulsors. In particular, detailed information was sought on the design loads on pods actually in service.

Extensive monitoring has been carried out on four ships with three different pod systems, full-scale measured data being collected and analysed. The ships involved are the cruise ships *Radiance of the Seas* (Azipods) and *Summit* (Mermaid pods), the ro-pax ferry *Nils Holgersson* (Siemens Schottel SSP), and the icebreaker/supply vessel *Botnica* (Azipods).

Measurements cover loads on the pods, their propellers and the hulls, as well as vibration levels, under all conditions, including extreme manoeuvres. A combination of long term, low frequency and periodically frequent measuring yields several gigabytes of information per ship per week.

A wide range of data input varies from each ship's operational parameters, such as draught, speed and position, to pressure fluctuations above the propellers, stresses and accelerations at a number of locations, and environmental conditions. The information derived is fed back into the design process, contributing to product development and generic advances in pod technology.

Such joint industry initiatives, combined with continual refinements by individual designers as service experience mounts, should ensure the pod sustains its challenge. 




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Second Notice

In March 2004, RINA will be holding its sixth SURV conference. This series of events have, since 1990, successfully provided a forum for discussion on the design, production and operation of surveillance vessels, pilot boats, and rescue craft.

This conference will not only provide an update on developments since the previous event in 2000, but we will also be extending the programme to cover RIB's, 'mother and daughter' concepts, the new generation of offshore standby vessels, Emergency Response and Recovery Vessels (ERRV's) and installation based man overboard boats (MOB's). The conference will aim to highlight developments in design, construction and operation of all relevant craft and their associated equipment and machinery.

The Institution invites papers on the following areas:

Design: design philosophies & practice, model testing, design for the future

New vessels: innovative features, trials, evaluations and operational experience

Construction: materials, production techniques, quality control

Operability: operational practices, reliability, maintenance and crew training, health & safety

Machinery & Propulsion: power plant, system layout, propulsion

Equipment: new & novel ideas, electronic control systems, advanced navigational aids and systems

The conference hopes to attract a large international audience and provide a forum for all those interested in surveillance, pilot, and rescue vessels including designers, builders and operators.



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New self-discharge orders and installations for BMH Marine

Richard Higgs reports on the newest designs, contracts, and installations in the shipboard cranes and cargo-handling sector. He begins with a series of interesting new orders secured by the Swedish self-loading/discharging equipment specialist BMH Marine.

THE Swedish specialist BMH Marine has recently completed commissioning of several shipboard installation contracts for self-loading and discharge plant, and has won several new orders for handling systems. New orders include one for a Nordströms-type self-unloading package for a 28,400dwt aggregates carrier being constructed at J J Sietas Schiffswerft in Germany for domestic owner Hans-Jürgen Hartmann; the ship is expected to be completed this year.

This contract includes Nordströms hydraulically operated basket gates in combination with hold belt conveyors and a C-conveyor for elevating the material onto a 85m-long boom. The whole layout has a 3000 tonne/h discharge capacity. This is the third vessel to be supplied with a self-unloading system by BMH Marine for Hartmann.

BMH Marine AB, the Swedish manufacturer of ship bulk materials-handling equipment, is being acquired by the Swedish investment company Catella Private Equity.

Catella, part Stockholm-based Catella Holding, has announced it reached agreement with BMH owner Babcock International Group plc for a takeover which involves the existing BMH management. CPE is a specialist turnaround management fund formed by the holding group in 2001.

BMH, based in Helsingborg, is a world leader in equipment such as ship unloaders, loaders and self-unloaders. The company had a sales turnover in the year 2002/2003 of around SKr370 million.

BMH operates from two main sites. From its unit at Bjuv, it handles ship unloaders and loaders, mobile unloaders, and complete dry bulk marine terminals. The Enköping operation handles self-unloader and mechanical and pneumatic conveying systems.

Catella plans to continue developing the BMH Marine business alongside the existing management. 'BMH Marine is engaged in a very interesting market and operates with world leading brands such as Siwertell and Nordströms. We see great potential, to which we can contribute by active ownership,' says Catella Private Equity chairman Björn Petersson.



This 7000dwt cement carrier *Takumi Maru* was commissioned in December 2002. She was built by the Chengxi Shipyard in China for the Japanese operator Taiheiyo Cement Corp and is equipped with a BMH Nordströms self-discharge package capable of loading cargo at 1500tonne/h and unloading it at 1000tonne/h.

Other self-unloading equipment has been ordered by Lehigh Northwest Cement Co, in Seattle, Washington state, USA, for a 7000dwt barge to transport cement from a plant at Delta, British Columbia, Canada, to a distribution terminal across the US border in Seattle. The barge will be equipped with pipelines for pneumatic loading at a rated capacity of 2 x 250tonne/h. Also included are aeration panels for the cargo holds, two vertical and two horizontal screw conveyors, and a blow pump for pneumatic unloading at 250tonne/h.

Commissioning recently took place in India of two 4000dwt cement carriers, *Ambuja Bhavani* and *Ambuja Lakshmi*, each equipped with Nordströms cement-handling systems. This pair is transporting cement for Gujarat Ambuja Cements Ltd between Muldwarka terminal on the Indian West coast and various cement plants in the area.

The discharge systems were installed in these ships, as well as in a third vessel for operation in Japan, at the ABG Shipyard, Mumbai (Bombay). The mechanical loading/unloading equipment has a capacity of 700tonne/h.

To date, more than 120 dry bulk carriers around the world have been equipped by BMH Marine with a Nordströms self-unloading/loading system, including the 47,700dwt bulk carrier *Balder*, which was discussed in this feature last year. Ⓡ



The 4000dwt *Ambuja Bhavani* is one of a new pair of cement carriers built in India by ABG Shipyard at Mumbai. She and her sister *Ambuja Lakshmi* are equipped with a BMH Nordströms plant for operating around the coast of India.

The new Indian cement carrier *Ambuja Lakshmi* is seen here loading cement at a rate of 700tonne/h.



Chinese factory and new crane design for Tsuji

THE year 2003 saw deck crane orders for Tsuji Heavy Industries Co Ltd totalling more than 130 sets for the Chinese market alone. A big rise in the number of ships already being constructed in China and the forecast further volume growth has led Tsuji to open what is claimed as the world's largest deck crane and hatch cover plant there. Tsuji, based near Nagasaki, in Japan, formally opened its factory in Zhangjiagang, near Shanghai, last November. The 330,000m² site includes eight covered manufacturing buildings and a 150tonne jib crane, travelling on a pier extending 65m into the Yangtze River. The shipping of structures as large as 1500tonnes is possible.

This Chinese plant was set up by and is operated by a newly formed US\$11.2 million (capital) Chinese subsidiary, Tsuji Heavy Industries (Jiangsu) Co Ltd, which is 100% owned by the Japanese parent company. Initially, it employs 500 Chinese workers and has a capacity to process 7000tonnes of steel monthly; in addition to cranes and hatch covers, ship sections and civil engineering structures will be fabricated.

By the middle of 2004, the new facility will expand to process 10,000tonnes of steel monthly. In addition to partially shifting the company's manufacturing of deck cranes and hatch covers from the Japan factory to the new Chinese plant, large orders have been placed by several major Japanese shipbuilders for the fabrication of ship blocks, with delivery scheduled from early 2004. Also recently contracted are a series of four 200tonne and one 30tonne lift capacity traversing tower yard-cranes for Tsuneishi Heavy Industries Inc, the shipyard of Tsuneishi Corp in the Philippines.

The workforce, which includes a 60-strong management team from Tsuji's Japanese head office, is due to grow to 1500 in 2006. Management of quality assurance, sales, purchasing, and contract matters will continue to be the responsibility of the Japanese head office. Meanwhile, Tsuji's Japanese plant is due to concentrate more on civil engineering work for Japan and research and development.

Inverter controlled heavy-duty cranes

Recently, Tsuji revealed it has received a string of orders for its newly developed inverter-controlled four-rope BEIS-series deck cranes. These specialised four-rope units are favoured when continuous heavy-duty loading or



Tsuji's large new Chinese factory will build not only deck and gantry cranes, but hatch covers and ship sections for both the domestic and export markets.



A typical Tsuji four-rope heavy-duty deck crane, which is now being offered with in a new version with inverter control. This feature is claimed to offer many benefits.

unloading is required frequently and for a long period of time. This frequency-controlled inverter-driven type is based on the Japanese manufacturer's experience with inverter-driven gantry cranes and cranes for discharging wood chips.

Tsuji admits the new cranes may cost slightly more to purchase than electro-hydraulic versions, but says that the long-term running costs will be substantially reduced. The new design is claimed to offer several important benefits when compared with the electro-hydraulic type. These include lower energy consumption; smooth and exact acceleration and deceleration; less maintenance costs due to no mechanical contact for the motors; and reduced sound and vibration.

Among contracts secured for the new cranes are one set for Sesa Goa (India), two sets each

Tsuji is currently supplying twin sets of travelling gantry cranes for a new series of 46,500dwt open-hatch bulk/forest product carriers on order at Oshima Shipbuilding in Japan.

for IMC Shipping and Andhika Shipmanagement, in Singapore, four sets for Barber Marine Consultants, India, and more recently four more sets for CSL International in the USA. All the cranes have either 30tonne or 35tonne capacity. In addition, Tsuji secured orders for two ship sets of a patented 150tonne two-rope twin crane for Mitsui OSK Line's new 12,000dwt heavy-lift cargo ships built in Japan by Shin-Kurushima, one delivered in October 2003 and the other due last month (January).

Large gantry cranes order for Saga Forest Carriers ships

The company will also design and manufacture travelling-type gantry cranes for a large series of ships on order by leading open-hatch bulk carrier operator Saga Forest Carriers at Oshima Shipbuilding. These cranes, of an improved model, will also feature the new frequency-controlled inverter drives, for efficient and smooth cargo handling. Tsuji has also manufactured travelling gantry cranes for new ships for Star Shipping, also at Oshima; one of these, *Star Oshimana*, is featured in the newly published *Significant Ships of 2003*. 

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The Group

100 cranes from MacGregor's Chinese factory

A SOLID supply record of more than 100 cargo cranes sold to Chinese shipyards has now been chalked up by the MacGregor Group AB, all produced by its local partner production plant, Lüzhou Machine Works in Nanjing. Among these contracts were those for GLH-type 320tonne cranes for the first of four 30,000dwt general cargo vessels to be completed at the Shanghai Shipyard for Chipolbros. Each ship is equipped with two of these GLH heavy-lift units and two GL 50tonne cranes. The MacGregor cranes for the first vessel underwent overload tests and commissioning last October, and the ship is now delivered and sailing. Commissioning and overload tests for the second vessel were taking place in December.

This leading supplier has won further orders for 16 cranes destined for two vessels to be constructed at the Kou An Shipyard in China for German owner FH Bertling, of Hamburg. Each will be equipped with four GL-type cranes, including foundations and cargo spotter, in combination with grab equipment. Crane delivery is scheduled for September 2004 and February 2005.

MacGregor has won further orders for 16 cranes destined for the Nantong COSCO Kawasaki (NACKS) yard, due for delivery late in 2004 and the beginning of 2005. The contracts include a repeat order for four bulk GLB3026-2 type cranes due for installation in September 2004 aboard a vessel being built there for the Singapore-based owner Dalien-Singapore International Corp.



Chipolbros's new 30,000dwt multipurpose ships from Shanghai Shipyard are each equipped with two MacGregor GLH cranes of 320tonnes each, plus one GL model of 50tonnes.

The NACKS yard has also ordered cranes from MacGregor for three 55,000dwt bulk carriers to be built for Jiangsu Ocean shipping. Each ship will carry four GLB3026.5.2 cranes which are set for delivery in the second half of 2004 and start of next year (2005).

In addition, the crane builder has won contracts for 14 more GL-type units for vessels being constructed at Wenchong Shipyard for Singapore-based North West Ship Management (two shipsets

of two cranes each) and, in a repeat order for the German owner Bernhard Schulte, five 1700TEU container ships will each be equipped with two cranes. All these cranes are to be delivered in the second half of 2004.

Finally, the MacGregor partner plant has secured orders for eight more GL cranes destined for four container ships under construction for Tom Wörden, of Germany, at the Jingjiang Sumec shipyard.

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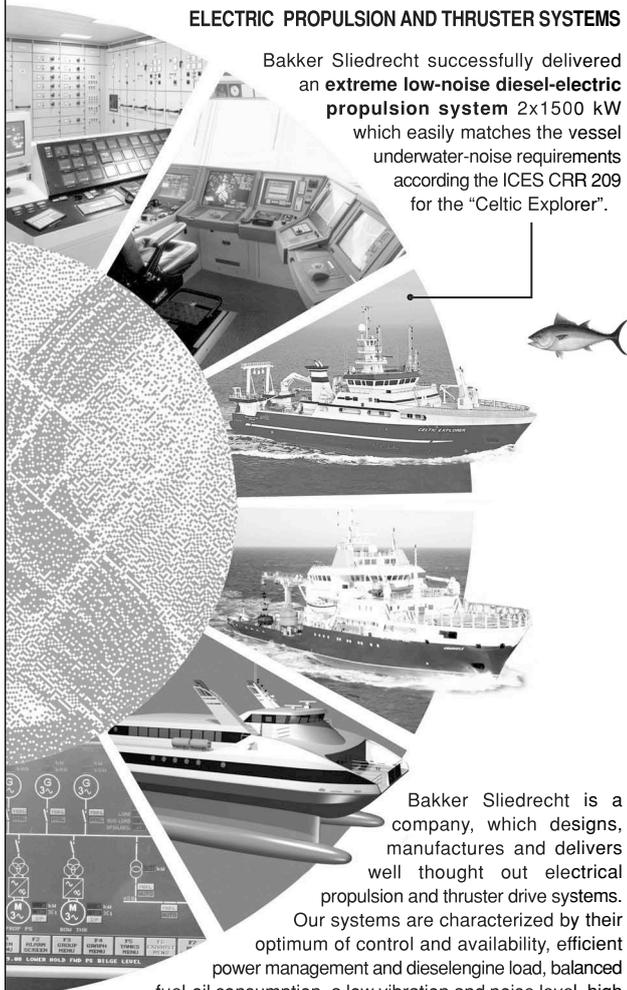
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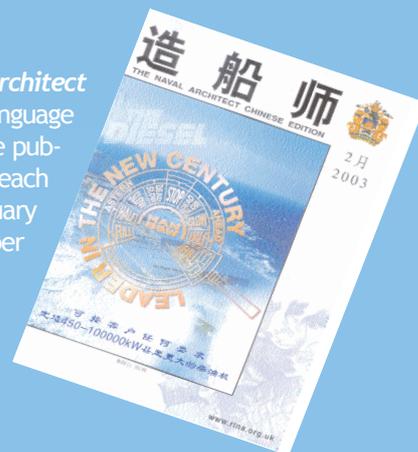
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New orders for Liebherr heavy-lift jib cranes

AUSTRIAN crane specialist Liebherr-Werk Nenzing GmbH is winning new orders for its recently re-developed heavy-lift deck cranes, among them supply of two 240tonne CBB units for the *Scan Brasil*, launched in December at Peene Werft in Germany. This ro-ro/lo-lo vessel has been ordered by the German company Scanscot Shipping Services (Deutschland) GmbH.

Further business for heavy-lift wire-luffing cranes includes contracts to provide eight cranes for four new ships being built by the Volharding Group in The Netherlands for Beluga Shipping GmbH. Each unit will have a lifting capacity of 250tonnes, at an outreach of 11m and 75tonnes at a radius of 33m.

Liebherr CBB cranes, designed for bulk and container handling as well as individual heavy loads, offer a number of advantages. These include a short distance between the jib pivot and slew bearing, thus lowering the centre of gravity for better vessel stability; greater jib rigidity due to direct integration in the jib beam of jib brackets; increased safety due to the Liebherr Litronic controls; and longer life expectancy as a result of the crane's three-row roller bearing. Most important is the special design of the hoisting winch without planetary gearbox, which is driven with four standard slewing gears to provide higher speeds at reduced load without shifting of gears.

In addition, the CBB unit offers greater efficiency, with reduced forces and operating costs, due to its advanced reeving system. Luffing winch forces are lower because the reeving runs through the jib centre rather than by the conventional route through the jib head. Cranes can also be supplied with an auxiliary hoist as an optional extra. CBB heavy-lift cranes can actually be installed in capacities ranging from 80tonnes up to 400tonnes and with a radius of between 24m and 43m.

Other units in the Liebherr heavy-lift range include the CBS version, aimed at heavy-lift and multi-purpose vessels, with capacities ranging between 60tonnes and 150tonnes at between 25m and 60m operating radius. The

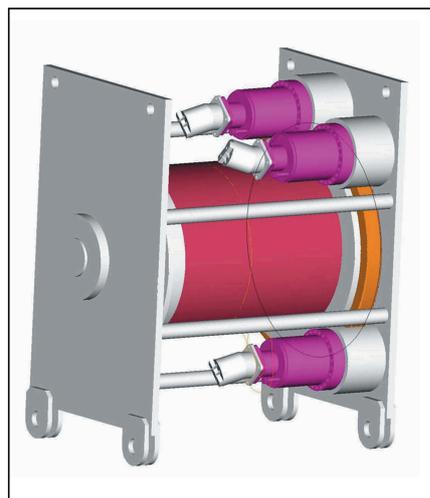
Two CBB wire-luffing heavy-lift cranes, each of 240tonne capacity, were recently installed aboard the new Scanscot Shipping Services (Deutschland) ro-ro/lo-lo vessel *Scan Brasil* at Peene Werft.



company has already installed several 100tonne and 150tonne cranes of this type onboard previous Scanscot ro-ro/lo-lo ships, including the 5105dwt *Scan Polaris*, featured in *Significant Ships of 1996*. This is one of a series of 10 vessels in total equipped with Liebherr CBS heavy-lift cranes.

Liebherr manufactures a complete range of deck cranes to suit a variety of ship types from container carriers and bulk vessels to reefer ships and tankers. This Austrian supplier's product range additionally offers tailor-made solutions for barges and trans-shippers, and it includes provision and hose-handling cranes. Ⓡ

The special-design Liebherr hoisting winch installed in CBB heavy-lift cranes.



TTS side-loaders for new Spliethoff ships

SIDE-LOADING systems are being delivered by Bergen-based TTS Ships Equipment to a new series of multipurpose cargo vessels ordered by Dutch trampship specialist Spliethoff from the resurgent Szczecin yard in Poland. This extremely versatile quartet of self-sustaining newbuildings perpetuates the design concept employed in the Amsterdam company's 21,400dwt S-type generation (featured on *Stadiongracht*, presented in *Significant Ships of 2000*), and features an enhanced cargo handling system using experience gained from the earlier class of 10 vessels, four of which had been constructed at Szczecin.

The latest examples of the B584 design entrusted to Stocznia Szczecinska Nowa will each incorporate three starboard side-loading systems serving the three cargo holds, based on the same elevator arrangements as delivered to the S-type vessels. Nos 2 and 3 holds will have double elevators inboard of the respective, single side doors, while No1 hold will be served by a single elevator in conjunction with a side door.

The principle of the TTS side-loading system is based on the premise that the best way to load or discharge cargo is by the shortest possible path, namely through the ship's side. Benefits are considered to include

compact cargo stowage, low cargo damage rates, cargo handling independent of tidal variations and in ports and terminals with limited facilities, and more expeditious turnaround times.

The latest Spliethoff series adheres to the company's belief in true multi-role flexibility and self-reliance, as expressed in full-width hatch access in addition to sidedoors, and in an outfit of laterally-mounted deck cranes, two to port and one to starboard. Deliveries are to take place at about four-month intervals from 2004 onwards, and the Dutch owner has an option on a further four vessels of the same type and size. Ⓡ

Single-hull tankers phase-out implementation at MEPC 50

THE 50th session of the Marine Environment Protection Committee (MEPC 50) was held at IMO's London headquarters during the first week of December 2003. This session was specially convened for the purpose of considering further the revised amendments to Annex I of MARPOL 73/78 (the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto). In particular, it considered the demand for an accelerated phase-out schedule for single-hull tankers (existing Regulation 13G), a ban on the carriage of heavy grades of oil by single-hull tankers (new Regulation 13H), and an extended application of the Condition Assessment Scheme (CAS) following MEPC 49 held in July last year. The European Union (EU) has already put these regulations in place, effectively banning single-skin tankers from European ports with effect from October 21 2003.

In July 2003, MEPC 49 decided that the phasing-out of Category 1 tankers (pre-MARPOL tankers) should be accelerated from 2007 to 2005, so this meeting focused only on the Category 2 and 3 tankers (MARPOL tankers and smaller tankers). The outcome of these deliberations is given below:

Regulation 13G Amendments of Annex I, MARPOL 73/78

Prevention of Accidental Oil Pollution - Measures for Existing Oil Tankers

The unresolved issue at MEPC 49 relating to the accelerated phasing out of Categories 2 and 3 oil tankers was dealt at this session, which culminated into a series of amendments to Regulation 13G, a brief summary of which are as follows:

- the new international maximum phase-out date for Categories 2 and 3 oil tankers would be 2010 instead of 2015
- a flag state may, however, allow the continued operation of these tankers beyond their phase-out dates to 2015, or when the vessel reaches its 25th anniversary, whichever is the earlier
- categories 2 and 3 oil tankers with double bottoms or double sides not used for the carriage of oil and extending over the entire cargo tank length, may also continue trading beyond 2015 but only up to their 25th anniversary
- categories 2 and 3 oil tankers over 15 years of age would be required to comply with CAS
- a party to the MARPOL Convention will, however, be entitled to have the right to deny entry into ports or offshore terminals under its jurisdiction to vessels operating beyond their anniversary of the date of delivery in 2010 or vessels with double bottom or double sides as aforementioned, operating up to their 25th anniversary beyond 2015

- a new unified interpretation for Category 2 tankers of 20,000dwt-30,000dwt to have SBT/PL (segregated ballast tanks/protective location) arrangements.

New Regulation 13H of MARPOL 73/78, Annex I

Prevention of Oil Pollution from Oil Tankers Carrying Heavy Grade Oil as Cargo

This new regulation dealt with the banning of the carriage of heavy grades of oil (HGO) in single-hull tankers, in particular the following issues:

- definition of HGO
- implementation date for the ban to carry HGO in single hulls
- exemptions and relaxation provisions relating to the ban to carry HGO in single hulls.

Definition of HGO

After much discussion and debate, it was agreed that heavy grades of oil are defined as any of the following:

- crude oils with a density higher than 900kg/m³
- fuel oils with a density higher than 900kg/m³, or with a kinematic viscosity at 50°C higher than 180mm²/sec
- bitumen, tar, and their emulsions.

Implementation date for ban on carrying HGO in single-hull tankers

The new regulation will apply to tankers of 5000dwt and above effective from April 5 2005 and to tankers of 600dwt up to 5000dwt from the anniversary of the date of delivery of the vessel in 2008. Exceptions to the above are:

- double-hull tankers of 5000dwt and above, notwithstanding that they do not fully meet the minimum distance requirements in Regulation 13F
- tankers of 600dwt and above but less than 5000dwt that are built with double bottom and double sides complying with Regulation 13F(7).

Exemptions and relaxation provisions relating to the ban on carrying HGO in single hulls

After much deliberation, the committee settled for the following exemptions and relaxation provisions, allowing vessels and flag states to derogate from the requirements of the new regulation 13H as and when deemed necessary:

- a flag state may allow tankers of 5000dwt and above with double bottom or double sides to carry HGO until they reach 25 years even beyond 2015
- a flag state may also, subject to CAS, allow single-hull tankers of 600dwt and above to carry HGO until they reach the 25th anniversary of delivery

- a flag state may further exempt oil tankers of 600dwt and above from the requirements of Regulation 13H if the tankers are engaged in domestic trade, eg. exclusively plying within an area under the jurisdiction of the flag state concerned or operating as a floating storage unit of HGO located within that area.

Notwithstanding the above exemptions/relaxations, a port state, subject to the provisions of international law, is entitled under this new regulation to deny entry to tankers carrying HGO to ports or offshore terminals under its jurisdiction. Furthermore, a port state could also deny ship-to-ship transfer of HGO in areas under its jurisdiction. The full text of the amended Regulation 13G and the new Regulation 13H was, at the time of writing, still pending due to minor editorial and linguistic amendments to be undertaken by the IMO Secretariat.

The above amendments to Regulation 13G, insertion of new Regulation 13H and the amending of IOPP Certificate (Form B) in relation thereto to Annex I, MARPOL 73/78 were adopted by MEPC 50 via Resolution MEPC 111(50).

Condition Assessment Scheme

In order for the above amendments to Regulation 13G and the new Regulation 13H to be implemented, the requirements of CAS had to be amended accordingly. As such, MEPC 50 adopted resolution MEPC 112(50), approving the necessary amendments required - essentially making CAS compulsory for tankers over 15 years of age. A brief summary of these amendments are as follows:

- CAS will be required for all Category 2 and 3 tankers of 5000dwt and above and of 15 years of age and over
- the CAS survey shall be aligned with the Enhanced Programme Inspection (EPH)
- the first CAS survey shall be undertaken at the first renewal/special survey or intermediate survey after 5 April 2005 for tankers reaching their 15th year
- subsequent CAS surveys will be required to be performed at intervals of up to five years and six months
- the CAS certificate is valid for five years and six months from the date of completion of survey for purposes of harmonisation with ESP
- recognised organisations (ROs) are allowed to issue interim statement of compliance, which is valid for five months after the first CAS. However this will not apply after the second CAS survey.

Comments from BIMCO

As mentioned, the EU has already ratified its own regime, which is quite similar to the amended and new MARPOL regulations, except that the EU has already imposed a ban on the carriage of Heavy

Grade Oil in single-hulled tankers from October 21 2003. Furthermore, it was made absolutely clear that the EU will not allow any of the agreed exemptions for tankers flying EU flags or for any tankers within EU waters. However, because the EU has endorsed the exemptions, the likelihood of a major lack of available tanker tonnage by 2010 is probably avoided. Thus, the EU has tried to ensure that there will be sufficient available double-hulled tankers to serve EU member states even after 2010.

When the EU member states presented the original proposal to IMO at MEPC 49 last July, it was claimed that this would bring MARPOL regulations in line with the OPA 90 (Oil Pollution Act of 1990), which governs in the USA. Later comparisons, however, show that this is far from being the case. One basic difference is that the

OPA phase-out scheme is based on gross tonnage, whereas MARPOL's is deadweight based. It is possible to pick a certain tanker (based on year built and size) and verify that it will be allowed to trade in EU waters up to a specific date, but will be banned from trading to the USA one year earlier. However, with another tanker the situation may be reversed. It is worth noting that the USA is not party to MARPOL Annex I, Regulations 13F and 13G and has claimed reservations regarding the new Regulation 13H at MEPC 50.

What next?

The present balance between double- and single-hulled tankers, for the larger ones at least, is close to 50/50 and by 2010 no single-hulled tankers will be plying EU waters any more. According to many EU politicians, this will mean an end to oil

pollution in EU waters, and that is also the perception of many EU citizens today, based on what politicians have been preaching.

What EU and IMO have addressed is basically oil pollution based on structural failures, which occurred in both the *Erika* and the *Prestige* incidents. However, as the majority of marine casualties are groundings and collisions, it is probably only wishful thinking that the ultimate panacea has been introduced by the phasing-out of single-hulled tankers. There is no doubt that double-hulled tankers are superior to single hulls in many cases and that double hulls are the best practical solution available today, but they are not a guarantee against future oil pollution accidents.

Thus, in the future there will probably be another major oil pollution incident, this time caused by a double-hulled tanker, and what will happen then? If the incident can in any way be attributed to engine or steering gear failure, the next step could be to require redundancy of such installations (duplicate steering gear is already mandatory for some sizes) followed by a phasing-out scheme for vessels without back-up systems. If the pollution is caused by collision will we then need to invent airbags for tankers?

The maritime industry has come a long way in increasing safety at sea and protecting the marine environment, both through self-regulation and by implementing new regulations. Oil pollution from ships today is a mere fraction of what it was a few decades ago, but the public perception has changed towards a 'zero-tolerance' culture. However, as long as oil is transported by sea and human element is involved, there will always be a risk of pollution. The fact that 99.98% of all cargo transported by sea reaches its destination intact goes completely unnoticed by the public and politicians are often seen as using the remaining 0.02% to gain personal attention and political 'brownie-points'.

Owners' reactions

The *Prestige* incident in particular has demonstrated a change in the maritime climate. Shipping is an industry with long-term goals and strategies, hence requiring long-term investments. This can only be achieved in a stable regulatory climate, but it is becoming almost common practice that international rules and regulations can be changed over night. This latest set of changes to MARPOL agreed in IMO was actually proposed even before the last set of amendments (after the *Erika* incident) actually took effect.

Given the forthcoming ban on single-hulled tankers, it might be anticipated that this will lead to many owners rushing out and ordering new double-hulled tankers. History has shown that this is often the way that owners react to actual or expected rises in freight rates. Let us hope that this will not be the case this time. At least the maritime industry can now hope that the present set of amendments will be left unchanged for a decent period of time; however, owners can have full confidence that this set of amendments will not be the last. ⚓

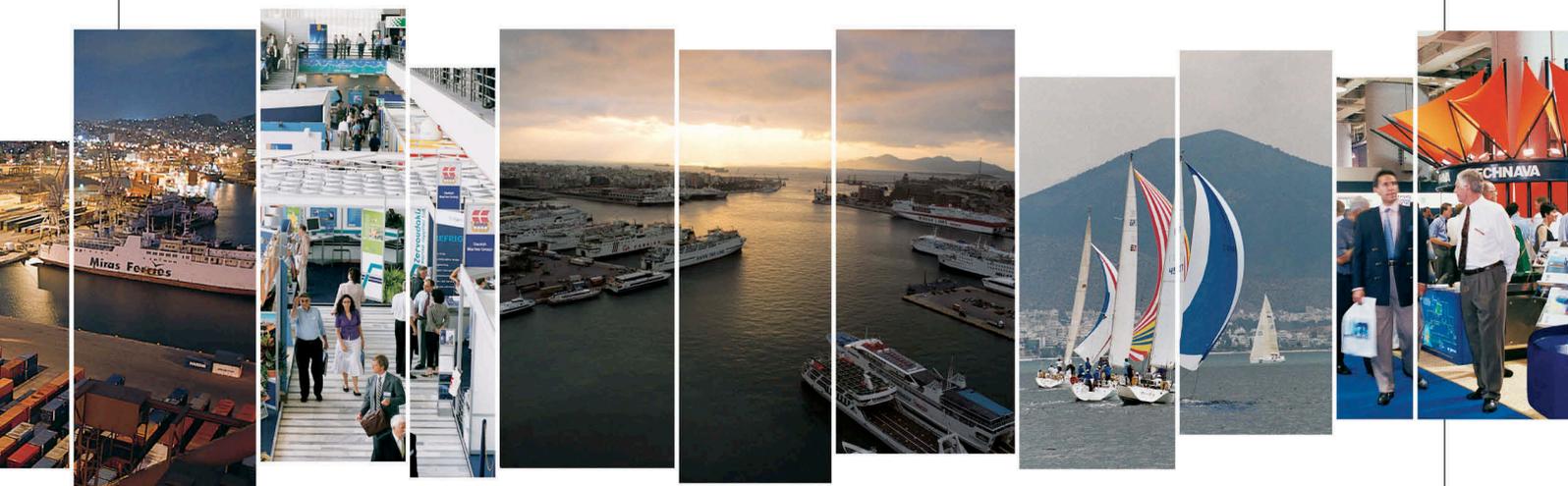
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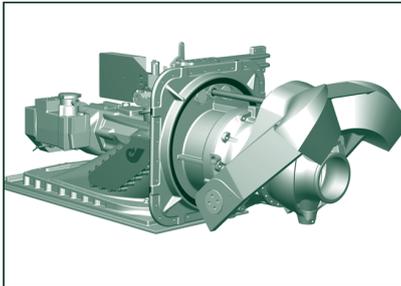
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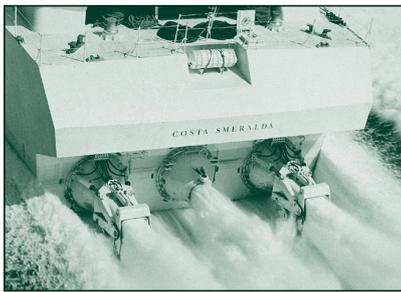
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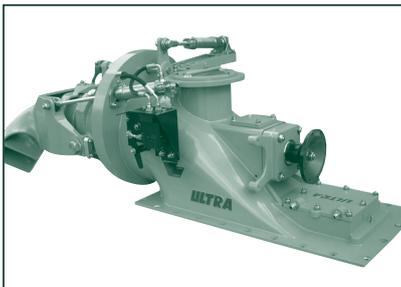


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As the technology matures, designers need better tools to help predict the performance and efficiency of these systems across a wide range of operating conditions. Computational fluid dynamics is an increasingly powerful tool which has become almost universal, but traditional model testing and trials measurements are still required to confirm critical results.



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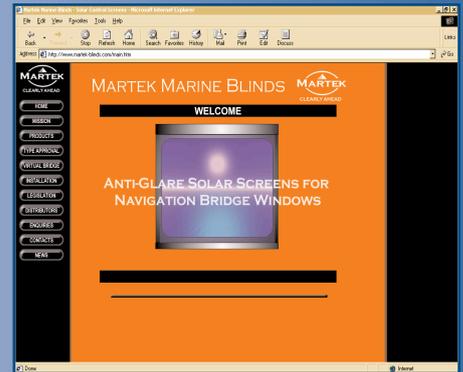
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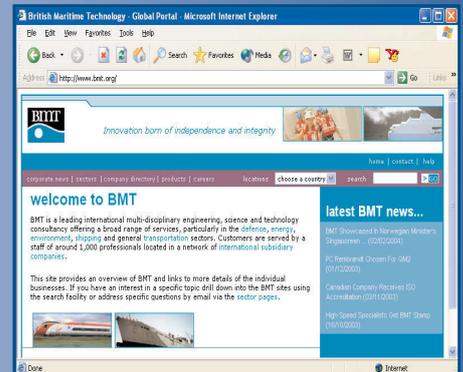
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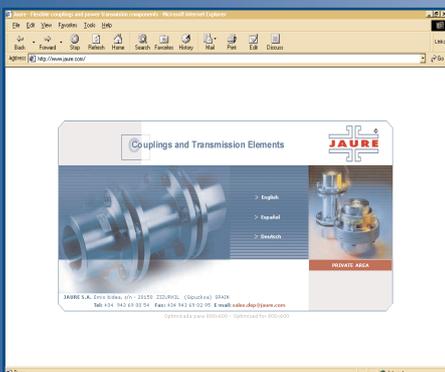
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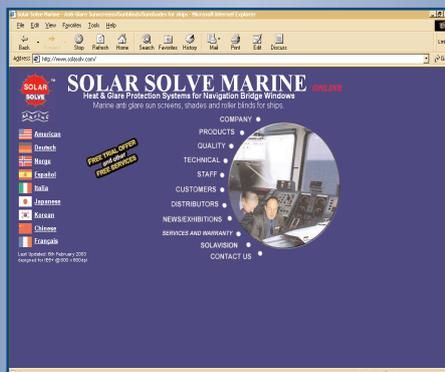
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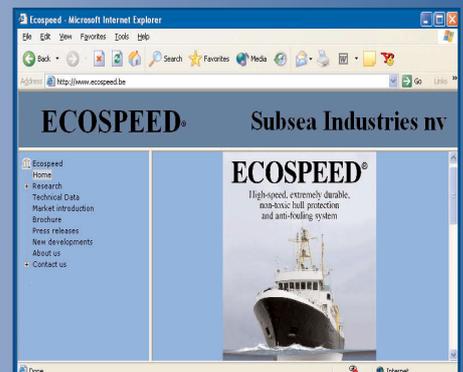
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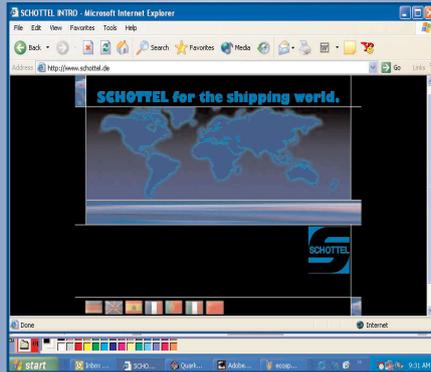
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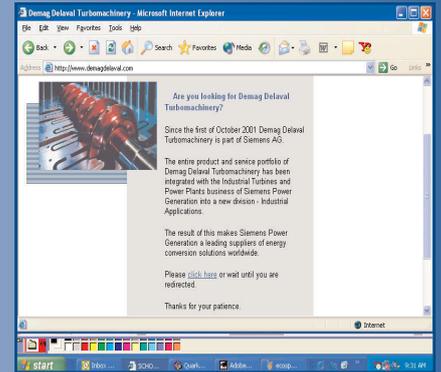
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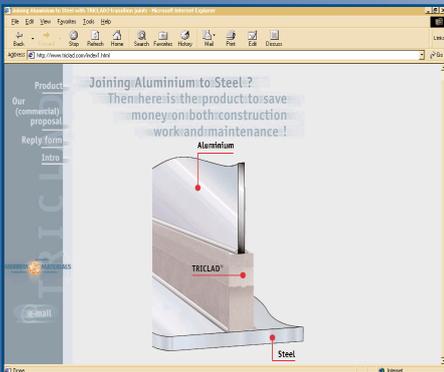
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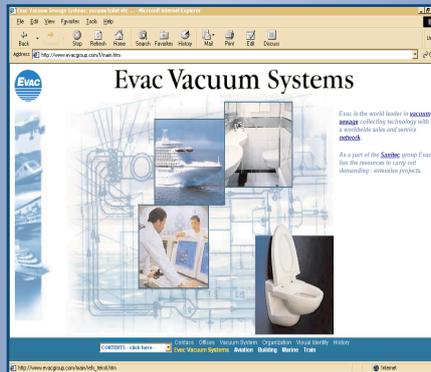
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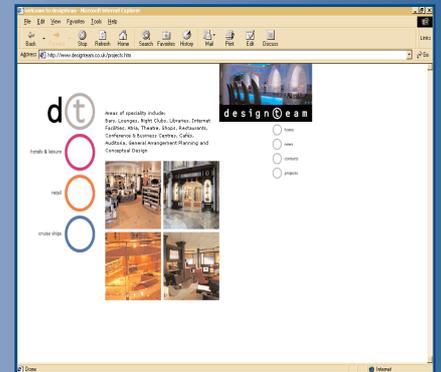
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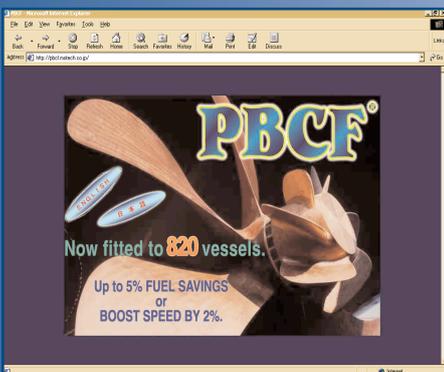
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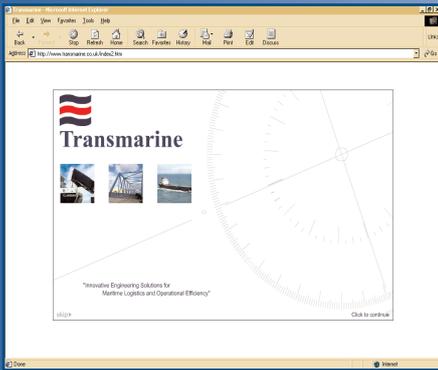
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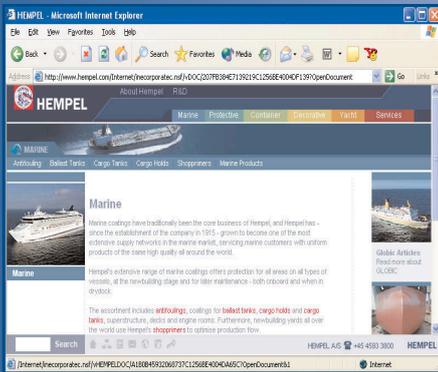
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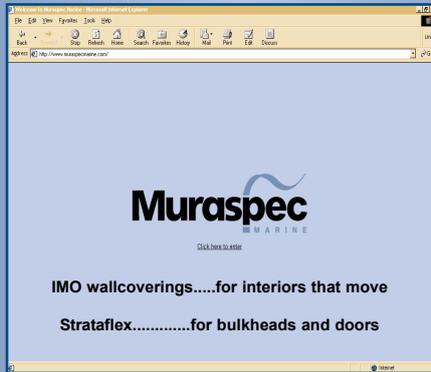
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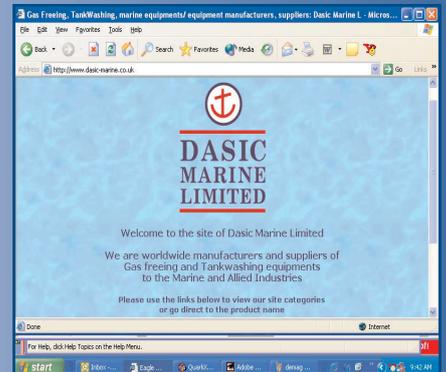
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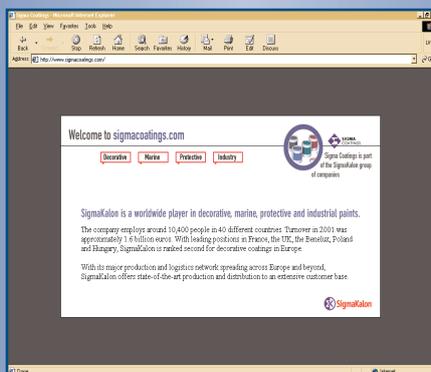
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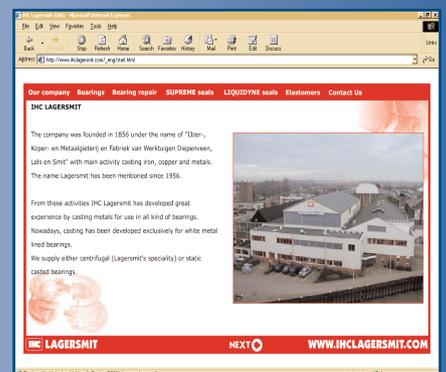
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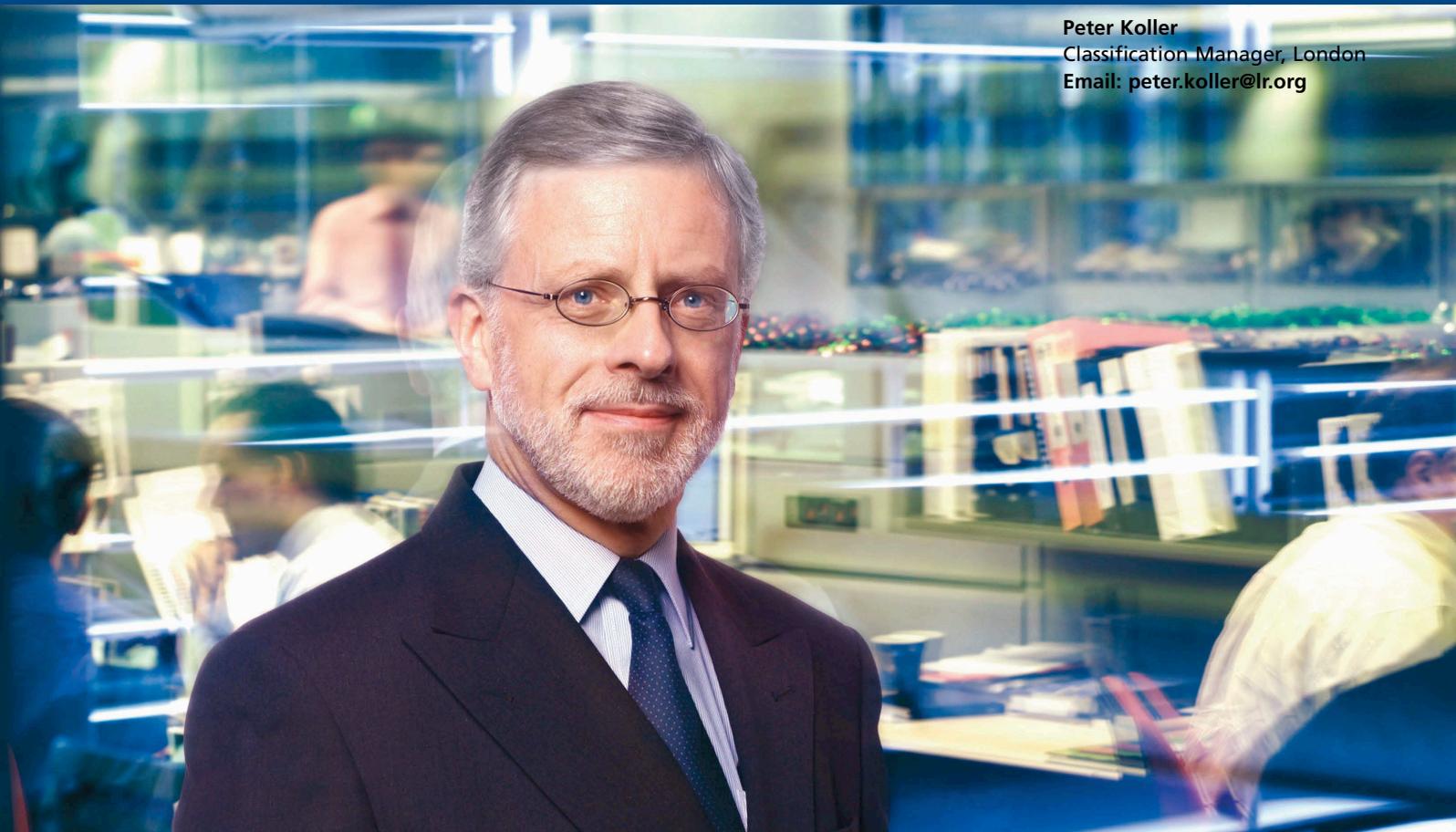
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