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Seen here at her launch earlier this year at the Chinese yard of Shanghai Edward is the 15,999dwt product/chemical tanker *Fure Nord*, expected to be delivered in August to her Swedish owner Furetank. A second vessel is under construction for another owner, Älvtank. Both ships are strengthened to Bureau Veritas 1A ice class and have been designed by the Swedish consultancy Fartygskonstruktioner (FKAB). More details appear in our Tanker Technology feature which begins on page 11.

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## Shifting to 'green' gas-powered ships in Norway

NORWAY'S continuing drive to limit emissions into the atmosphere (this country is one of those trying hard to commit itself to the Kyoto protocol, by restricting greenhouse gases in the period 2008-2112 to a maximum of 1% the 1990 level) is about to enter a new phase. As part of a Public Roads Administration plan to revolutionise the country's extensive ferry services - which has already seen the introduction of the FerryCat with its four Azipull thrusters, the design of a fleet of five coastal ferries to be powered by LNG fuel is taking shape, and the government is expected to approve a specification and select operators for two routes - around Bergen and Stavanger - by the end of this year, with the first ship ready in 2007. A service speed of 22knots is planned - much faster than older-style ferries, possibly using twin engines in an arrangement yet to be decided.

Where such ships will be built is an interesting question; traditionally, such ferries (the new ones will be double-ended in the Norwegian style) have been constructed in domestic yards but a few recent contracts have been placed in Spain and Poland, so this will be a tightly fought

An artist's impression of one possible version of a new Norwegian double-ended ferry to be powered by LNG fuel, perhaps employing Bergen K-G4 engines. This design has been submitted by the leading operator of ferries and buses, Hardanger Sunnhordlandske D/S (HSD) - one of those bidding for some of the new services.



contract. Norway's government is deeply involved because 40% of the country's total NOx emissions come from ships running on national routes and from fishing boats; as is well-known, Norway's geography makes the sea the ideal transport medium. Furthermore, between 1990 and 2002, emissions rose by 20%, mainly as a result of offshore activity.

Handily, Norway is blessed with a large volume of clean LNG gas from North Sea fields, and already one ferry, the 2000-built *Glutra* from Langsten Slip, and two diesel-electric offshore supply ships for Simon Mokster and Eidesvik (completed in 2003 by Kleven Verft and with dual-fuel machinery) are running on this fuel. The introduction of such tonnage does, nevertheless, call for additional investment in special LNG tanks, both on the ships and at terminals, and in extra safety equipment, so some government incentive must be expected.

In Norway, plans are believed to be in hand for a coastal bunkering infrastructure to be in place by 2006, partly with assistance from the Norwegian research centre, Marintek, at Trondheim, which has been carrying out a coastal gas distribution study (the INNOGASS and KYSTGASS projects), and a study on the use of LNG as bunker fuel. Ships such as the newly completed mini LNG tanker *Pioneer Knutsen* (*The Naval Architect* March 2004, page 11) will almost certainly be used for refuelling such storage tanks. Incidentally, this ship has gas-fired Mitsubishi main engines.

A leading contender for the propulsion plant of these new ferries will be the Bergen engine works of the Rolls-Royce

group, which has built up a considerable portfolio and much experience in land-based gas-powered installations over 15 years - around 300 engines, either driving compressors or alternators in power plants. This possibly makes Bergen the world leader in this field.

Two models, featuring Otto-cycle lean-burn spark-ignited combustion, are well established; the larger BV series was discussed in our January 2004 issue, page 11, but current interest for the proposed new ferries centres on the slightly smaller but faster running K-G4 type (normally 1000rev/min but 600rev/min is also possible). This has a cylinder output of 220kW and can be built with up to 18 cylinders, thus offering a maximum output of 4000kW. An 18-cylinder version was inspected on the testbed last month by *The Naval Architect* during a special visit to Bergen.

Bergen engineers believe that spark-ignition combustion overcomes some of the problems associated with dual-fuel machinery (such as promoted by the Finnish designer Wärtsilä and specified for several new marine projects, including the two sizes of new LNG tanker ordered at Chantiers de l'Atlantique by Gaz de France). Since dual-fuel engines rely on compression-ignition with high pressures and temperatures, gas can self-ignite and cause the familiar 'knocking'. This can cause problems at high load and mis-firing at low load, with subsequent operational difficulties, believes Bergen. Such concerns, claims the company, are already being felt by operators with dual-fuel engines in service.

Features of Bergen technology include a pre-chamber for gas injection, mechanical gas injectors and double-walled safety piping (for marine versions), air throttle flaps for low-load lambda mixture control, and ABB turbochargers with variable geometry. All these will be controlled by an engine management system. For those owners wishing to revert to diesel operation at some time, the company offers conversion kits. Testbed trials have also shown that optimum combinator profiles can be handled when engines are coupled to CP propellers, and it is claimed that load-changing features are very good, with 90% load achievable in only 8sec.

Bergen further claims that there are no low-load limitations and that crash stops can be carried out without 'choking' an engine. Crash stops would be important for the proposed Norwegian ferries, since new-style operations call for much speedier ferries with fast terminal approaches. Green credentials should be ensured by emission levels (1.3g/kWh), below the IMO limiting curves for NOx, much less CO<sub>2</sub> emissions (450g/kWh against 680g/kWh for diesel engines), and nil SO<sub>2</sub> or particulate emissions. Other economic attractions are claimed to include low lubricating oil consumption and extremely long oil-change intervals compared with a diesel engine.

Bergen sees many other types of ship as candidates for its gas engines - including smaller types of tanker, offshore supply vessels and inland river cruise ships - in either mechanical-drive or diesel-electric layouts. Such ships could perhaps include Rolls-Royce Nordvestconsult's new 604PT tanker concept with Azipull propulsion, offered in sizes up to 20,000dwt; the first example, a 4200dwt model with diesel propulsion, has already been ordered in Turkey at the RMK Marine yard for Bergen Tankers. Meanwhile, it is hoped that Norway's pioneering lead in the gas-fuel field will be followed by others, even though they may not have a handy supply on their doorstep. ☞

See also the article on page 9.

## More success for Flensburger's ro-ro designs

RO-RO ships continue to be a happy source of new orders for **Flensburger Schiffbau-Gesellschaft**. In recent weeks, this active German yard has secured contracts for an extra vessel for **DFDS Tor Line**, which will be identical to the innovative 10,407dwt *Tor Magnolia* and her sisters (*Significant Ships of 2003* and *The Naval Architect* April 2004, page 16) and will bring this series to six hulls, of which two have been delivered so far. Three of the six will be deployed on the AngloBridge route between Gothenburg and Immingham, and two on the EuroBridge service between Gothenburg and Ghent. The last ferry will sail between Esbjerg and Immingham.

The second order is from another already satisfied customer, the Turkish operator **UND**, which is today renamed **U N Ro-Ro**, and is for a pair of 3735lane-metre designs. This operator's *UND Akdeniz*, which was presented in *Significant Ships of 2000*, was the prototype for a highly successful Flensburger concept, and with the new orders brings the total contracted by this operator to 10 vessels. The ships were originally ordered to sail between Istanbul and Trieste, to avoid lorries have to travel through dangerous areas of the Balkans.

The latest two ferries will be improved versions of the modified four-vehicle-deck type, an addition applied to the third vessel and following ones; the new pair will offer 15% extra cargo space by raising the deckhouse and extending the topmost cargo deck to the transom. Other dimensions and the 21.50knot service speed remain unchanged. Flensburger believes that its success in the ro-ro sector is mainly attributable to its large in-house design department, thus avoiding reliance on outside bureaux.

**TRIBON SOLUTIONS SALE** - A UK engineering software and services group, Aveva,



Seen here at sea is the new heavy-lift ship *Jumbo Javelin*, following successful final trials in the North Sea. With her two Huisman-Itrec 800tonne capacity mast cranes, plus 19,000m<sup>3</sup> of hold space and a main deck of 2650m<sup>2</sup>, she is claimed as the largest ship of her class. A sister, *Fairpartner*, will be delivered in September. Both vessels were built by Damen Shipyards' Galatz yard in Romania, and further details can be found in our May issue, page 22.

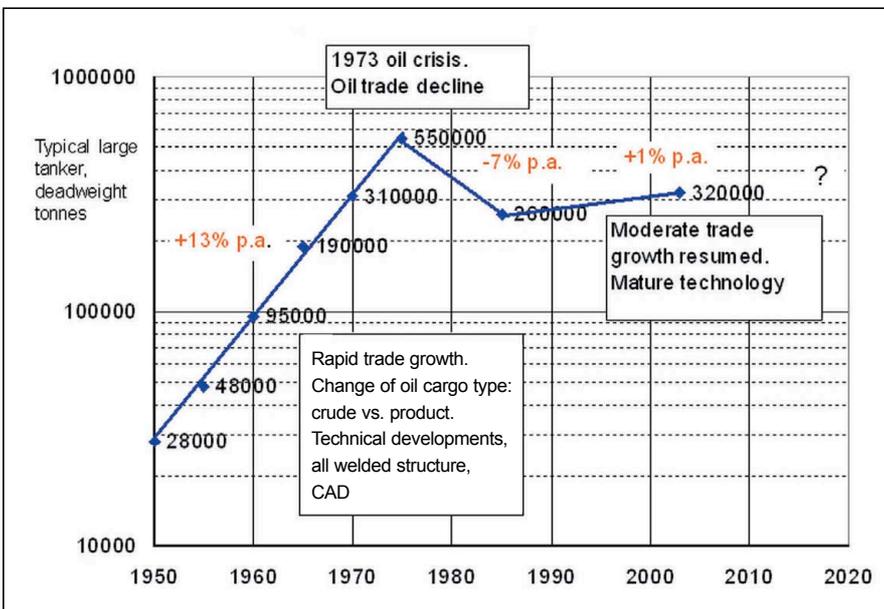
a company with headquarters in Cambridge and with experience in offshore design, is proposing to purchase Tribon Solutions, the leading innovator in integrated marine design and production software. The proposal is expected to complement Aveva's existing expertise.

**ROUTE CONFIRMED FOR TRIMARAN** - The large and fast 126.7m long passenger/vehicle trimaran ferry, currently being built by Austal Ships for Fred Olsen, will sail between Los

Cristianos, on Tenerife, to San Sebastian, Gomera, and the island of Palma. When delivered later this year, she will be named *Benchijigua Express*, replacing a smaller ferry of the same name. She will be able to carry 1350 passengers and more than 340 cars, as well as having more than 400lane metres available for freight. Service speed will be in excess of 40knots. Superior seakeeping performance is expected.

**NEW HIGH-SPEED DESIGN TOOL** - New design software to improve the safety and cost-effectiveness of high-speed craft is being launched this month by Bureau Veritas. The Safety at Speed tool has been developed by 15 companies with EU funding, with Bureau Veritas as the work package leader, with assistance from the University of Newcastle. This software is expected to help designers, class societies, shipyards and government authorities.

In the article 'Trends in ship sizes - will hulls always grow larger?', which was published in our April 2004 issue, page 22, some text was missing from Fig 3 - Tanker deadweight trend. The correct version is as printed here.

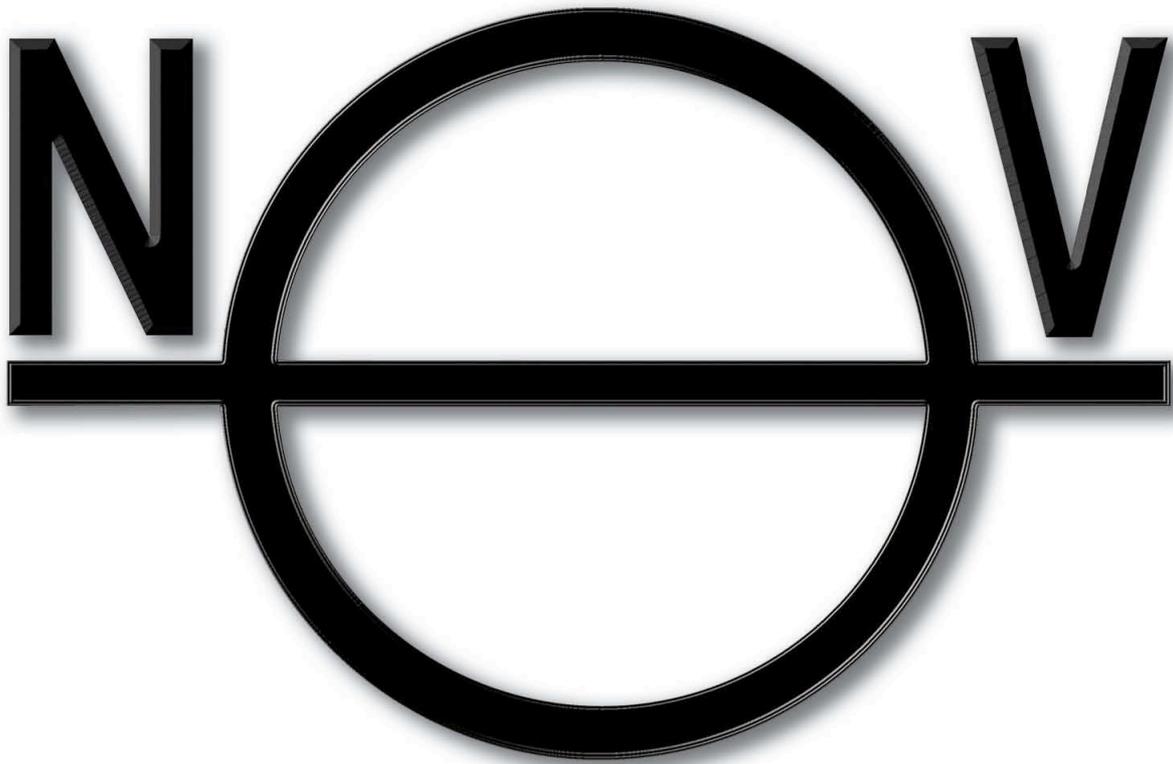


### PEOPLE

**BO-ERIK BLOMQUIST** has been appointed executive vice-president and deputy to the chief executive of Kvaerner Masa-Yards. **SEPPA LAUTAMÄKI** has been appointed senior vice-president, production, and a member of the management team.

**ABS** has elected **ROBERT D SOMERVILLE** to the post of chairman of the classification society. He replaces **FRANK J IAROSSA**, who has stepped down after 14 years.

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# Ship squat and Queen Mary 2

Dr C B Barrass, FRINA, considers the influence of the ship squat phenomenon on Cunard's large new flagship, which could have considerable bearing on ports and harbours visited when cruising. Information on other ship types is also given.

A NUMBER of critical questions will have been faced by Cunard when considering *Queen Mary 2's* cruising programme. A full list of dimensions and other details appear on page 24 of The Royal Institution of Naval Architects' recent publication *Queen Mary 2: Genesis of a Queen* (Ref 1) but it should be noted her overall length is 345m, her breadth moulded is 41m, her draught moulded is 10m, her gross is 150,000gt, and the depth from keel to masthead is 72m. Her block coefficient is in the order of 0.600.

These questions include:

- how does ship squat vary with ship speed?
- which ports could this new liner safely visit?
- which speed should be adopted to avoid grounding at the bow or stern?
- what were the likely squats in open waters at these speeds?
- what were the likely squats in rivers or canals at these speeds?
- what were the minimum remaining underkeel clearances at these forward speeds?

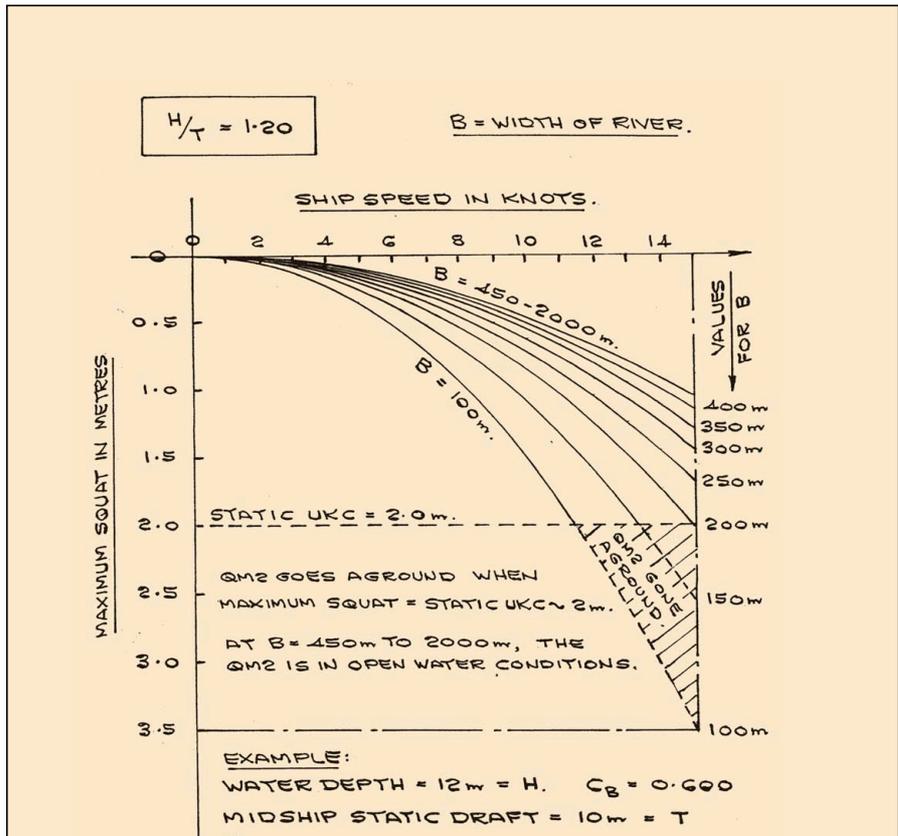


Fig 1. Maximum squats in a river for *Queen Mary 2*.

## What exactly is ship squat?

Squat is the loss of under-keel clearance as a vessel moves forward compared with when she is at rest. Squat generally consists of two components: one is mean bodily sinkage, the other is trim ratio forward or aft. On small vessels and those with slow service speeds, squats will only be a few centimetres. They will be inconsequential.

On larger vessels and on vessels with high service speed, squats can be as high as 2.00m. This is why, today, ship squat has become so much more important to consider. Because of her size and her high service speed, *QM2* is likely to produce high values of ship squat.

## Observations regarding Fig 1

Fig 1 shows maximum squats for *QM2* when she is in open water, that is, without the presence of adjacent river or canal banks. Ship squat varies parabolically with ship speed. At a speed of 7.5knots, she will have a maximum squat of approximately 0.25m at the stern. At a speed of 15knots, she will have a maximum squat of around 1.00m at the stern.

However, as the liner moves into port, she will encounter the presence of riverbanks or canal banks. Consequently, her squats will increase. Fig 1 shows that they will increase as the width of river decreases from 450m down to 100m. When *QM2* has a forward speed of 11.5knots in a width of river of 100m, she will have a maximum squat of 2m. At this speed and in this width of river, she will have grounded at the stern!

Ship pilots and officers-of-the-watch obviously need to know what the maximum speed is in order to avoid such a grounding. Indeed, they need to be able to predict the maximum squat from which they can predict a reasonable minimum dynamic under-keel clearance at the bow or stern. Some port authorities and some owners suggest this remaining under-keel clearance, at a requested forward speed, should be as low as 0.60m. It has produced many debates of safety against commercial pressure.

In some cases, because of the huge size of *QM2*, there will be several 'ports of call' that she cannot enter because of water depth restrictions. This could restrict her passengers having a sight-seeing trip ashore.

## Width of influence

Detailed calculations by the author have shown there is a width of influence for each type of ship. For merchant ships, this width of influence ( $F_b$ ) may be estimated using:

$$F_b = 7.7 + 20(1 - C_b)^2 \times \text{ship's breadth mld.} \dots \dots \dots \text{metres.}$$

$C_b$  is the block coefficient appertaining to the actual of loading for the ship, be it loaded departure, loaded arrival, ballast, or lightship condition.

For *QM2*, this width of influence is approximately 11 ship breadths (or 450m). At

less than this 450m, *QM2* will be in confined channel conditions. In confined channel conditions, officers onboard will observe:

- increased wave-making just ahead of the bow
- reduction in ship speed for similar input of engine power
- reduction in propeller revolutions
- possible start-up of vibration which was not present when ship was in sea conditions
- ship becomes more sluggish to manoeuvre
- increased resistance or drag
- increased squat values.

## Factors affecting ship squat

Research by the author has shown that squat varies directly with the block coefficient. Hence, full-form ships such as tankers will squat more than fine-form ships such as passenger liners.

Squat varies with speed raised to the power of 2.08. However, a good approximation shows that squat varies as the speed squared. Consequently, in a situation of danger for a ship, speed should be halved and thus squat will be quartered. Put another way, if speed is doubled, then squat is quadrupled!

Research has shown that squat varies reciprocally with the ratio of water depth ( $H$ )/ship's mean draught ( $T$ ). So, squat varies as  $T/H$ . If *QM2* were to discharge ballast water (reducing  $T$ ) or be moved into deeper waters (increasing  $H$ ), then squats would be reduced.

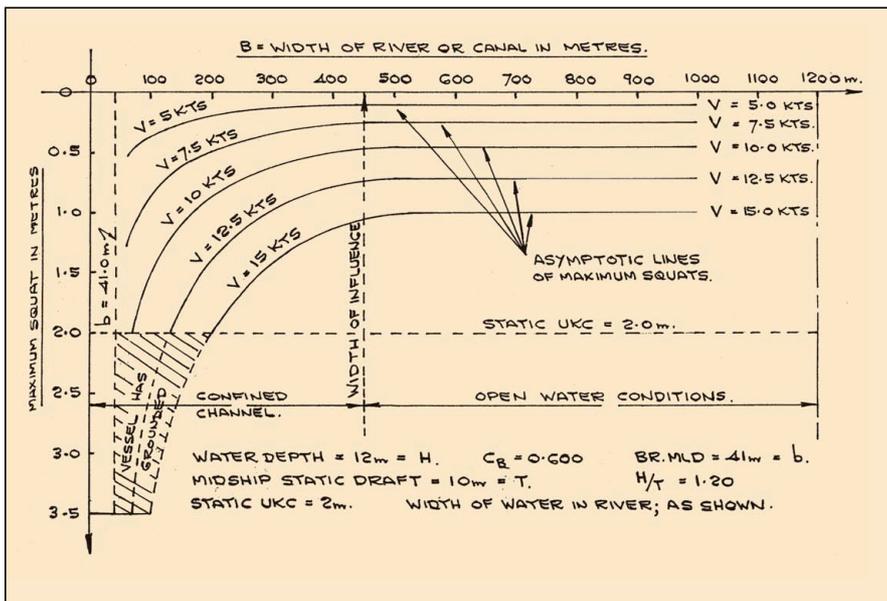


Fig 2. Maximum ship squats for *Queen Mary 2*, plotted against various river widths.

Squat varies with the blockage factor (S). This is the ratio of the ship's cross-sectional area at amidships ( $b \times T$ ) divided by the cross-sectional area of the river ( $B \times H$ ). For this article, all research was for  $H/T$  of 1.10 to 1.40 and for  $S$  of 0.100 to 0.300.

Location of the maximum squat will depend on the static trim of a ship. For *QM2*, she is likely to be on even keel or trimming by the stern when static. If so, she will also trim by the stern when underway and have maximum squat at the stern. However, there may be occasions when she has static trim by the bow. If so, she will trim also by the bow and have maximum squat at the bow when she is underway.

### Why does it pay to be able to predict ship squat?

Fig 1 shows *QM2* on even keel with 2m static under-keel clearance stern to bow. Naturally, any forward speed producing a squat of more than 2m will cause grounding and severe damage at the stern. This could lead to:

- a large repair bill for the owner
- loss of passenger bookings in the weeks following a grounding
- compensation for passengers already booked
- possible claims for oil spillage
- compensation claims for loss of life.

In recent years, 13 vessels, it is believed, have gone aground due to high speeds leading to excessive squats. This helps focus on not what could happen, but what has actually happened. It should perhaps be remembered that, in a Marine Court of Law, ignorance is not acceptable as a legitimate excuse for a ship going aground!

### Observations regarding Fig 2

Fig 2 is a diagram of cross-curves produced from Fig 1. At a speed of 15knots, a perpendicular line was drawn on Fig 1. The intersection with each B curve was lifted and re-plotted onto Fig 2.

These plotted points were then drawn as shown. This process was repeated for *QM2* speeds of 12.5knots, 10.0knots, 7.5knots, and 5knots.

At around 450m, a series of asymptotic lines appeared. This verified earlier comments about the width of influence. At greater than 450m, the maximum squats did not decrease. They are a constant value. This means that when *QM2* is steaming up the English Channel, the width of water to be used in the calculation for ship squat is not the distance between Southampton and northern France, but a distance of about 11 ship breadths.

At less than 450m width of influence, the squats increased. They increased sharply as the width of river approached the limiting value of 41m (the moulded breadth of *QM2*). Note in Fig 2, how 450m is a demarcation line between open-water conditions and confined channel conditions.

### Worked Example 1

For *QM2* operating in a port, the depth of water (H) is 12m, the width of water is 250m, the static draught (T) is 10m even keel and  $C_b$  is 0.600. If the forward speed is 11.70knots, determine the maximum squat at the stern. What is the remaining under-keel clearance (ukc) at the stern at this speed of 11.70knots?

Using Fig 1: when  $B = 250m$  and speed = 11.70knots, maximum squat = 1.00m.

Static under-keel clearance =  $H - T = 12 - 10 = 2.00m$ .

Remaining ukc =  $2.00m - 1.00m = 1.00m$  at the stern, at a speed of 11.70knots.

Note there also that there will be 0.60m squat occurring at the bow, thus leaving a dynamic ukc of 1.40m at the bow for this speed of 11.70knots.

### Worked Example 2

What approximately are the widths of influence, in terms of breadth moulded, for a VLCC, a general cargo ship, and a container ship?

VLCC.....assume  $C_b$  of 0.825

$$F_b = 7.7 + 20(1 - 0.825)^2 = 8.31 \text{ ship breadths.}$$

General cargo ship.....assume a  $C_b$  of 0.700  
 $F_b = 7.7 + 20(1 - 0.700)^2 = 9.50$  ship breadths.

Container ship.....assume a  $C_b$  of 0.575  
 $F_b = 7.7 + 20(1 - 0.575)^2 = 11.31$  ship breadths.

### Conclusions

Summarising, it can be stated that because maximum ship squat can now be predicted, it has removed the 'grey area' surrounding the phenomenon. In the past, ship pilots have used 'trial and error', 'rule of thumb', and years of experience to bring their vessels safely in and out of port.

Empirical formulae by the author quoted in this article for *QM2*, plus squat curves modified and refined over a period of over 32 years research, give firmer guidelines. By maintaining a ship's trading availability, an owner's profit margins are not decreased. More important still, it is hoped that this article can help prevent loss of life as occurred with the *Herald of Free Enterprise* grounding (in 1987).

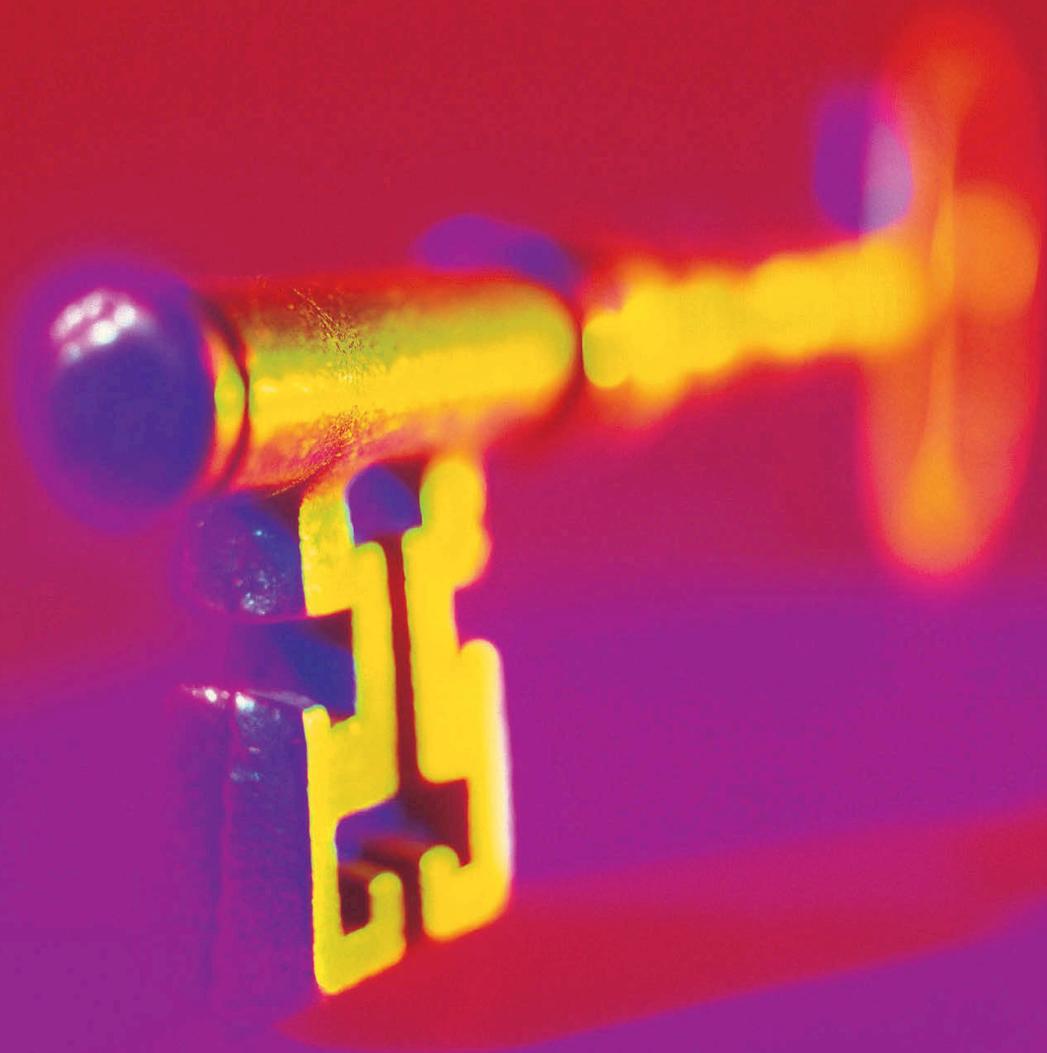
It should be remembered that the quickest method for reducing the danger of grounding due to ship squat for *QM2* (and, of course, other ships) is to reduce the ship's speed. Prevention is better than cure, less worry, and much cheaper! ⚓

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2. *Ship Squat - involving 32 Years of Research*, by C B Barras (to be published in 2004).
3. *Ship Squat - a Guide to Masters*, by C B Barras (2003).

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# Gas engines to the fore in Norway

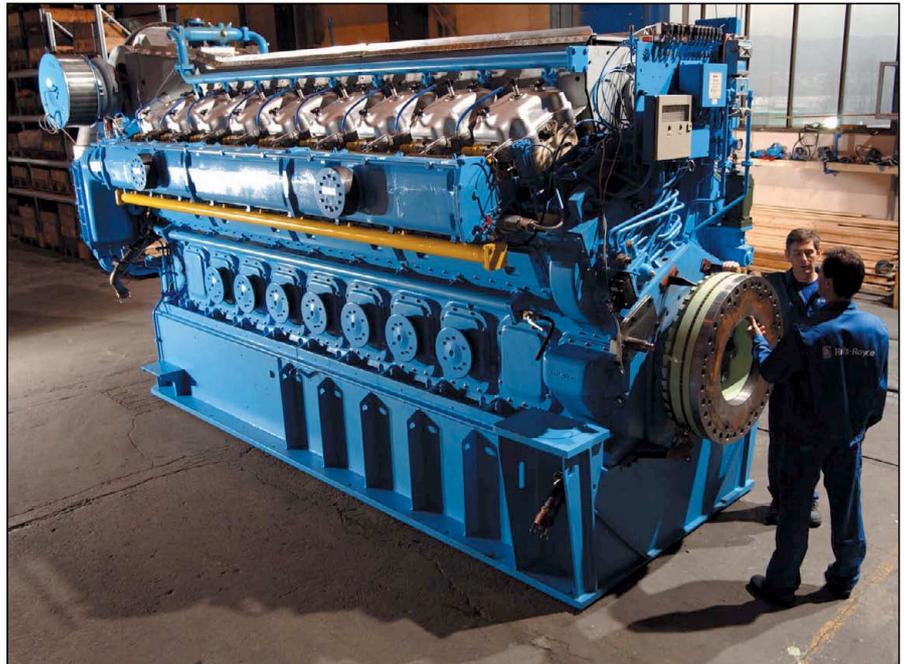
GOOD prospects appear to exist in Norway, and perhaps elsewhere, for a new generation of ships powered by spark-ignited gas engines designed and manufactured by Rolls-Royce Bergen. This company has accumulated considerable experience with Otto-cycle lean-burn combustion, with around 300 engines in land-based operation, mainly driving alternators and compressors; however, Norwegian actions in meeting the country's commitment to emission levels established at the Kyoto summit are making such engines, with their very clean exhausts, highly attractive to shipowners.

Norway has a good supply of liquefied natural gas (LNG) from its North Sea fields, and a national coastal distribution network for this fuel is expected to be in operation within two or three years. One prototype LNG-burning ferry, *Glutra*, is already operating, along with two offshore supply vessels, and most recently Knutsen took delivery of a gas-burning mini LNG tanker to deliver fuel to this network of supply points. This interesting latter ship, *Pioneer Knutsen*, with Mitsubishi gas-burning machinery, was featured in our March 2004 issue, page 11.

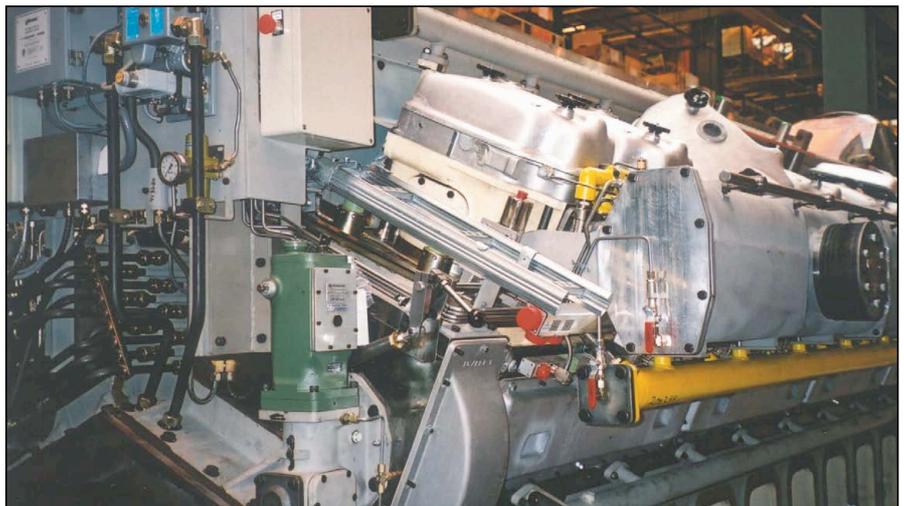
The Bergen factory of Rolls-Royce has two gas-burning designs, a larger B35:40V model of 440kW/cylinder output (featured in our January 2004 edition, page 11), and a smaller design, the K-G4 model of 222kW/cylinder. As yet, none have gone to sea in ships, but this could change very soon: the K-G4 is seen as an ideal candidate for powering a planned new series of coastal ferries to operate much faster services than earlier. The specification for these and operators to run them (initially for routes out of Bergen and Stavanger) is expected to be agreed by the government by the end of this year.

These ferries could be either diesel-mechanical or diesel-electric - Bergen does not mind, it says its engine is eminently suitable for both techniques. The company additionally offers benefits over rival dual-fuel proposals, saying that there should be no problems with claimed mis-firing and sometimes difficult operation at low load. Speedy acceleration and fast stops should be taken in the K-G4 engine's stride; this will be especially important, since new-generation Norwegian ferries will be travelling quite fast, at 22knots, and are expected to be approaching terminals at relatively high speeds.

Although immediate marine prospects appear most optimistic in Norway, other countries could find this very clean fuel attractive for powering ships. More information can be found in our Editorial Comment on page 3.



An 18-cylinder version of the Bergen K-G4 engine. This interesting LNG-fuelled design, with its spark ignition, can deliver up to 4000kW at speeds between 600rev/min and 1000rev/min, in mechanical or electric propulsion trains.

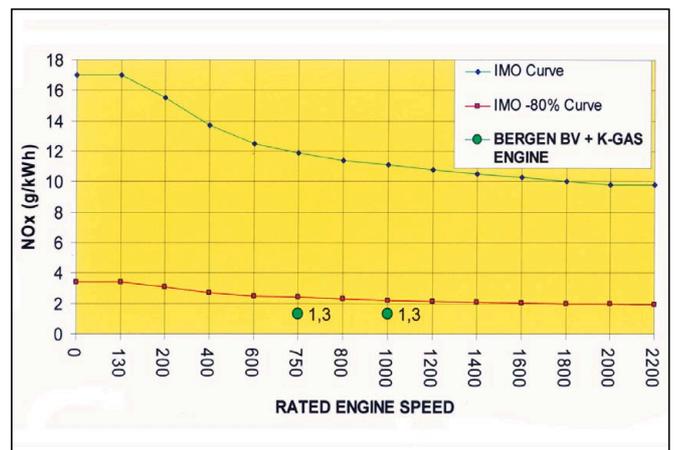


Key components of the new Bergen K-G4 gas engine are the mechanical gas valve and supply pipe (both shown in yellow here). This is a land-based engine; marine versions will have double-walled piping to meet safety requirements.

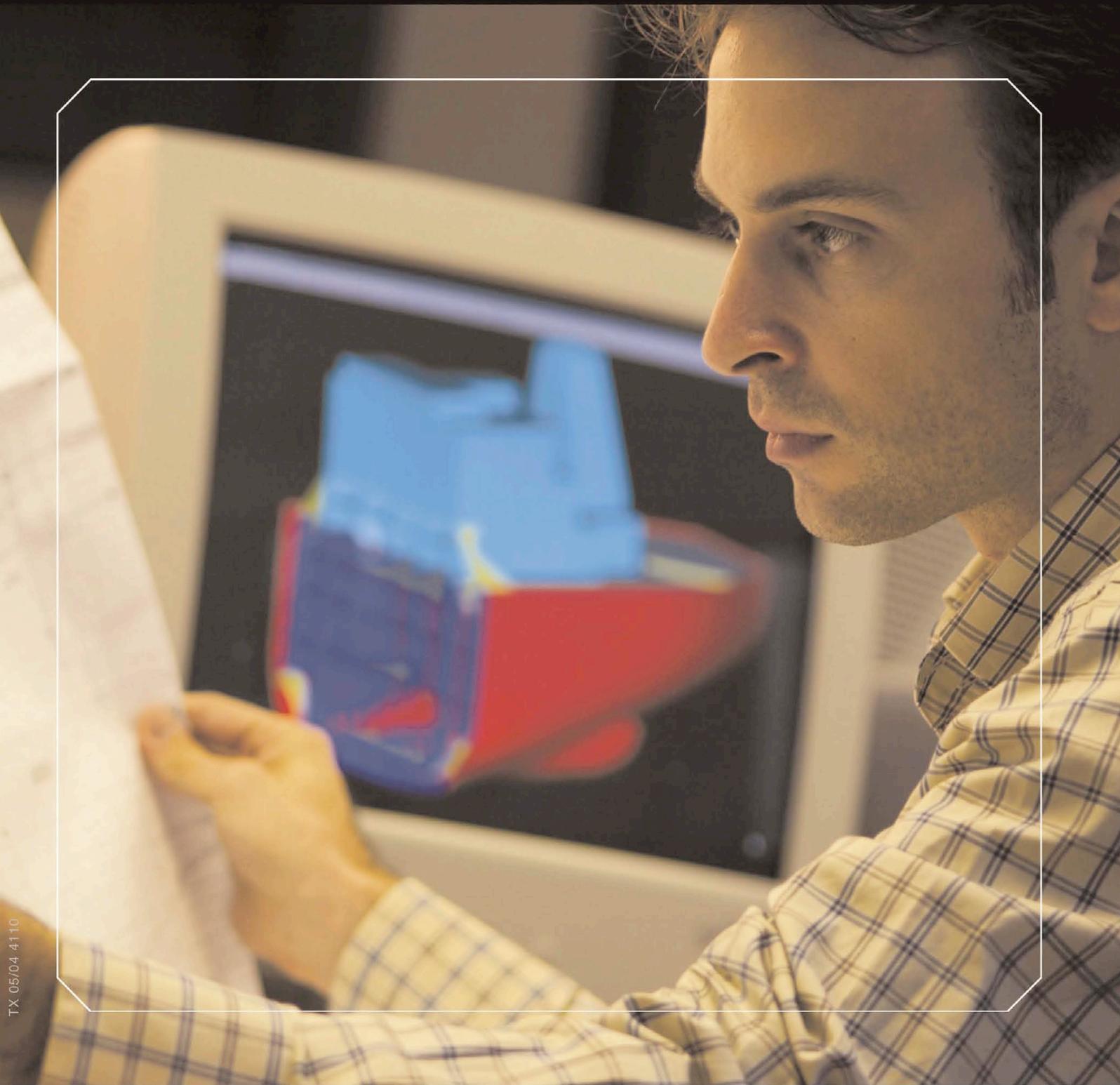
## TECHNICAL PARTICULARS BERGEN K-G4 GAS ENGINE

Bore.....	250mm
Stroke.....	300mm
Output.....	222kW/cylinder
Speed.....	600rev/min-1000rev/min
Cylinder numbers.....	6, 8, 9, 12, 16, 18
Efficiency.....	42%-44% ISO

A graph showing IMO curves for NOx emission limits, and the attractive position of both Bergen gas-fuelled models, the B35 and K types, below IMO's proposed 80% reduction limit.



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# Permanent means of access made simpler

**IMO has had to amend its permanent means of access requirements for new tankers and bulk carriers even before the provisions have entered into force, reports Horst Lormes, naval architect in the newbuilding sea-going ships department, Germanischer Lloyd.**

CONCERNS over the structural integrity of tankers and bulk carriers, prompted by recent accidents such as the *Erika* and *Prestige* sinkings, have led to the development of requirements governing the provision of permanent means of access (PMA) for such vessels to allow close-up inspections of internal structure. By means of Resolution MSC 133(76), the International Maritime Organisation (IMO) adopted PMA standards for ballast tank and cargo tank/hold spaces on new tankers and bulk carriers in December 2002.

The requirements for permanent means of access are laid down in the new Regulation 3-6 of Chapter II-1 of the Safety of Life at Sea (SOLAS) Convention (Res MSC 134 [76]) and are intended to enable class surveyors, flag state inspectors, ships' crews, and other relevant parties to carry out more thorough inspections of ship structural details in a safer manner than has been possible in the past.

These new requirements will enter into force on July 1 this year and apply to all tankers of 500gt and above and all bulk carriers of 20,000gt and above, constructed on or after January 1, 2005.

## Manuals onboard

Regulation 3-6 also calls for each applicable ship to be in possession of a *Ship Structure Access Manual*, approved by the administration, which describes the permanent means of access that has been provided on that ship to enable overall and close-up inspections and thickness measurements to be carried out. A copy of the manual is to be kept onboard.

This manual shall include for each space in the cargo area the following items:

- plans showing the means of access to the space
- plans showing the means of access within each space for overall inspection and close-up inspection, along with the position of critical structural areas
- instructions for inspecting and maintaining the structural strength of all means of access.

## Problem areas

Because the maritime industry was under considerable pressure to finalise and adopt the PMA standards laid down in Resolution MSC 133(76) as quickly as possible, it is acknowledged that the rulemaking process was not as rigorous as it could have been. Classification societies and shipowners have had a chance to study the implications of these new requirements over the past year, and both have agreed that the measures result in over-elaborate PMA arrangements in places and could actually create new hazards for surveyors and crew.

In cooperation with the International Association of Classification Societies (IACS), owners and builders have identified a range of problems with the technical provisions specified in Resolution MSC 133(76). These include the following:

- measures necessitate extensive vertical climbing to gain access
- use of the PMA measures increases the risk of human error
- PMA arrangements would be vulnerable to sloshing and dynamic forces
- careful maintenance of the coatings on the PMA arrangements would be necessary
- it would be necessary to carry out safety checks of the PMA arrangements before use
- the safety and reliability of PMA arrangements would be open to question as the ship ages
- PMA arrangements, as specified, would entail high initial costs.

## Revising PMA provisions

Following a campaign by industry and IACS societies to highlight dangers inherent in the proposed PMA requirements, in November 2003 the 23rd IMO Assembly agreed that the rules should be reviewed. As part of this campaign, three meetings of the joint working group on PMA matters (JWG/PMA) were held in 2003. This group was comprised of representatives from IACS and the leading shipowner and shipbuilding organisations. One of the outcomes of this work was the development of new IACS Unified Interpretations (UIs) on PMA arrangements.

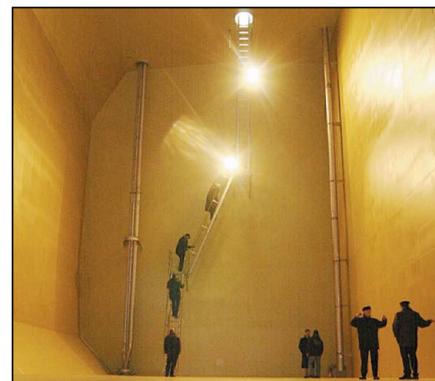
The JWG/PMA work was also noted in submissions by the Greek government and by industry organisations to the 47th session of the IMO Ship Design and Equipment Sub-Committee (DE 47), which was held on February 25-March 5, 2004. The submission from Greece proposed that SOLAS Chapter II-1 Regulation 3-6 and its associated technical provisions be amended, while the industry organisations submission, which was supported by IACS and Korea, suggested text for the revised technical provisions.

In the event, the draft amendments to the PMA rules were agreed at DE 47. They were submitted to the 78th session of the Maritime Safety Committee in May 2004 (MSC 78) for adoption as a new resolution for entry into force in July 2006.

## Outstanding issues

Because the original PMA rules as specified in Resolutions MSC 133(76) and MSC 134(76) have already been accepted, their January 1, 2005 application date still holds. To overcome the possibility that these rules will be implemented from that date, although revised rules are already adopted, it is reported from MSC 78 that IMO will issue a circular inviting member states to apply the new, amended PMA requirements in lieu of the current provisions from the outset.

In addition, questions arose over several of the draft provisions agreed at DE 47, and MSC was called upon to make a final decision as regards their acceptability. Firstly, according to the text of



**According to revised rules, there will be no need for permanent access in cargo tanks without any internal structure, since all structural elements can be inspected from outside. Nevertheless, some IMO delegates have pointed out that even tanks such as these will sometimes need to be inspected internally for other steelwork. Photograph: Frank Behling.**

the Greek submission as it stands, none of the PMA requirements apply to chemical tankers, even when these ships also carry oil products. Chemical tankers are built to comply with the rigorous standards laid down in the International Bulk Chemical (IBC) Code. Furthermore, the cargo tanks in chemical tankers are inspected virtually every time a new cargo is loaded, and cargo quality is closely monitored. As a result, it is accepted that structural problems are unlikely to arise in the cargo tanks of such ships. However, the ballast tanks in chemical tankers are subject to the same corrosion risks as the ballast tanks in any other type of ship, so this factor may need to be taken into account. It is reported from MSC 78 that only the cargo tanks of combined chemical/oil tankers will be exempted from the PMA rules, if the tanker is complying with the IBC Code.

Also, under the revised requirements, as proposed by DE47, there would be no requirement at all for permanent means of access in the cargo tanks of new oil tankers built without underdeck structure, ie, with longitudinals and deck transverses located external to the cargo tank on the main deck. While this provision is acceptable as far as it goes for inspection of deck structure, a number of delegations point out that it does not take into account the possible need to inspect other cargo tank internal structure such as bulkhead structure and web frames.

Finally, for cargo tanks with no internal structure arranged in top of the longitudinal bulkheads on either side or in deck, eg, corrugated bulkheads with upper stool, no longitudinal permanent access would be required.

## Agreed provisions

The revised PMA regulation and related technical provisions agreed by the IMO Maritime Safety Committee at its 78th session in May 2004 will be implemented by means of a new MSC Resolution. IACS is prepared to make any final changes to its new Unified Interpretations necessitated by the decisions agreed at MSC 78. 

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# Vapour recovery: saving money and protecting the environment

**Vapour recovery systems can now eliminate the hydrocarbon gas emissions produced when loading shuttle tankers, providing economic as well as environmental benefits.**

NORWAY is driving through legislation that will require 70% of all offshore loading operations to have volatile organic compound (VOC) reduction plants in place from 2005; from 2006 this requirement increases to 95%. 'All countries have the same obligation to reduce VOC emissions, but only Norway has issued specific emission limit permits with which for oil companies must comply', said Tore Lunde, who is responsible for Hamworthy KSE's liquid natural gas and VOC activities. 'We believe other countries such as the UK, Denmark, the USA, and Canada will follow Norway's example for shuttle tanker activities'.

VOCs are (as discussed in *The Naval Architect's* November 2003 edition, page 12) a mixture of light-end hydrocarbon components and are usually divided into those that do not contain methane (NMVOCs) and methane itself. When cargo tanks are loaded with crude, the gases are usually vented to the open air - the loss from a shuttle tanker may typically be between 100tonnes and 300tonnes each time a ship loads, according to a study undertaken by the Norwegian research organisation Marintek. Environmental legislation is designed to stop emissions, but recovering the VOCs would also provide economic benefits, since a proportion can be used as fuel.

Three methods have so far been developed and tested to reduce NMVOC emissions during loading:

- absorption of NMVOC into the crude being loaded
- liquefaction and storage of NMVOC; this can be discharged later, or some or all of it used as fuel onboard
- sequential transfers of tank atmospheres during loading and discharge.

Reduction of VOC emissions by 100% has recently been technically solved, but 100% recovery has not yet been achieved, as some of the reclaimed VOCs are used to fuel the recovery process.

Hamworthy KSE is paving the way for complete recovery of VOC emissions during offshore oil loading. The company developed a solution for VOC recovery in partnership with Norwegian shipping company Navion ASA. 'Hamworthy KSE's VOC recovery plant not only meets the Norwegian authorities' requirements for NMVOCs but exceeds them by reducing VOC emissions by 100%, including methane, which is not specified', says Tore Lunde.

Reliquefied VOCs can be:

- used to fuel the VOC recovery plant and other steam-driven systems on board



The prototype Hamworthy VOC recovery plant being lifted on board the 127,000dwt *Stena Alexita* last year.

- discharged ashore for use as a fuel or for continued refining
- re-injected into the crude oil while discharging the ship
- used as a hydrocarbon blanket gas in cargo tanks instead of inert combustion gases.

A major advantage of Hamworthy KSE's optimised VOC recovery system is that the prototype of the process plant has been proven. The system is mainly self-supplied with energy which reduces the operational cost considerably. All VOC emissions are taken care of and are not transferred to the next station in the product chain. Investment can be recouped by the use or sale of recovered VOCs, and the system can continue to operate after tanker loading has finished - which results in increased VOC recovery.

Hamworthy KSE is to supply five of its VOC recovery plants so that Statoil, in cooperation with other oil companies, can meet the Norwegian authorities' emission regulations. The contract was awarded to Hamworthy KSE by Teekay. ExxonMobil has issued a letter of intent for another system to be installed on *Stena Sirta*, sister to *Stena Alexita*, which was retrofitted with the prototype plant. With final confirmation of this, HamworthyKSE's order book will amount to six VOC plants.

The systems ordered are similar to that on the 127,000dwt shuttle tanker *Stena Alexita*, which was built in 1998, and on the 10-year-old 130,000dwt *Navion Viking*. *Stena Alexita* is on

long-term charter in the North Sea to ExxonMobil as part of the Uglund Nordic Shipping fleet of Teekay Shipping Corp, which recently acquired Navion.

'Using experience gained from the systems on *Navion Viking* and *Stena Alexita*, Hamworthy KSE has optimised the VOC recovery system', Mr Lunde said. 'The objective has been to exceed all requirements for NMVOC recovery specified by the Norwegian Pollution Control Authority three years ago.

'In addition, the system takes care of the methane component in the emissions, which typically accounts for 5%-30% of all VOC emissions. The optimisation project has resulted in an improved system which is less complex, smaller and lighter and has a good recovery rate'.

## VOC recovery process

The VOC recovery process in Hamworthy KSE's plant is based on condensation of the gases, using seawater cooling and a propylene cooling plant. The liquefied gases are stored in a tank under pressure for later use.

An independent steam/boiler system supplies steam as the main power source for the compressors. The steam system is crucial for reducing surplus emissions of methane and ethane, and surplus gas is used as fuel for the boiler - Hamworthy KSE has been granted a patent on this part of the process.

Gas is sucked in from the cargo tanks through the inert-gas distribution pipe system through a

knock-out drum/demister. The demister separates particles such as crude oil droplets, rust, and carbon from the main gas stream. A small amount of liquid in the vessel absorbs the particles. The gas is then fed to the compressors at a rate of  $2 \times 8000\text{m}^3/\text{h}$ . The compressors increase the gas pressure to a maximum 11bar g and temperature to  $115^\circ\text{C}$ .

The compressed gas is fed to a first-stage condenser that uses sea water as the coolant. Around 50% of the hydrocarbon gas and 90% of the water vapour is condensed and separated

in this separator. Water is drained to a cargo slops tank, and the VOC condensate is pumped into its own storage tank. All surplus gas is fed to the drier. From here, dried gas is fed to the second-stage separator, for further condensation using propylene at  $-43^\circ\text{C}$  as coolant. The condensate is taken from here to the VOC tank via a heat exchanger.

Surplus gas is also used to 'sub cool' the incoming gas in the second stage. The surplus gas is then fed to the boiler for combustion. An expansion valve controls the process pressure

in the plant and if under extraordinary circumstances, combustion does not use all the gas, the excess is emitted to the atmosphere.

The process of regenerating gas through the drier is done after loading is completed. The compressors run at low duty (2bar-3bar and  $2000\text{m}^3/\text{h}$ - $4000\text{m}^3/\text{h}$ ), and circulate a gas stream via a heater to raise the temperature to around  $200^\circ\text{C}$  before this enters the drier. The gas is returned to the compressor suction side and the water is condensed in the first-stage condenser. ⚓

## Siemens-Schottel pod propulsion for third Shanghai Edward tanker

A THIRD pod-driven product/chemical tanker for the Swedish owner Donsötank has been ordered from Shanghai Edward Shipyard, which has become quite successful in building special tankers for European owners. This 19,500dwt lengthened version of *Prospero* (presented in *Significant Ships of 2000*) and her sister *Bro Sincero*, both 16,740dwt, is having its basic design work carried out by the same consultancy, Fartygskonstructioner (FKAB); and like them, she will also be powered by a Siemens-Schottel azimuthing SSP pod system with the German design's distinctive propellers fore and aft of the pod as well as fins.

The hull will be lengthened by 6m, and the propulsion plant is being supplied by Wärtsilä. Four generating sets for the electric pods will be installed: three with 6L32 engines (3 x 2880kW at 750rev/min) and one with a 4L20 engine (625kW at 1000rev/min). The three larger engines will feature the designer's common-rail fuel injection technology. Although the earlier ships also had Wärtsilä machinery, they each had four 9L20 models. ⚓



An impression of the new Donsötank 19,500dwt product/chemical tanker to feature Siemens-Schottel pod propulsion and to be built at the Shanghai Edward Shipyard to an FKAB design.

## Multipurpose monitoring from Tankssystem

AS a manufacturer of level gauging and monitoring systems, Tankssystem has always focused on advanced technology for reliable and cost-effective performance. Today, ships are fitted with various systems for monitoring and control of various parameters, and bridges and control rooms feature a wide variety of panels, cabinets, and repeaters for display of monitored parameters. Often, different systems are supplied by various makers, and this creates subsequent problems for processing the information.

Being mindful of the need to offer a universal and flexible solution to these problems, Tankssystem developed its advanced multipurpose monitoring system. This features a TDU display unit with colour touch-screen and configurable software via a Windows-based configuration program. Local set-up of display functions and measurement units should make the interface user-friendly and easy to operate. The unit's design, size, and easy installation contribute to creating a more human-friendly and ergonomic design solution.

Through virtually unlimited expansion possibilities, this new system can handle virtually endless numbers of channels, adding or removing monitoring points whenever a need arises. Configuration of a new monitoring point or update of the configuration can be done on-site by connecting the TCU to a PC via a serial line. Input channels are handled by I/O cards combined with zener barriers.

The TCU control unit performs all signal processing from the I/O cards and supplies power to the I/O cards and display unit. Each TCU has a power consumption of 90W (maximum), power supply redundancy, automatic switchover (24V DC), power supply, and communication to both I/O modules and the TDU.

Each TCU accommodates 16 x AN-ZB485 (128 inputs - for example, cargo tank sensors or water ingress sensors) and 16 x AN-ZBANA (192 inputs 4mA-20mA), and communicates to third-party systems by RS485 and RS232 protocols by serial



A typical display from Tankssystem's new multipurpose monitoring and control system.

line. The control unit supports communication protocols to the majority of makers' automation systems - eg, digital I/O and thermocouples.

Custom software, a friendly interface, and expandability possibilities are claimed to make the Tankssystem multipurpose monitoring and control system a cost-effective and efficient solution - one that can free bridges and control rooms from the variety of differences in size, colour, and display method. ⚓

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## Tankers preparing for chilly waters

**I**N our May Editorial Comment column, we commented on significant current interest at the present time in large ice-class tankers (mainly Aframax sizes but also a few Suezmax versions). Many of these were originally options at shipyards in Korea which have now been firmed up, but with upgraded specifications to meet classification society ice-standard strengths. The prime reason for such moves is the focus on booming oil exports from Russian Baltic ports, such as Primorsk and St Petersburg (as shown in the map on page 40 of our May issue), where first-year ice up to 1.2m thick is common. At the same time, far-sighted owners are also eyeing exports from the ice-infested Sakhalin fields in the Russian Far East and, in the longer term, oil (and mineral) prospects along Russia's northern seaboard.

One of the principal challenges facing naval architects, shipbuilders, and classification societies has been the leap from relatively modest-size ice-classed ships up to now - typically ro-ro paper carriers and products tankers - to 100,000dwt

crude oil tankers. As we noted last month, the more or less *de facto* standard specification for ice-strengthened hulls has been the respected joint Finnish/Swedish rules, but these are based on close framing, depending on zone and class - both longitudinal and transverse solutions of between 350mm and 450mm spacing. Unfortunately, such spacing is incompatible with steelwork production lines at major Korean yards, where automated welding equipment is set up for frame spaces of around 500mm or 600mm.

Lloyd's Register has taken a lead in tackling such problems, with its classification work on Fortum's pioneering 106,200dwt double-acting tankers *Tempera* and *Mastera* (*Significant Ships of 2003*), built in Japan by Sumitomo to 1AS ice standards. Much analytical work has been undertaken by this society, particularly for the many ice-classed tankers currently on order in Korea, including Aframax ships (1A class) for BP at Samsung, for Teekay and Essberger (1A class) at Daewoo, and Aframax tankers (1A hull and 1C machinery) for Greek owners at Hyundai Samho, also Suezmax-class vessels (1C), again for Greek operators, at Hyundai's Ulsan yard. With the experienced gained, more analysis for individual ships is now being carried out by yard designers themselves or by R&D teams and then submitted to Lloyd's Register or another society for approval.

Tentative guidelines for application of a direct calculation method for longitudinally framed hull structures were first released in March 2003 by the Finnish Maritime Authority, and Lloyd's Register then established the methodology, which was first applied to an ice-classed Aframax tanker design - an option which was upgraded to 1C standards at Hyundai's Samho yard. Det Norske Veritas and ABS have likewise been involved in developing suitable structures for first-year ice and also have some ships delivered or on order in Korea.

To promote these new technologies, during 2003 Lloyd's Register hosted two Korean workshops, as well as individual presentations, for design and R&D staff for all shipbuilders in that country. A key presenter at these events was Mr Kaj Riska, an ice scientist and Professor of Arctic Marine Technology at the Helsinki University of Technology, who is also technical adviser to the Finnish Maritime Authority and a leader in the development of new rules. In general, Finland



A large tanker being model-tested in the ice basin at the Masa-Yards Arctic Research Centre (MARC), in Helsinki. Replicating real ice conditions is often a difficult task, and much detail refinement is made through observation.

appears to have honed to perfection all aspects of ice and shipping - in particular, operating a highly efficient icebreaker service, where four hours is considered the maximum waiting time for assistance.

Still ongoing is a joint Finnish Maritime Authority/International Association of Classification Societies (IACS) project aimed at clarifying and developing hull structure rule elements for application of longitudinal framing to large vessels such as tankers, where designs adopt wide frame spacing (as illustrated in our May Editorial Comment). Lloyd's Register is also taking part in the EU-funded ARCOP (Arctic Operational Platform) programme to develop a total new-generation shipping solution for the Russian Arctic and Northern Sea Route.

Owners hoping to serve the latter routes will certainly have to have their ships constructed to higher standards to deal with multi-year ice up to 3m thick, and will need much extra low-temperature equipment onboard. The double-acting tanker concept from Kvaerner Masa-Yards and ABB, as applied to *Tempera* and *Mastera*, could well be a prime candidate for such trades. With these moves in mind, IACS is currently nearing completion of a new set of Polar classification rules (as explained in a separate article in this issue). One interesting associated development could actually see VLCCs visiting the western Arctic port of Murmansk - which is warmed by the Gulf Stream and therefore ice-free - to pick up export cargoes brought there from further east by shuttle tanker or pipeline. ⚓

**A**n interesting project connected with ice-classed Aframax tankers has been carried out recently by the HVA model basin in Hamburg, Germany. That organisation's *NewsWave* publication (issue 2004/1) reports on tests on behalf of Hyundai Heavy Industries to overcome the difficulties of large tankers with breadths of between 40m and 46m moving in a channel cut by an icebreaker whose hull breadth is much less.

One solution is to use two icebreakers operating in parallel but staggered to create a wider channel. In ice thicknesses of between 0.3m and 1.0m with a flexural strength of 500kPa, the tanker shifted ice floes aside, submerging and sometimes breaking larger blocks; a speed of more than 5knots was possible at both design and ballast draught with the available installed power.

Further tests in a channel filled with brash ice were carried out to determine the ability of the same tanker to fulfil Finnish/Swedish ice rules. Here, it is interesting to note that the required power was found to be lower than that predetermined, based on the equation in the regulations.

Discussion on a new generation of Russian icebreakers to meet the needs of Baltic shipping and the first-year ice found there appeared in *The Naval Architect*, May 2004. ⚓

## Innovative new C2G centrifugal pump

Hamworthy KSE has more than 100 years experience in design and manufacturing of centrifugal pumps for the marine industry. Continued research and development has resulted in the launch of a new pump series, the C2G. Using CAD technology and the most advanced Laminated Object Manufacturing machine for pattern making, the new pump has better hydraulic efficiency and features a high degree of standardization of components, hence lower operating costs. The range covers all duties onboard sea-going vessels.



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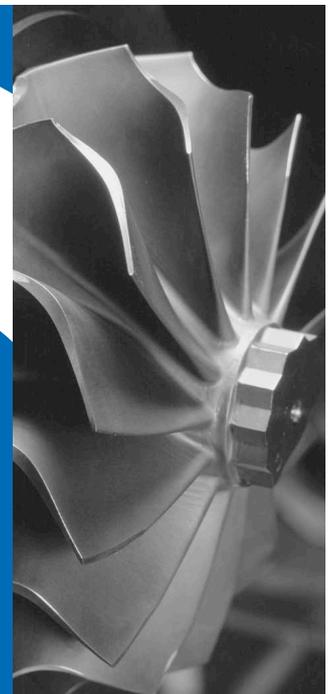


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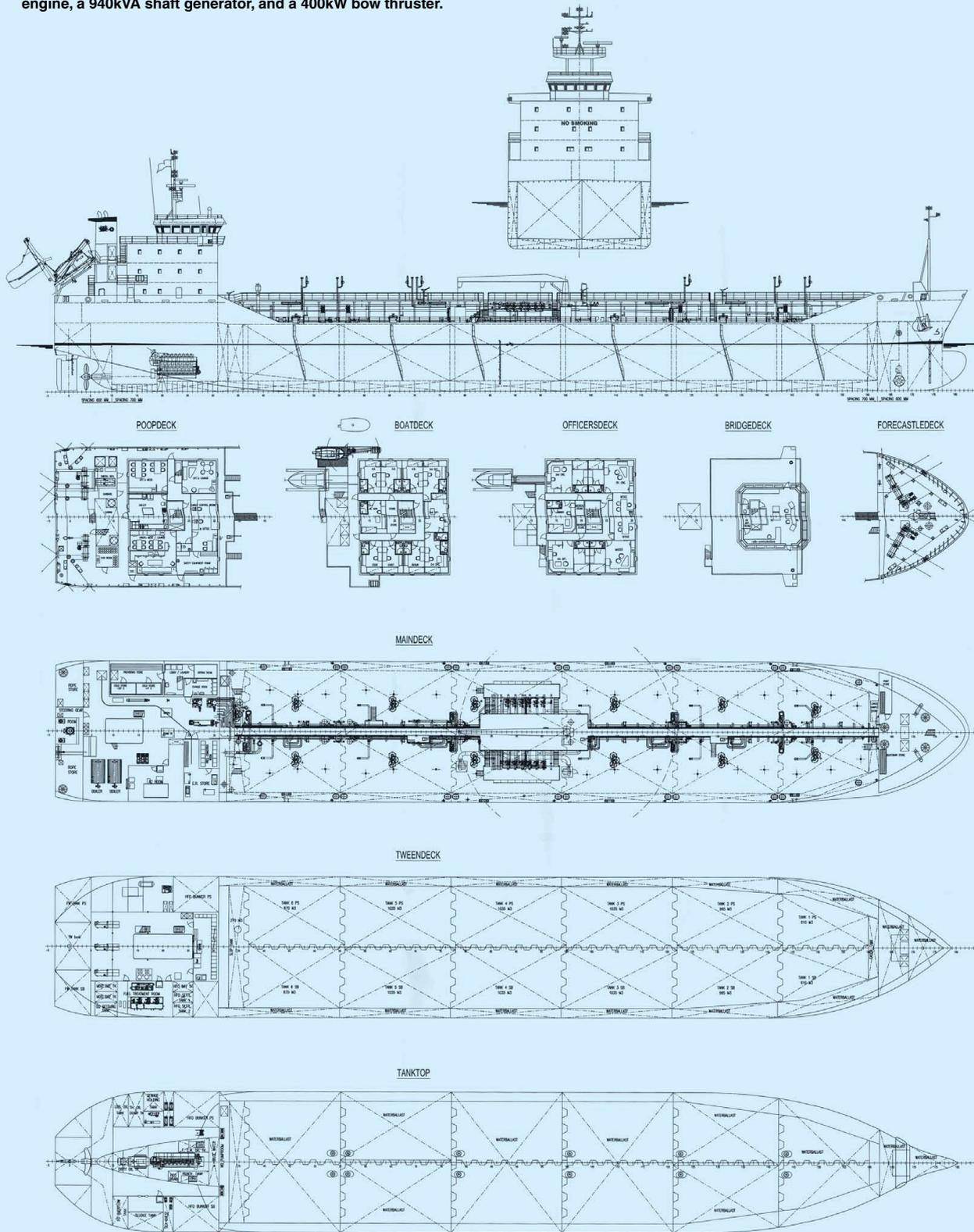
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General arrangement plan of Volharding's new 10,000dwt IMO Type II product/chemical tankers, mentioned in more detail in the May edition of *The Naval Architect*, page 11. Two of these vessels are set to be delivered soon to a German owner.

Another new tanker series, nicknamed the IceCube class, has also been designed. This has a high cubic capacity, and is strengthened to Ice Class 1A, with a shallow draught, and length restrictions. Features include a deadweight of 14,000dwt, a cargo capacity of 19,000m<sup>3</sup>, redundancy for the 3840kW main engine, a 940kVA shaft generator, and a 400kW bow thruster.



## 60 electric deepwell cargo pumps for Stena P-MAX series

DEEPWELL cargo pumps of the new Danish Svanehøj CKL 300 design are being supplied by Hamworthy KSE for six medium-range products tankers being built to the innovative Stena P-MAX concept (*The Naval Architect* October 2003, page 6). Four of these 54,500dwt tankers were ordered by Concordia Maritime in July last year from the Brodosplit Shipyard in Croatia. At the end of 2003, Concordia exercised its option for two more, and the six tankers on order are scheduled for delivery in 2005-2007.

Each Stena P-MAX features five cargo separations (plus two slop tanks), and the cargo tanks are arranged as five pairs. Hamworthy KSE is supplying complete pumping systems: as well as ten CKL 300 cargo pumps (60 for the six ships) - complete with motors, switchboard, and frequency convertor mounted in the switchboard, each package includes two 300m<sup>3</sup>/h slops pumps, ballast pumps, heavy fuel oil pump, and portable pumps.

The company offers two types of electric-drive Svanehøj deepwell pumps: one with cargo-lubricated bearings, the other with oil-lubricated bearings.

The CKL 300 pumps for the P-MAX series have 16m-long shaft transmissions, and are rated



at 800m<sup>3</sup>/h at 120 mlc. The CKL series - which is being extended by larger and smaller models than the 300 - uses an oil-lubricated shaft.

Hamworthy KSE's CKL 300 was first introduced to the offshore market a year ago, initially for use on FPSOs and FSOs. The offshore version is tailored to pump crude oil cargoes but the products carrier model differs only in a few mechanical parts.

A total of 60 of these new Svanehøj deepwell cargo pumps are being supplied by Hamworthy KSE to six Stena P-MAX products tankers on order at the Brodosplit yard in Croatia.

The CKL 300 has a capacity range from 800m<sup>3</sup>/h to 1400 m<sup>3</sup>/h at 120mlc to 200 mlc, and the company claims that this system provides a solution to today's demand for a simplified distributed pump layout using an electric motor on the weather deck connecting to the pump unit via a long drive shaft. The design's double-suction, double-volute, and single-stage impeller results in a pump efficiency of 85% and low NPSH (net positive suction head) for reducing the time taken for stripping. This is said to mean less power consumption for the same capacity compared with other pumps.

Hamworthy KSE is making the benefits of deepwell cargo pumps available to larger and larger tankers by developing its electrically-driven ranges. The company is currently targeting Panamax and smaller Aframax tankers - up to around 100,000dwt. In the offshore sector, it has recently won an order for a cargo handling package including electric-drive deepwell pumps with 23m-long shaft transmissions for a 150,000dwt FPSO on order at Samsung Heavy Industries in South Korea.

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## New Chinese-built tanker for Swedish owner

PLANNED for August delivery this year (originally April) is the first of two new 15,999dwt product/chemical tankers being built at the Shanghai Edward yard in China. As reported in our June 2003 issue, page 43, they have been designed by the Swedish consultancy Fartygskonstructioner A/B (FKAB), with one ship for Furetank Rederi and the other for Älvtank, both based at Donsö.

The accompanying illustration shows the Furetank hull, named *Fure Nord*, after her launch earlier this year, and afloat in the Huangpu river, and a general arrangement plan appears on an adjacent page. *Fure Nord* has 12 cargo tanks, plus a pair of slop tanks; all cargo spaces are fitted with Frank Mohn hydraulic deepwell pumps (12 x 330m<sup>3</sup>/h), and two similar pumps of 500m<sup>3</sup>/h each are provided for water ballast duties.

Main propulsion machinery comprises a 6300kW MaK 7M43 medium-speed engine, which drives a highly skewed CP propeller through a gearbox fitted with a take-off shaft for a 1000kW alternator. Three 798kW gensets driven by Volvo Penta engines are also fitted. An interesting feature to provide emergency propulsion as well as manoeuvrability is an 850kW retractable bow thruster. Service speed is planned to be 14.50knots.



The 15,999dwt product/chemical tanker *Fure Nord* afloat in the Huangpu River following her launch in Shanghai.

Like her sister, the new tanker is being built to Ice class 1A standards of Bureau Veritas, as well as to the requirements of the Svenska Sjöfartsverket. Meanwhile, FKAB is involved in two other projects at Shanghai Edward: a lengthened version of the tanker *Prospero*, to be built for another Swedish owner, Donsötank. *Prospero*, presented in *Significant*

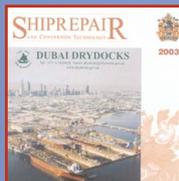
*Ships of 2000*, was the first commercial vessel to be fitted with a Siemens-Schottel SSP podded propulsion system, and the new vessel is to be likewise equipped (more information appears in a separate article in this feature). The second vessel is a 16,000dwt bulk carrier for the same owner but with a conventional propeller. 



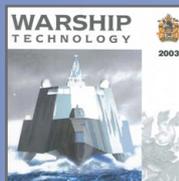
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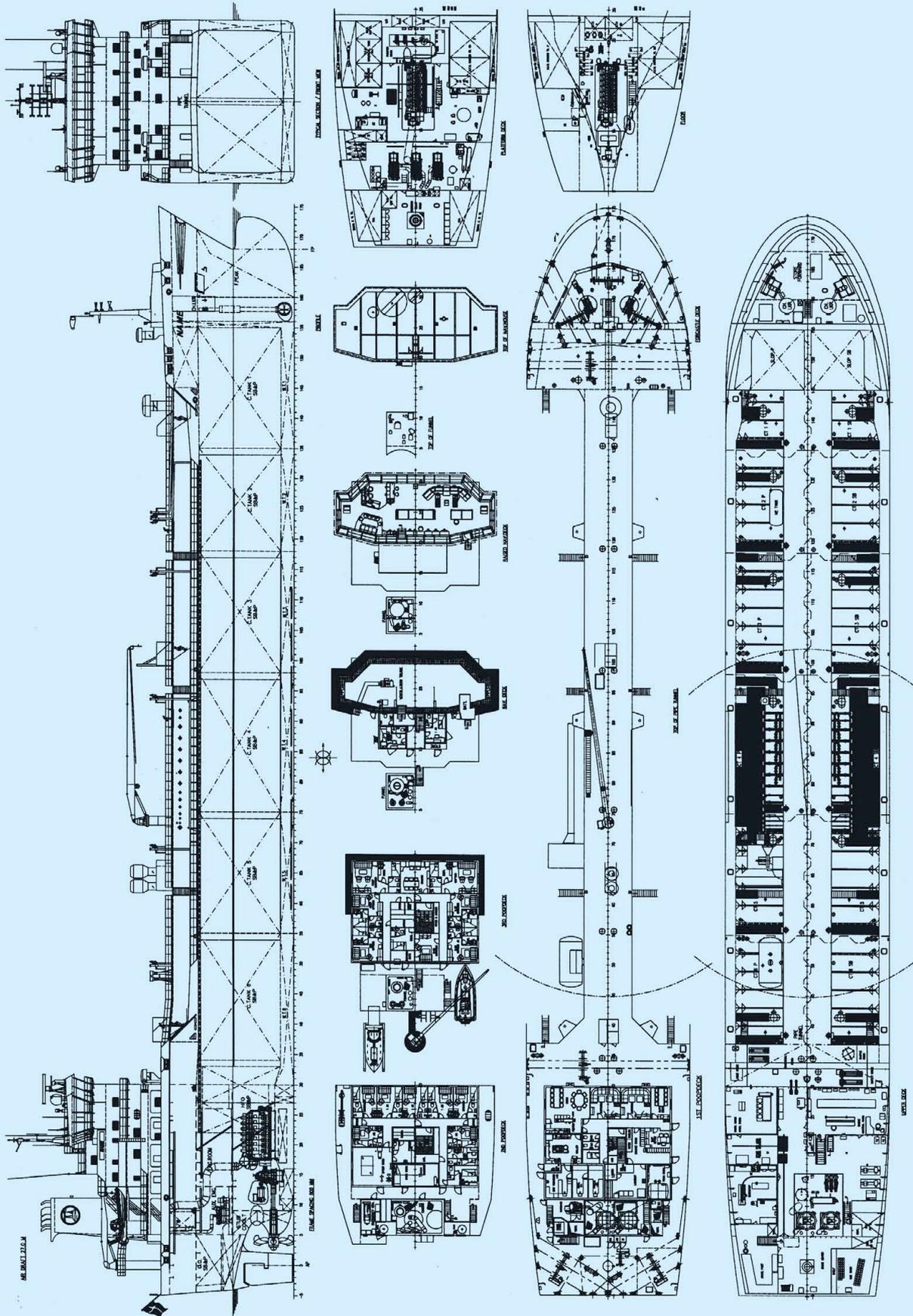
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General arrangement plans of the new ice-classed product/chemical tanker *Fure Nord*, designed by FKAB and currently being outfitted at the Shanghai Edward Shipyard for her Swedish owner, Furetank.



## Wind over Waves II: Forecasting and Fundamentals of Applications

*Edited by S G Sajjadi and Julian C R Hunt. Published by: Horwood Publishing Ltd, Coll House, Westergate Street, Westergate, Chichester, West Sussex PO20 3QL, UK. 250 pages. Price: £50.00. ISBN 1 898563 81 0.*

In August and September 2001, two international conferences on the subject of water waves were held in Cambridge. The first entitled 'Mathematics of Surface Water Waves' was held at the Isaac Newton Institute (INI) for Mathematical Sciences, and the second, organised by the Institution of Mathematics and its Applications (IMA), was held at Churchill College, entitled 'Wind over Waves, Fundamentals, Forecasting and Applications'.

The book here reviewed contains a set of 17 papers presented at the second of these conferences. In its introductory pages, Lord Hunt, one of the two named editors, contributes a preface offering a helpful overview of all the papers and also recapitulates remarks he made when opening the first session of the earlier conference.

The cast of over 30 authors drawn from nine different countries includes many distinguished contributors, mostly with a strong theoretical background.

It is necessary to highlight two key points for this review. The first is that history offers many examples of research initially scorned as too esoteric to be useful, and later found to have great practical significance. The second is that RINA membership now embraces an increasingly wide range of interests, including concerns with offshore engineering as well as more conventional naval architecture.

The first of these points comes to mind when considering the opening paper which recounts the early history of water wave research, with emphasis on the work of Stokes and his predecessors. The concept of the high-order Stokes wave may have once been thought rather academic, but in recent years the fifth-order solution has been extensively used, especially by offshore engineers, as a basis for modelling extreme waves for design purposes.

The second is important because the papers in this book cover such a wide range of aspects of the relation between wind and waves. This extends from consideration of the profile of wind speed above the water surface, through the mechanics of air/sea interaction and the properties of the resulting waves, down to the effect of the associated pressure disturbance on the seabed.

Prominent among topics interesting for naval architects is the need to be able to use wind speed data for estimating severity of wave conditions. For this purpose, it is important to take account of the considerable variation of wind speed with height above the sea surface and to ensure consistency regarding assumed heights for quoted wind speeds. The normal practice is to use a standard height of 10m and to assume that the speed profile follows a so-called log law expressed in terms of parameters such as surface roughness and stress related to the wave generation process and associated growth rate.

For given wind data, it is common practice to assume that the resulting sea conditions can be described by wave spectral formulae expressed in terms of parameters such as wind speed, fetch, and duration. A widely used example is the so-called JONSWAP spectrum which was derived from the findings of a major international field study known as the 'Joint North Sea Wave Project' published in 1973.

Several of the early papers in the present publication are relevant to such uses of wind data and with the support of substantial experimental evidence raise some questions about the validity of established practice. A recurring theme of these papers is the extent to which wind speed profile and associated wave generation parameters are influenced by feedback from the wave surface, notably by the effect of 'wave age' (a measure of the ratio of wave speed to wind speed) and wave steepness.

In particular, one paper indicates that the presence of swell waves, which are independent of the local wind, can invalidate the log law. Other papers suggest that this may also help to explain the tendency for under prediction of growth rate. Mention should further be made here of a paper which claims that the 'downshifting' of wave energy from high to low frequencies is mainly due to the driving force of the wind. This challenges a key finding of the JONSWAP investigation that the downshifting is due to nonlinear wave-to-wave interaction. Surprisingly however, neither here nor in any other paper, is any reference made to the JONSWAP project, which I believe many would regard as a landmark in the history of wind wave research.

Another topic of great engineering relevance is the requirement to prescribe wave forms of extreme severity for design purposes. Mention has already been made of the use of high-order Stokes waves, but as noted by Lord Hunt in his introductory remarks, such waves were found in 1964 by Benjamin and Feir to be unstable beyond certain steepness limits.

A number of papers address this topic but the penultimate paper, on standing waves, is specially significant. The author, Longuet-Higgins, is well known for his many distinguished contributions to wave research, including a 1950 paper showing how pressure disturbance due to standing waves, which are quite common in the ocean, can penetrate to the seabed and cause microseisms detectable at great distances. The important feature of this latest paper in the present context is that it demonstrates that steepness of standing waves can exceed the theoretical limit for periodic waves. When this happens there is a grouping into sets of three consecutive waves, in which one is of extreme height and the other two, as illustrated by a spectacular photograph, are flat topped.

This book is a rich mine of distinguished recent contributions to wind wave research aimed mainly at the specialist reader. This brief review has only been able to offer a few highly selective comments pointing to aspects I believe to be most relevant to RINA members. Since, as stated in Lord Hunt's preface, even the great Sir George Stokes

thought the work of Reynolds on turbulence was unimportant, I admit I may have missed some of the gold dust.

*Neil Hogben, FRINA, FREng*

## The End of an Era

*By Jack Daniel. Published by Periscope Publishing, Penzance, UK. Softback. ISBN 1 904381 18 9. £17.99.*

This is the autobiography of one of the greatest warship designers of post-Second World War years. Daniel's career began with commissioning trials of UK wartime submarines followed by service in uniform with the Eastern and Pacific Fleets. He was off Japan when the war ended and was the first Briton to visit Hiroshima and Nagasaki. Further 'nuclear' experience came as part of the UK team at the Bikini tests.

Post-war experience as staff officer to the UK Director of Naval Construction taught him some of the wiles of Whitehall. Design experience came on the *Hermes* class and an abortive large cruiser. When the cruiser was cancelled, the design section became the nuclear submarine section. In various capacities, Daniel claims responsibility for five classes of nuclear submarine, each better and safer than that before and completing to time and cost. This surely must have been the high point of his career. There was further surface-ship experience leading to the Types 21 and 22 frigates as well as an R&D post. He became Director General Ships in 1974.

The title of the final part says it all - The Wasted Years - as board member for warship building in British Shipbuilders. The main topics are the attempts to sell submarines to Australia and to Canada, frustrated by lack of commitment from politicians and admirals.

It is a fascinating book - I could not put it down. Though light-hearted in style, there are many serious lessons to be learnt from it.

*David K Brown, FRINA, RCNC*

## LETTER TO THE EDITOR

### Ship squat register - call for information

*Sir* - I am compiling a register of ships that, in recent years, have gone aground because of excessive squat. At present, I have a list of 13 ships, some of which are well known but I am seeking more. I would like to invite readers of this journal to send me information on vessels grounding for this reason.

The details I need for my register are simply:

- name of ship
- type of ship or deadweight
- geographical location of grounding incident
- date at which grounding of ship occurred.

*C B Barrass, FRINA  
19 Arundel Road  
Southport  
Merseyside PR8 3DQ  
UK*

# Developing guidelines for container carrier structures

Much work has been carried out by the Japanese classification society ClassNK to perfect a new series of structural guidelines not only for current large ship sizes but also for ultra-large liner concepts of the future.

OVER many years, tanker oil spills and bulk carrier accidents have led to heightened interest in the safety of life and property at sea, and protection of the marine environment. New demands are almost constantly being made on the shipbuilding, marine and other related industries to enhance the structural safety of ships. In light of this background, and with classification societies' role in enhancing structural safety becoming ever more important, ClassNK embarked on a major revision of the rules pertaining to the structural strength of ships.

It was decided that all the revisions must offer even greater transparency and rationality in the rules, by collating all the advanced technologies and technical information that had been accumulated to date. Firstly, the fundamental requirements related to structural strength were totally redeveloped based on both past experience and current research and technical information. At the end of 1999, they were compiled as the Technical Guide Regarding the Strength Evaluation of Hull Structures, as a first step in ensuring structural safety.

Based on the fundamental concepts included in these guidelines, important publications were issued related to the structural strength of three kinds of large ships, namely tankers, bulk carriers and container carriers. These included the Guidelines for Tanker Structures, published in November 2001, Guidelines for Bulk Carrier Structures, published in August 2002, and most recently, the Guidelines for Container Carrier Structures, which was developed and published in November 2003.

The guidelines for container ships involved the incorporation of results of new research on a wide range of topics, such as the development of new load estimation methods considering 3D effects (Fig 1), large-scale structural analyses using whole-ship FEM models (Fig 2), and tank tests (Fig 3), as well as the results of measurements on actual ships, with a view to improving the structural safety of both current container carriers and future ultra-large designs of 10,000TEU and above.

In order to properly consider the structural features of container carriers, which have large openings on the upper deck, specific guidelines related to torsional strength assessment of the hull were also added to the three standard components of the previous guidelines for tankers and bulk carriers. Thus, the four components of guidelines for container carriers are:

- direct strength analysis
- hull girder torsional strength assessment

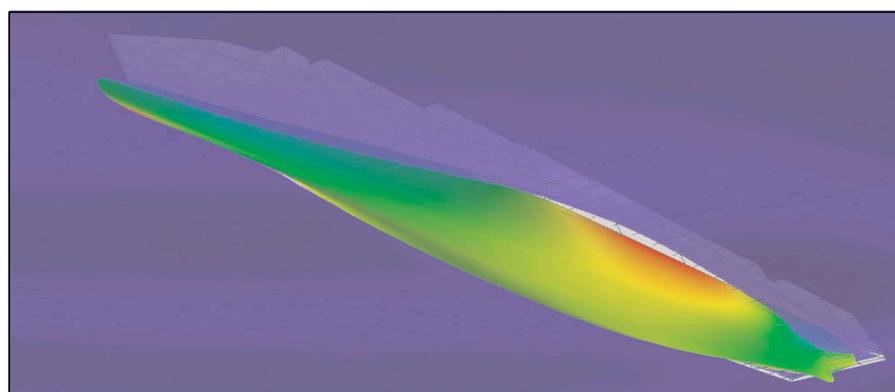
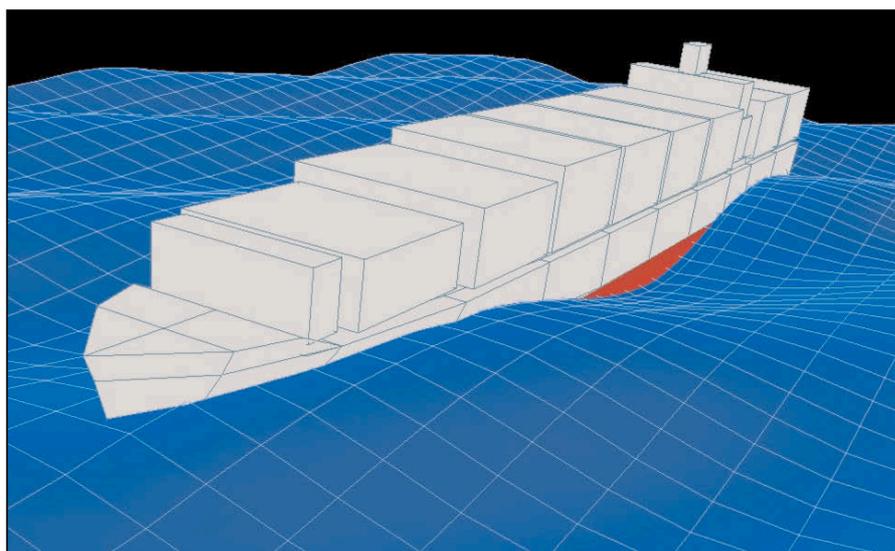


Fig 1. An example of load estimation results on a typical container ship hull, considering the 3D effects (viewed from the side and the hull bottom).

- fatigue strength assessment
- ultimate hull girder strength assessment.

## Guidelines for direct strength analysis

The guidelines for direct strength analysis were developed for evaluating yield strength and buckling strength by direct strength analysis using the net dimensions of primary strength members of the container carrier. These guidelines incorporate the results of research carried out over a wide range of topics including wave loads, container loads, structural response, strength assessment, and corrosion deduction.

## Guidelines for hull girder torsional strength assessment

These guidelines have been developed for the assessment of the hull torsional strength. This structural response is specific to container carriers having large openings on the upper deck. The development of these guidelines also involved the incorporation of results of research over a wide range of topics, such as

development of load estimation methods considering 3D effects, large-scale structural analyses using whole-ship FEM model, tank tests, and results of measurements on actual ships.

## Guidelines for fatigue strength assessment

These were developed for the evaluation of fatigue strength of primary strength members including upper deck plating and the corners of openings at the top of coamings. Again, they incorporate the results of research of a wide range of topics related to fatigue strength assessment, including design loads and strength analysis methods conforming to the guidelines for direct strength analysis, and fatigue strength assessment standards considering the effects of welding residual stresses and mean stresses.

## Guidelines for ultimate hull girder strength assessment

These guidelines were developed for confirming the hull girder strength of structural

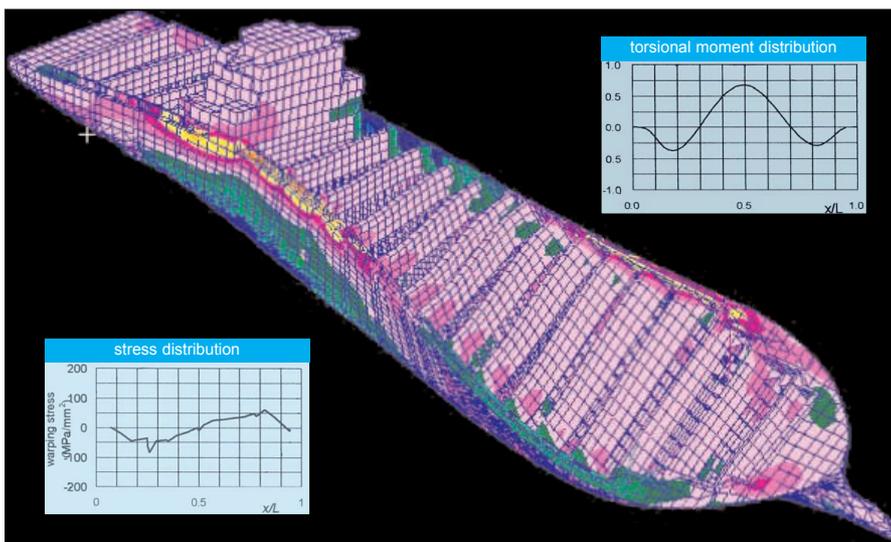


Fig 2. An example of a structural analysis results using a whole-ship FEM model.

members, to which no damage occurs even if they are corroded and the ship encounters severe sea conditions. The aim of these guidelines is to prevent hull damage. The ultimate hull girder strength is confirmed by evaluating the ability of transverse sections to withstand the hull girder moment considering the reduction in strength after buckling.

Application of these guidelines to a new ship during the approval process will result in class notations such as PS-DA (PrimeShip-Direct Assessment) or PS-FA (PrimeShip-Fatigue Assessment) - when the design evaluation for approval is carried out according to the guidelines applicable. PS-DA is assigned to ships that comply with the requirements of guidelines for direct strength analysis and guidelines for hull girder torsional strength assessment. PS-FA is for ships that undergo satisfactory fatigue strength assessment.

Some of the direct advantages of these notations are the effective redistribution of structural scantlings and the application of more rational corrosion margins. A ship with these notations indicates that it was designed and constructed based on the above advanced design standards, which increases structural

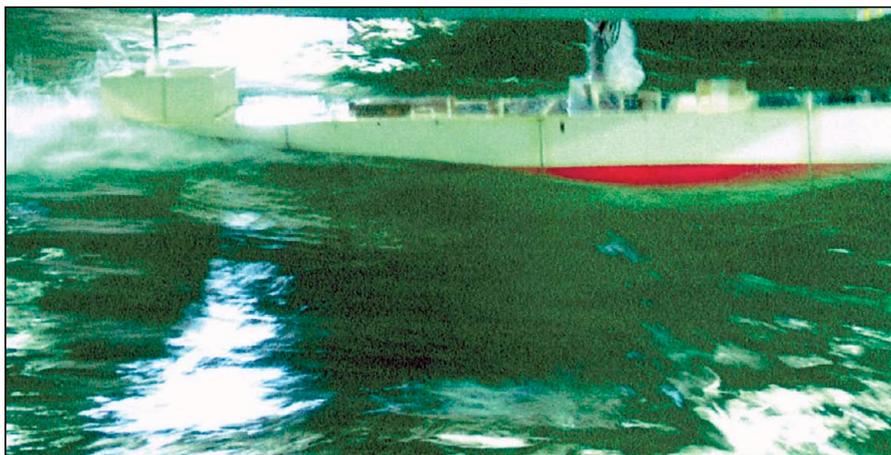
safety and reduces the structural maintenance over the ship's life, and in turn minimises total lifecycle costs. This assessment service is a part of the ClassNK structural strength assessment service known as PrimeShip-HULL.

**Increasing transparency, rationality, and consistency**

As with the earlier guidelines for tankers and bulkers, the goal has been to increase the transparency, rationality, and consistency of all processes, in each design stage, from load estimation to final strength evaluation, as is expected today of technical standards for designing ship hull structures. The longer term goal for ClassNK is to achieve implementation of guidelines for various kinds of ships as part of the establishment of a totally new set of rules for hull and equipment, which will eventually replace the current traditional Part C rules.

ClassNK has also developed a fully computerised direct strength assessment support system incorporating the above features and based on the guidelines. This system, which is an essential part of the PrimeShip-HULL package, was released in March this year.

Fig 3. As part of the information-gathering process, model tests were carried out, together with full-scale measurements on container ships in service.



# Massive ore carrier for MOL

IN March this year, the leading Japanese ship operator Mitsui OSK Lines (MOL) agreed with Nippon Steel Corp to develop and build one of the largest ore carriers ever built. This 323,000dwt giant is to be constructed by Mitsui Engineering & Shipbuilding, and, when complete in the second half of 2007, will haul iron ore from Brazil to Japan, discharging at major Nippon Steel terminals. The hull will have a length of 340m, a breadth of 60m, and a draught of 21m.

The worldwide ore trade is showing remarkable growth at present, largely boosted by China's huge appetite for steel. Since last year, MOL and Nippon Steel have held several discussions about the most efficient way to transport iron ore from Brazil. It was concluded that this large type of bulk carrier not only fits Nippon Steel's fleet deployment plan, but will also enable competitive freight rates, even for the long-distance shuttle between Brazil and Japan, because it can fully utilise the capabilities of ports serving those steel works at Oita and Kimitsu.

## New equipment from Japan Radio Co

LAST October (page 36), we discussed the newest integrated nautical system from Japan Radio Co - the interesting Ocean Explorer II concept. New this year from JRC are some smaller items of equipment, the JHS-182 automatic identification system and a ship security alert system, the JUE-75C, both essential in today's safety and security-conscious environment.

The identification equipment comprises a transponder with combined antenna, and single standard co-axial cable connection to a control panel. The 6in LCD screen display provides easy viewing and has simple graphic modes.

The security equipment integrates with the GMDSS Inmarsat-C system for global routing of alerts and messages, and it utilises the existing JRC Inmarsat-C unit for add-on kit such as security buttons and a controller. Installation is said to be easy, with no exterior cabling.

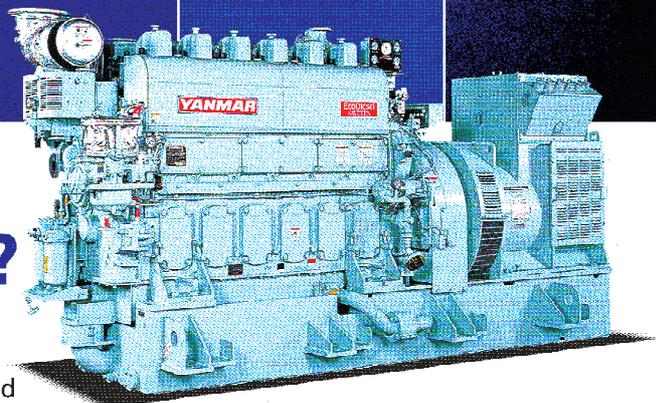
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## New alarm and monitoring equipment from JRCS

At the Sea Japan exhibition, held in April this year, JRCS Corp, the Japanese company that specialises in electrical switchboards and marine monitoring concepts, launched several new products. One of those of most interest was the SMS-22-K alarm and monitoring system, which incorporates many of the features and benefits of the SMS-32-K integrated monitoring and control concept. It uses 15in LCD touch-screen displays as standard, with both keyboard and track-ball available, if required.

In addition to standard display functions of auto alarm, overview, group, channel graph (bar/deviation/meter), trend, free, summary, and history, it is possible to incorporate up to 32 mimic screens. These enable owners to display, for example, power management features, motor/valve positions, and dynamic flows. Even more advanced features cover fuel consumption, fuel rate consumption, engine power, propeller rate, and tank volume.

JRCS has additionally reduced the size of its JSB-2L low-voltage switchboard, following a similar operation on the JSB2 high-voltage model. Thus, both high- and low-voltage boards can be sourced from one supplier. A completely new design is the JGP-21 group starter panel, which has several new features and benefits.

This year, JRCS will be delivering packages of high- and low-voltage switchboards, emergency switchboards, and group starter panels to four LNG tankers at Mitsui (one) and Daewoo (three), and a similar package next year for another LNG tanker at Kawasaki. Also scheduled for delivery this year is an integrated monitoring and control system, with engine and cargo control consoles, for a 145,000m<sup>3</sup> LNG tanker at Kawasaki for Sonatrach. Since 1991, the company has also delivered a large volume of equipment to Japanese-built LPG tankers, mostly in the 80,000m<sup>3</sup> class.



A 21st century optional self-standing unit featuring the new JRCS SMS-22-K console. Up to 32 mimic screens can be included if required.

## SPB gas-tank containment system licence for Samsung

A NEW era could be opening up for the Japanese SPB gas-tanker containment system, with the recent announcement by the inventor, the shipbuilding giant IHI (today IHI Marine United) of a licence agreement with the leading Korean shipbuilder Samsung Heavy Industries. To date, this interesting technology, mainly an alternative to the French membrane designs of GTT, has not made a great impact on the market, but this situation now might change.

The first ship to feature SPB tanks was the 89,880m<sup>3</sup> LNG tanker *Polar Eagle*, built in 1993 at IHI's Aichi yard for Phillips Alaska/Marathon Oil/Eagle Sun Co; she was followed by a sister *Arctic Sun*. Details appeared in *The Naval Architect* October 1993 and *Significant Ships of 1993*. SPB is an acronym for 'self-supporting prismatic-shape tank IMO Type B'; today, it employs stainless

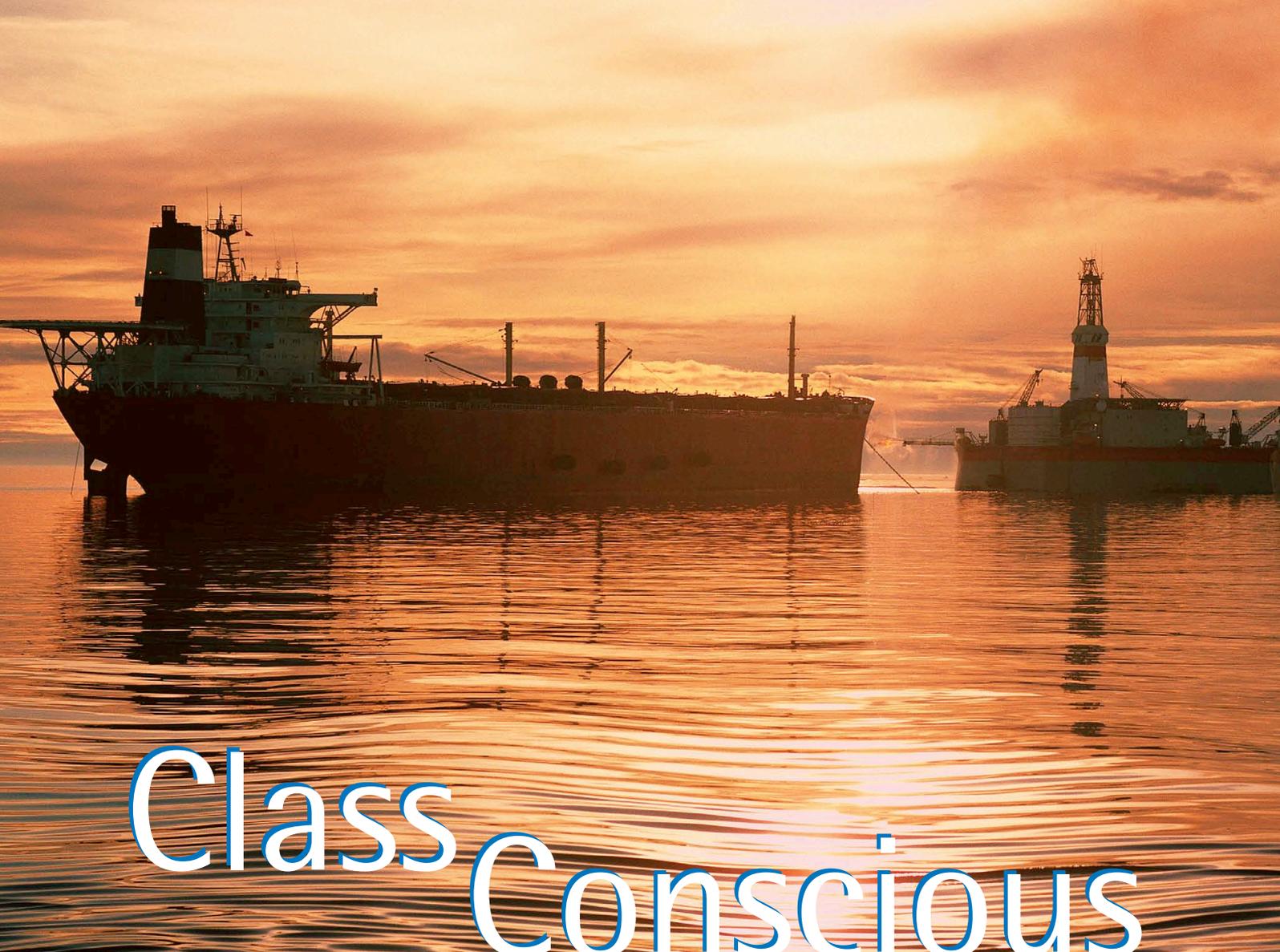
steel material (SUS 304 grade) but originally A5083-0 aluminium was employed. The use of stainless steel should strengthen the concept's competitiveness, thanks to reduced material costs, no need for major yard investment, and cost-effective production.

A useful benefit for shipyards is that on the original ships, between 91% and 93% of tank welds were made automatically, and at that time engineers anticipated that 97% would be achievable in the future. Centreline bulkheads limit sloshing, and polyurethane foam blocks are used for insulation. Easy operation and reduced maintenance is claimed, due to no need for differential pressure control, no requirement for heating coils, and good accessibility to the hold space between inner hull and cargo tanks. Complete tanks can be lifted into position.

In our 1993 article (page E434), IHI claimed that the SPB concept would be suitable for

ships up to 230,000m<sup>3</sup>. At that time, such sizes were not generally being considered, but of course today, these are quite likely to become a reality soon. An important new reference for IHI will be the completion later this year at its Kure yard of the first-ever FPSO for LPG cargoes, which will feature SPB cargo tanks. This vessel is designed to work in the Sanha field off Angola for ChevronTexaco.

The new licence agreement with Samsung enables the Korean company to build and sell LNG tankers and offshore LNG storage structures, including FPSO and FSRU (re-gasification) designs. IHI Marine United has obtained approval in principle for the SPB concept from the American Bureau of Shipping, Lloyd's Register, Det Norske Veritas, ClassNK, Bureau Veritas, and the US Coast Guard.



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# New harmonised Polar ice rules from IACS

A **T**IMELY new initiative from the International Association of Classification Societies (IACS) is close to realisation; this is a programme of unified rules for ships sailing to Arctic and Antarctic regions - a move noted in last month's Editorial Comment and one to be welcomed by the marine industry in view of activities to develop oil, gas, and mineral reserves along the northern coast of Russia. Development of these Unified Requirements for Polar Ships, as they are called, emanated from IMO's Guidelines for Ships Operating in Arctic Ice-Covered Waters, which were promulgated in December 2002 as a joint MSC/MEPC circular (MSC/Circ.1056, MEPC/Circ.399).

The structure and format of the IMO guidelines are divided into construction, equipment, operational, and environmental protection sections, although the guidelines themselves include only a minimal set of direct technical requirements for construction. Mainly, they outline performance standards and reference compliance with IACS Unified Requirements for Polar Ships as demonstrating adequate performance. Originally, the Guidelines for Ships Operating in Arctic Ice-Covered Waters were developed by an outside working group and were referred to as the Code of Polar Navigation (or the Polar Code). The intention was that this Polar Code would be a mandatory instrument applicable to both Arctic and Antarctic waters.

However, once submitted to IMO, the mandatory nature of the Polar Code was removed, as was its reference to the Antarctic, since separate guidelines were to be developed for those waters. Nevertheless, the original intent of the IACS Unified Requirements for Polar Ships has not changed. They have been developed with both the Arctic and Antarctic in mind (hence the nomenclature 'Unified Requirements for Polar Ships' as opposed to 'Unified Requirements for Arctic Ships').

A total of seven Polar classes are described in terms of nominal ice conditions based on WMO (World Meteorological Organisation) sea ice nomenclature. These descriptions are very general, due to the considerable variability of

ice conditions in Polar waters. The overall intent in defining technical requirements for each class has been to provide a relatively smooth increase in requirements (and cost), to assist owners in matching the requirements for a particular ship with its intended voyage or service. Accordingly, the new IACS unified requirements are equally well-suited to ships navigating Antarctic waters as well as Arctic waters.

In response to a need for the technical requirements described above, IACS established an ad-hoc group (known as the AHG/PSR group), to develop the Unified Requirements for Polar Ships, with one working group for structural requirements and another for machinery. The first efforts of AHG/PSR have resulted in three sets of draft unified requirements for such ships; UR 11 (Polar-class descriptions and application); UR 12 (structural requirements for Polar-class ships); UR 13 (machinery requirements for Polar-class ships). It should be noted that the AHG/PSR group has included non-IACS working members, who have expertise and knowledge to assist in the development of requirements for this specialised subject.

These new harmonised rules have partly been developed by drawing on the best aspects of all current classification rules, and incorporate many of the analytical principles pioneered by one society particularly experienced in ice navigation needs, the Russian Maritime Register of Shipping. However, the Unified Requirements for Polar Ships also include enhancements in many areas that have been agreed to by leading Russian experts in the field. Furthermore, care has been taken in aligning the new IACS requirements with existing navigational control systems for waters in the Russian and Canadian Arctic, as well as the Baltic Sea.

The scope of the UR 11 section includes neither structural nor machinery requirements, since the objective is simply to specify the application of structural and machinery requirements for Polar ships (UR 12 and UR 13), and to provide descriptions of the various

Polar classes used throughout these requirements to convey differences with respect to operational capability and strength. The scope of UR 12 includes specific strength requirements for plating, framing (including web frames and load-carrying stringers), plated structures (such as decks and bulkheads), and the hull girder. It also includes material requirements, as well as corrosion/abrasion allowances. In addition, general strength requirements are also included for hull appendages, stem and stern frames, as well as some provisions for local details, direct calculations and welding.

The scope of UR 13 includes specific strength requirements for the main propulsion shaftline components, including auxiliary support systems and material requirements. The objectives of both UR 12 and UR 13 are to provide a unified set of structural and machinery requirements to enable Polar-class ships to withstand the effects of global and local ice loads, as well as those low temperatures characteristic of the operating areas.

At the end of April, Unified Requirements 11 and 12 were largely complete, with only some validation work of the latter remaining. In the absence of any unforeseen problems, these requirements will be submitted to the IACS General Policy Group by June 30. Pending approval by this group, these requirements will then be submitted to IACS Council for adoption. Once adopted, IACS member societies have one year within which to implement them.

Unified requirement 13 is also largely complete, but the remaining validation work is more extensive. Furthermore, the timescale for completion depends partly on the Finnish and Swedish administrations, with whom IACS has cooperated in order to establish recognised equivalencies between the two lowest IACS classes (PC6, PC7) and the two highest classes in the Finnish-Swedish Ice Class Rules (IAS, 1A). However, machinery requirements for these classes are expected to be finalised by the end of this year. 



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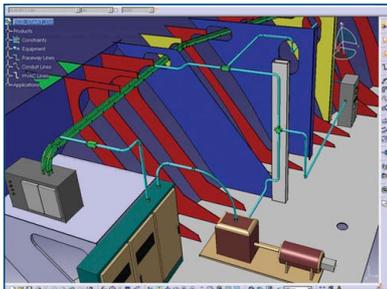


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Over the past 30 years, the European shipbuilding, and repair conversion industry has seen substantial rationalisations, mergers and consolidation. While there has been a reduction in market share, the industry has enjoyed relatively greater success in the high added value specialist vessel, shiprepair and the marine equipment sector.



Against a background of increasing shipbuilding capacity in China and South Korea continuing arguments on shipbuilding subsidies, how can the European maritime manufacturing sector maintain and increase its market share? Through the "LeaderSHIP 2015" initiative, the European shipbuilding and shiprepair industry has defined a long term strategy to develop appropriate policies to strengthen the competitiveness and ensure sustainable growth of the industry. This strategy envisages a knowledge-based industry for both product and production process, concentrating on more complex vessels. Research, Design and Innovation (RDI) is a key factor in this strategy.



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# Jotacote Universal - an attractive new shipbuilding primer

DESPITE difficult trading conditions related to exchange rates, Jotun continues to be a world-leading organisation - a recent prestigious reference was the supply of SeaQuantum tin-free antifouling to *Queen Mary 2* - and has recently launched a number of new marine coatings. Possibly the most interesting is Jotacote Universal, a pure-epoxy shipbuilding primer, developed in response to today's very fast construction times for new vessels - particularly by large yards in Korea where a huge throughput of hulls calls for precision production scheduling. Thus, this new primer has a maximum drying time (to recoat) of 24 hours, and that is at -5°C ambient; at a more typical +23°C, drying time is approximately four hours. Such attractive timing will allow painting teams to apply an optimum two coats in only one day.

Despite a slightly shorter pot-life, this one-version-only coating can thus be used almost anywhere at any time of year, thanks to a high level of cross-linking which allows curing to take place over a wide temperature range. In addition to standard aluminium, red, and grey, Jotacote Universal comes in three main colours - buff, light red, and turquoise, depending what will be the final topcoat. Jotun claims that its new coating can be overcoated by alkyd paints, something that it says is not possible with all competing products.

Jotacote Universal can be used in almost any part of a ship, external or internal, including in petroleum products cargo tanks; the only place for which it is not suitable is potable water tanks. Apart from its time attractions, the product also offers high levels of corrosion and abrasion resistance - indeed, Jotun reports abrasion performance up to 25% better when compared against a leading competitor.

Apart from its use in Korea, Jotacote Universal is also being used in other production-efficient yards in countries including Romania, Croatia, and Poland. Marketing is also currently starting in China. Japanese yards are generally considered more traditional and remain more interested in long-established modified epoxy primers.

## New SeaQuantum addition

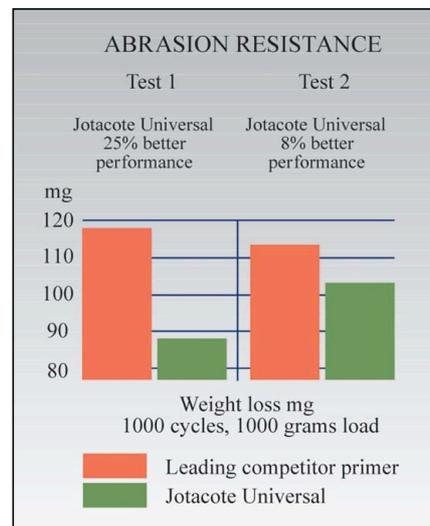
For a number of vessels where antifouling smoothness is not a special consideration, for



A graph showing the speedy drying times at various temperatures for Jotun's new Jotacote Universal shipbuilding primer.

example, in workhorse bulk carriers travelling at relatively modest speeds, Jotun has developed an additional version of its advanced SeaQuantum tin-free antifouling range launched four years ago and described as a hydrolysing product which offers uninterrupted performance regardless of drydocking interval (*The Naval Architect* June 2000, page 42). This new variant is SeaQuantum LLL, which is priced more competitively to appeal to bulk carrier and crude oil tanker owners.

Like others in the range, this is said to offer predictable performance while inhibiting the build-up of leached layers of paint at the surface of an exposed antifouling where composition can change, with resulting reduced mechanical strength. Jotun argues that the true cost of a paint system can only be calculated by including maintenance expenses, and the company believes that bearing in mind the technical benefits of SeaQuantum, the possible extra expense of applying this system will be offset by reduced work at drydocking time.



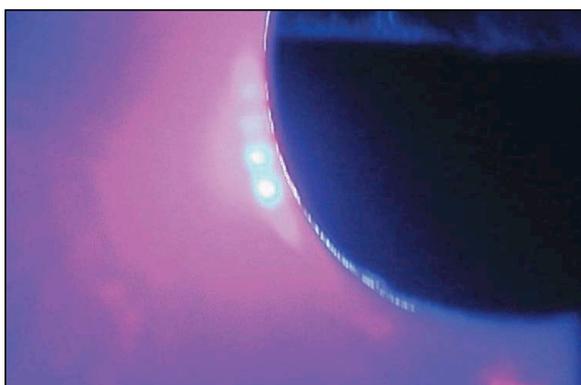
Graphs showing improved abrasion resistance achieved during two tests with Jotacote Universal, when compared with a leading competitor.

## Ultra-violet reactive ballast-tank coating

Meanwhile, Jotun continues to promote its Balloxy HB Light modified-epoxy system for ballast tank protection. The company pioneered light-coloured ballast systems for ease of application and inspection but has recently launched an interesting two-pack innovation - an optically active coating that reacts to ultra-violet light. This is known as Balloxy HB Lumi and enables an inspector to highlight easily any application defect for remedial work. A further feature of this paint is that it can be easily monitored throughout the coating's life and if necessary photographed for records.

At the time of writing, only very few ships had had this interesting product specified; however, the fact that the US Navy has given approval to the luminous concept used in Balloxy HB Lumi must be seen as an indication of its qualities. Nevertheless, Jotun must still convince commercial owners of such a product's technical superiority.

Looking to the future, Jotun believes that good prospects exist for silyl-polymer-based paints for antifouling (not to be confused with the MarineLine Siloxirane technology used successfully for cargo tank coating by the US specialist Advanced Polymer Sciences). Many manufacturers are understood to be considering switching to such systems. Other highly interesting possibilities, which will appeal to the 'green' lobby, are totally biocide-free antifouling incorporating silicone. In the meantime, Jotun has won the contract to supply SeaQuantum antifouling to Royal Caribbean's new Ultra Voyager cruise liner building at Kvaerner Masa-Yards, and in an associated field, the company feels that the continuing rise in the number of contracts for megayachts offers interesting possibilities.



A Balloxy HB Lumi second coat applied in a ballast tank and showing how the low dry-film thickness on the edge appears as a bright line when exposed to an ultra-violet torch. This illustration also proves the importance of stripe coats on difficult parts of steel structures.

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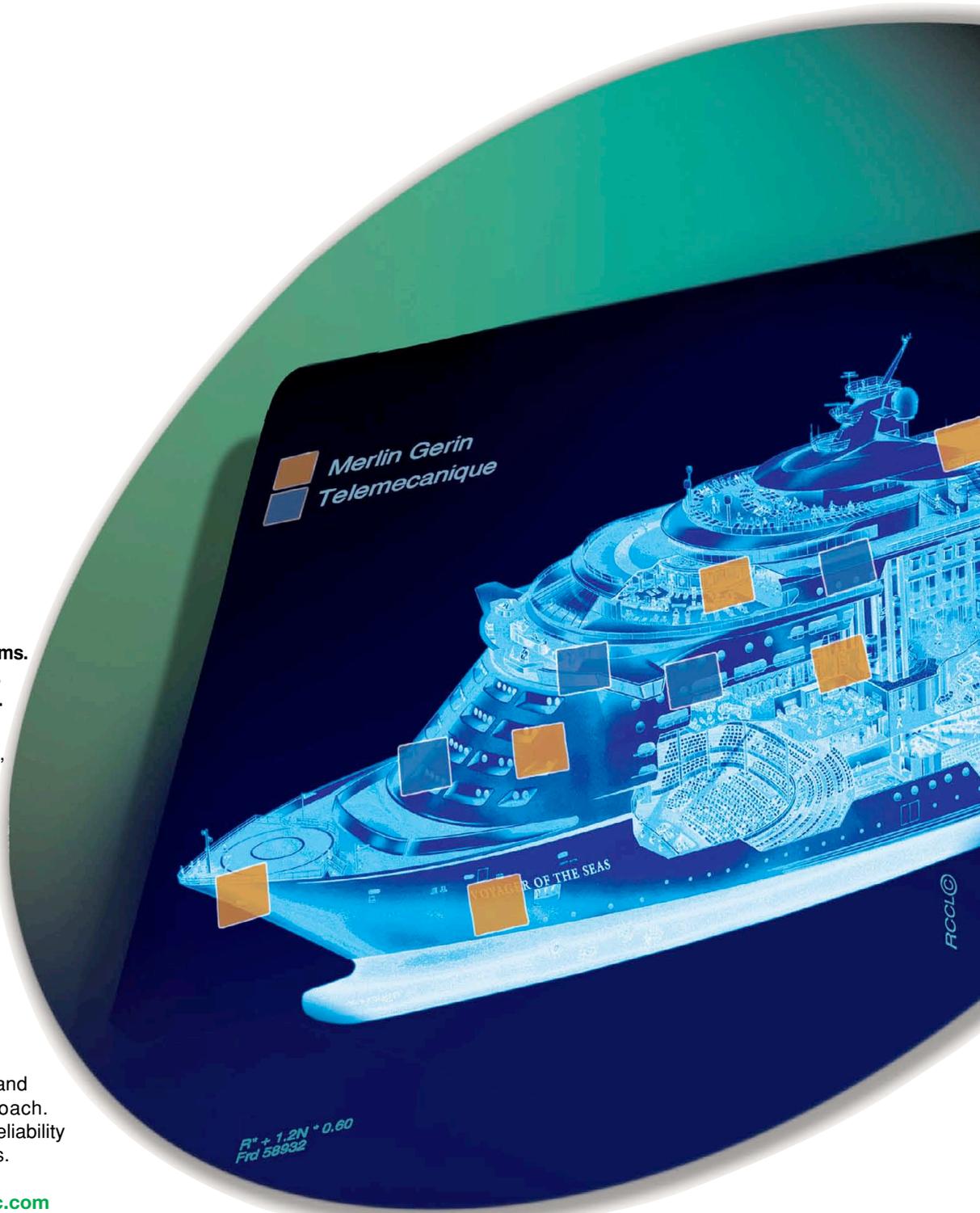
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# New coatings from Korea

TWO important new marine coating systems have recently been launched by the Korean Chemical Co; these are Korexane ST1020, a polysiloxane top coat, and a special antifouling system for ships likely to stay afloat in rivers during construction. Due to demands for high performance, considerable effort has been put into the evolution of topcoats, starting with epoxy, which has good mechanical properties and corrosion resistance; however, the arrival of urethanes introduced new levels of weather resistance.

Nevertheless, ever better performance can today be offered by polysiloxane, which is included in the new Korexane ST1020, an organic acryl/inorganic silicon hybrid product, which is said to exhibit long-term durability through the inclusion of inorganic components, as well as good workability. Levels of weathering are also claimed to be much improved over aliphatic polyurethane, although careful colour choice is needed to avoid possible loss of gloss and colour. Other benefits include resistance to ultra-violet light, no oxidisation, and freedom from isocyanates.

Test applications have been made on hatch covers of the container ship *Hyundai Bridge* (work done at Hyundai Mipo Dockyard) and on the forward part of the forecastle deck on the VLCC *Iran Noah* (applied at a Singapore yard).

## New antifouling to combat special problems of river water

Other interesting recent Korean Chemical Co products are Seacare A/F795(H)-Red and Seacare A/F795(H)-Develop. These tin-free antifouling - special versions of the company's established SPC antifouling range - have been formulated to overcome particular problems noted at shipyards situated in rivers, for example, in China, where TBT-free SPC

coatings have been found to blacken, blister, peel off, crack, soften, or dissolve. These new paints are designed to protect hulls against chemical and ionic attack after launching and before delivery. So far, hulls painted with Seacare A/F795(H)-Red and immersed for nine months have shown no defects.

The Red version is recommended when re-docking is planned prior to delivery; the procedure would be to apply anti-corrosive and sealer coats, followed by 50microns of Red, at the block stage, then when the ship is on the berth or in the building dock, welded areas are touched-up using the same system. When afloat (ideally not longer than eight months) and then re-docked, the hull can be washed and followed by a main antifouling system, eg, Seacare A/F795 or A/F795(H).

On ships where no docking prior to delivery is planned, anti-corrosive and sealer coats, plus Seacare A/F795 or A/F795(H), plus 50microns of the Develop version, would be applied at the block stage. When the hull is in the building dock or on the berth, it would only be necessary to touch-up welded areas (as in the previous procedure) but that would be all. Again, maximum time for floating in river water is recommended by Korean Chemical to be eight months.

## Protection of ballast tanks

One of the major challenges facing owners, yards, and paint suppliers today is to ensure satisfactory coating of water ballast tanks, especially on new-generation double-skin tankers and bulk carriers. Coal-tar products have long been regarded as the best product for this purpose, but possible harmful effects on people and inspection problems with the dark colour have caused manufactures to seek alternatives.

Immersion Periods	3 months	6 months	9 months
Commercially Available Product (TBT-free)	1.Small crack started 2.Soluble	1.Full surface crack 2.Very soluble	1.Severe crack 2.Very soluble
Seacare A/F795(H)-RED	1. No crack 2. Not soluble	1. No crack 2. Not soluble	1. No crack 2. Not soluble

Illustrations of paint panels immersed in river water at Hudong, China, showing the good condition of Korean Chemical Co's Seacare A/F795(H)-Red after nine months, compared with a conventional product.

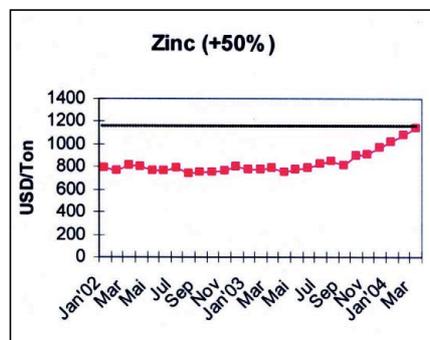
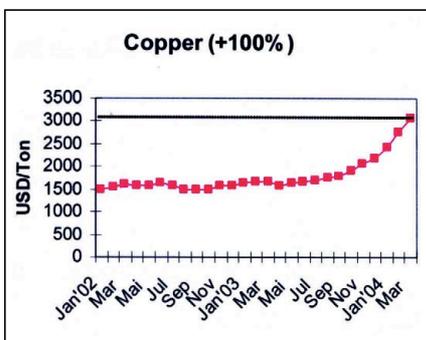
For some years now, Korean Chemical Co has been successfully applying its own-developed product, Korepox EH2350, a light-coloured, two-component modified-amine cured epoxy, and to date, the ballast tanks of nearly 200 ships have been protected using this. The coating can be applied at temperatures down to -18°C, and it meets VOC regulations due to low organic solvent content (SVR > 80%). If required, Korepox EH2350, as a universal primer, is also suitable for other parts of a ship, such as cargo holds, exposed weather decks, boot-tops, topsides, and superstructures. Tests in Norway at Marintek by Det Norske Veritas gave Korepox EH2350 a B-1 rating (no blisters and no rust).

# Alarming rise in paint raw material costs

LARGE increases in the costs of raw materials are forcing marine paint manufacturers to hoist the prices of their products. As an example, International Marine Coatings reports that it has already initiated price rises of between 5% and 15% but the company also forecasts that material prices are set to rise again 'throughout 2004'.

Important materials affected include copper, zinc, epoxy resins, titanium dioxide, and specialist solvents. Resin producers are said to be raising their prices to counter higher energy and feedstock costs, zinc prices have apparently risen by more than 30%, and manufacturers of titanium oxide have announced a US\$150/tonne increase.

As regards feed stocks, increased tension in the Middle East and high demand for crude oil has resulted in a 14-year high point of almost US\$40/barrel. World demand for copper (mostly used in the land construction and electrical industries, but only a small amount for antifouling) has pushed copper prices up 40% to more than US\$3000/tonne.



Two graphs, kindly provided by Jotun (and sourced from <http://metalprices.com>), which show the alarming rise in the price of two basic marine paint materials, copper and zinc, since January 2002.

As Jotun notes in another article in this feature, currency exchange variations (particularly the decline of the Dollar against the Euro) are also causing problems, as is the increasing price of steel, which affects paint can costs. The economic boom in China has been a

major influence on steel and copper prices; copper consumption in China increased by 20% in 2003. However, Jotun also reports that long-duration fixed-price contracts for series of ships have likewise affected the marine paint industry.

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## Key topics aired at IMO design and equipment sub-committee

THE International Maritime Organisation (IMO) Sub-Committee on Design and Equipment (DE) met for its 47th session at IMO headquarters in London from February 25 to March 5 2004. Delegates from BIMCO participated together with 54 member Governments and 23 inter- and non-governmental organisations and UN agencies. Many key topics - some controversial - of interest to naval architects were discussed.

### Amendments to Resolution A 744(18)

The guidelines on the enhanced programme of inspections during survey of bulk carriers and oil tankers have undergone a number of amendments since they were adopted by the 18th Assembly in 1993. At DE 47, amendments to Part A (for bulk carriers) were made with regard to hatch covers, incorporating the technical provisions of the International Association of Classification Societies (IACS) Unified Requirements (UR) S30. Also, MSC/Circ 1071 (on survey of hatch covers) was incorporated into the text and thus made mandatory. IACS was invited to submit its hull survey requirements for double-skin bulk carriers, when completed, to the next session of the DE Sub-Committee.

Annex B (applicable to tankers) was divided into two parts: Part A for double-hull oil tankers, and Part B for oil tankers other than double-hull oil tankers. Also, some elements from the Condition Assessment Scheme (CAS) were incorporated in Annex B. The agreed amendments have been sent to the Maritime Safety Committee (MSC 79, which meets in December 2004) for adoption.

### Protection of fuel tanks

Several submissions had been made on the requirements for the protection of fuel tanks for new ships. The rationale here is that the environment should be protected from pollution by heavy oil, whether it originates from a cargo or fuel tank, bearing in mind that heavy fuel is carried by almost all larger vessels and has proved to be a very difficult pollutant to combat. BIMCO had submitted its opinion that any regulations should allow for a probabilistic approach to the distribution of fuel tanks, rather than only allowing one rigid set of design parameters, such as a double hull. The principles for the requirements would thus be in line with those applied for safety considerations, such as damage stability for dry cargo ships.

On many large vessels, such as tankers and bulk carriers, double hulls in way of the fuel tanks can easily be accommodated without the loss of cargo space. Other ship types, such as container ships, however, can only provide double-hull protection at the cost of cargo space, and this will render them uncompetitive compared with existing ones.

It was decided to establish a correspondence group. The group was instructed to develop the proposal for new ships and for heavy fuel tanks only and, in spite of some delegations

advocating only a double-hull solution, to also consider the probabilistic method, as suggested by BIMCO. The correspondence group is to report back to the next session of the sub-committee. Possible new rules, when and if agreed and adopted, are expected to enter MARPOL Annex I.

### Anchoring, mooring, and towing requirements

A submission was made to the committee suggesting that regulations be introduced regarding anchoring, mooring, and towing equipment, as well as the marking and condition of mooring and towing lines. After discussion, it was decided that there was no compelling need for regulations on mooring and towing lines.

The proposal called for structural requirements to be applied to anchoring, mooring, and towing equipment for new and existing vessels. However, in the end it was decided to require new vessels only to be fitted with arrangements, equipment, and fittings of sufficient SWL, and to mark the equipment to that effect.

### Protection of tanker pumprooms and access to shore-based computer programs for salvage operations

It was decided to insert a new Regulation 13I in MARPOL Annex I, requiring double bottoms in pumprooms except if the bottom plate is higher above the base line than the required double-bottom height, as may be the case with gondola stern designs. If flooding of the pumproom does not render the ballast or cargo pumping system inoperable, double bottoms are not required.

The requirements for shipboard oil pollution plans were augmented with the mandatory availability of shore-based strength and damage stability calculation facilities. Both decisions were sent to the Marine Environmental Protection Committee for final decision and possible adoption at its 52nd session in October 2004.

### Fitting of water ingress alarms in single-hull cargo ships

Vessels with a single cargo hold will be required to fit water level detectors in the lowest part of the cargo spaces. Originally, the proposal was to apply to new vessels only, but after discussions in Plenary, a retro-active application was agreed. This is actually in line with a similar set of regulations for bulk carriers. It applies to vessels of less than 80m length, or 100m if built before 1998, and the regulations will take effect at the date of the first renewal or intermediate survey after a date of entry into force (to be decided by MSC). The regulations do not apply to vessels with double sides up to the freeboard deck.

### Empty holds and double hulls for bulk carriers

In 2002 a major FSA study on bulk carriers was finalised and the results submitted to MSC 76. A number of new safety measures for both new and existing bulk carriers were agreed to, and many

of these were sent to various subcommittees for further development and drafting. The working group established during DE 47 was thus expected to finalise draft amendments to SOLAS Chapter XII and submit them to MSC 77, which met on May 12-21, for adoption.

Amongst the measures was an alternate hold loading ban for bulk carriers. It was agreed to prohibit bulk carriers from sailing with empty holds unless the structural requirements to new ships in SOLAS Chapter XII are complied with and the hold frames comply with IACS UR S12 Rev 2.1 or equivalent. The ban applies only to the fully loaded condition, which is defined as 'a draught corresponding to 90% of the ship's deadweight at the relevant freeboard'. Finally, in order to avoid loopholes, the term 'empty' is defined as 'a hold loaded to less than 10% of the hold's maximum allowable cargo weight'.

Double side-skin construction of bulk carriers was tentatively decided by MSC 76 and thus not open for discussion by a sub-committee. At the last meeting (DE 46), the technicalities of the mandate were discussed, in particular the appropriate width of the double side spaces. Participants agreed to a minimum internal clearance of 600mm and that the distance between the outer and inner shells should be kept at 1000mm. Present designs show that this figure will actually be around 1200mm for a Handymax increasing to around 1800mm for a Capesize.

There have been strong oppositions against mandating double side-skins for new bulk carriers, based on the claim that the side shells of newly designed single side-skin bulk carriers have sufficient strength. In fact, a single side-skin bulk carrier built today is much stronger than one built 10-15 years ago and would indeed strength-wise be superior to a new double side-skin vessel if the latter is optimised to the limit.

As the working group could not discuss the pros and cons of double side-skins but only draft text reflecting the tentative decision taken by MSC 76, it is to be expected that a major discussion on this subject will take place at MSC 78. If sufficient and adequate new information is fed into the debate, the decision on mandating double side-skins could be revoked.

### Application of structural standards in SOLAS chapter XII

It was basically agreed that the structural standards of Chapter XII at present applying to single side-skin bulk carriers should also apply to new double side-skin bulk carriers, whether or not double side-skins will be mandated.

### Improved loading/stability information for bulk carriers

The SLF Sub-Committee had drafted amendments to SOLAS Chapter XII/11, which was incorporated in the text to be forwarded to MSC 78. The new paragraph to SOLAS XII/11 implies that new bulk carriers of 150m length and below shall be fitted with a loading instrument providing information on stability.

*continued*

**Performance standards for protective coatings**

A new draft regulation 6.4 of Chapter XII was agreed to, referring to coating standards to be developed by IMO. The sub-committee was informed that IACS and the industry is at present working on such standards and decided to await further development until the industry standards were available.

**Free-fall lifeboats with float-free capability**

A new regulation 33.3 to SOLAS Chapter III was drafted and amendments to the Life Saving Appliance (LSA) Code were

proposed. It was, however, decided that there was a need for further development of the performance standards for float-free free-fall lifeboats.

**Permanent means of access**

These new SOLAS regulations and referenced technical provisions were adopted by MSC 76 in December 2002. However, based on industry concerns and a timely submission by Greece, the sub-committee was instructed to revise the regulations even before they enter into force. Permanent means of access (PMA) were introduced as a concept to ensure better methods for close-up

inspections as required by the Enhanced Survey Programme, which was a direct spin-off from the *Erika* accident in 1999.

However, it was not until the regulations were applied to actual designs that it became apparent how impractical they could be in many circumstances. Hence, the industry decided to try, through major flag states, to revoke the adoption, but a submission from Greece made it possible to start the amendment procedure now.

A drafting group was established which made a few, but substantial, amendments to the SOLAS text. One basic amendment is that the word 'permanent' has been removed allowing for alternative new inventive means to be applied. Also a number of amendments to the technical provisions were agreed, basically making the entire concept more workable and safe.

**Mandatory emergency towing systems in ships other than tankers greater than 20,000dwt**

A proposal from Germany to expand the scope of the present emergency towing arrangements for tankers of 20,000dwt and above to cover all ships above 300gt, was rejected by plenary. It was, in particular, emphasised that on many smaller vessels, eg, offshore supply vessels, such arrangements could not be fitted as they would hamper basic operations. It was, however, agreed to discuss it again at the next session of the sub-committee (DE 48), and Member States and NGOs were encouraged to submit papers to further the discussion.

This article is produced in association with BIMCO (The Baltic and International Maritime Council).

**Ecospeed for propeller coating**

THE new Belgian glassflake coating Ecospeed, developed by Subsea Industries (an associate of the leading underwater repair specialist Hydrex) is now finding another use - as a propeller coating. Subsea Industries has recently applied this product to the blades on a dredger and claims that they are now completely shielded from all corrosive elements. When coated, the propeller is said to be electrically inert, thus preventing the de-alloying process and increasing service life. Cavitation damage is also claimed to be virtually eliminated, due to the very tough surface.

In addition to all this, the smooth finish should keep a propeller operating at maximum efficiency and give a self-cleaning effect. Further details of Ecospeed, whose basic claim is to offer a new non-polluting approach to the problems of antifouling coupled with a very long lifespan, can be found in the 3rd Quarter 2003 edition of our associate journal *Shiprepair and Conversion Technology*, page 24.

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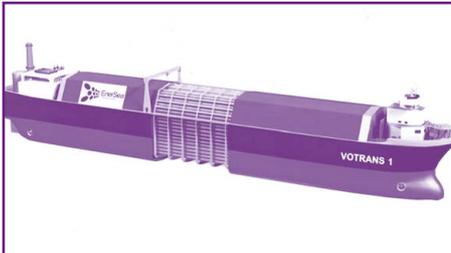
## DESIGN & OPERATION OF GAS CARRIERS

22 - 23 September 2004, London, UK

### Second Notice



There is currently considerable optimism about the future growth of the natural gas market and while not all the proposed LNG schemes may materialise, many still expect a significant increase in the number of vessels in the world LNG fleet. Recently, there has been both an increase in orders and an increased programme of scrapping of older vessels. The market is also moving away from the traditional long term 20-year time charter and greater use is being made of spot market vessel charters.



While some companies are looking at the possible economies of scale of larger vessels (in the range of 175,000- 250,000 cu.m.) others are looking to develop options for developing small vessels to exploit shortsea and coastal trades in LNG.

New alternatives including compressed/pressurised natural gas (CNG/PNG), where the gas is stored under pressure at ambient or semi-refrigeration temperatures, are also being developed. There is also a growing interest in LNG Floating production, storage and offloading systems for offshore oil & gas developments and re-gasification tankers and plants designed to avoid the need to construct huge land-based processing and distribution centres.



Steam turbines have traditionally been the preferred power plant for LNG carriers; however, other options such as medium speed diesel electric or slow-speed diesel engines, with reliquefaction plants to reclaim boil-off gas, are being developed.



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# New car carriers and LNG tankers for Leif Hoegh

IN line with a strategy of fostering growth in its ro-ro and LNG transport business segments, identified as the future core activities of the refocused group, the leading Norwegian operator Leif Hoegh has implemented a major fleet renewal and development programme at Far Eastern yards. Playing to traditional deep-sea strengths, the company - like competitor Wilh Wilhelmsen - extended its investment commitments in the pure car/truck carrier (PCTC) category during 2003. In addition, it has two LNG carriers under construction to provide the initial export conduit for the Snøhvit scheme, a prospective, considerable addition to Norway's industrial fabric. The Group's operations in the short-sea domain will assume a new dimension with the delivery to its French interests of a ro-ro vessel conceived specifically for intra-European movements of Airbus aircraft components.

A total of seven PCTCs, offering a capacity of 6100 car-equivalent units (CEUs), are on order at Daewoo Shipbuilding & Marine Engineering for delivery into Hoegh's HUAL service network over the course of 2005 and into 2006. According to the group, the design of the newbuildings is based on the 'flexible, state-of-the-art solutions' already employed in the HUAL fleet. Indeed, the versatility of the ship type in terms of vehicular cargo mix is unsurpassed, and reflects the considerable changes in market demand of recent years, with a shift towards higher and heavier cars, the growing popularity of 'people carriers', and emergence of the sport utility vehicle (SUV), coupled with the requirements of the commercial, agricultural, and construction vehicle and passenger transport production sectors.

The contracts at Daewoo form part of the renewal plan for the HUAL fleet, whereby current tonnage dating from 1980/81 will be superseded at around the 25-year age mark by incoming newbuildings. But the project also denotes capacity development, in keeping with buoyant demand for flexible PCTC vessels on most of HUAL's services. Complementing the in-house orders, Hoegh has entered into long-term charter agreements covering a further five PCTC newbuildings compatible in size and stowage versatility to the nascent 6100CEU series.

The multi-deck configuration of Hoegh's new PCTCs provides a total garage area of some 54,000m<sup>2</sup>. On the basis of an all-car load, this would give a stowage area of about 9m<sup>2</sup>/unit.

However, the actual maximum number of units in practice depends on the size and height of cars to be transported. While there has been a pronounced trend towards an increase in size, reflected in HUAL carryings, the operator has conveyed single loads of as many as 8000 small cars from Korea to Europe. The normal intake rate for large PCTCs is around 1000 cars for each eight-hour shift, such that the loading process, when the full vessel capacity is being utilised, generally takes 48 hours.

Nordic technology underpins the working of such vessels, perpetuated in the new class at Daewoo, for which Norwegian-owned, Gothenburg-based TTS Ships Equipment has been retained to design and deliver the full cargo access equipment (CAE) outfit. The TTS scope of supply includes stern quarter and side ramps, internal ramps and covers, hoistable car decks, and access doors.

A veritable floating garage, the Daewoo PCTC type embodies 12 cargo decks, of which four are designated for 'high and heavy' vehicles and potentially other ro-ro freight, with integral

hoistable car decks. The factor of shipment and stowage flexibility has been further increased by arranging two locking positions for the raisable decks, such that the 'high and heavy' decks No 1, 3, 5 and 7 each offer the option of three clearances, up to a maximum of 5.0m in No 5 level with the platform decks stowed clear.

Each of the Hoegh newbuildings will be powered by a seven-cylinder MAN B&W S60MC two-stroke diesel, built at Changwon by HSD Engine Co, in which Daewoo is a shareholder. The installation is rated for 14,300kW, and should ensure a speed of 20.7knots at the design draught. During its deliberations as to powering arrangements, Hoegh Technical Services had considered an electronically-controlled, ME version of the engine ultimately selected. While headroom availability was one factor which led to the adoption of conventional MC plant, the operating flexibility and through-life fuel and emission saving properties of the new ME generation should make it a candidate for future tonnage planned by the group. ⚓

## New Hoegh LNG tankers for exporting Snøhvit gas

THE two 147,000m<sup>3</sup> LNG tankers on order at Mitsubishi Heavy Industries' Nagasaki yard for operation by Leif Hoegh's UK arm will serve initial export flows of gas arising from the Snøhvit development in the waters off northern Norway. The first ship will be the subject of a 20-year charter to Norwegian energy group Statoil and some of the other owners in the Snøhvit project, which has enormous long-term significance for Norwegian industry. Statoil had sought a 140,000m<sup>3</sup> capacity in a spherical tank-based cargo containment system. While MHI's existing design at the time was 135,000m<sup>3</sup>, the Japanese builder formulated a new design solution giving 147,000m<sup>3</sup> in four Moss tanks.

The lead vessel, in which the Hoegh Group has a 34% ownership stake, with Mitsui OSK and Statoil having 34% and 32% respectively, is scheduled for handover in October 2005. She is expected to implement exports from the new, north Norwegian terminal at Melkoyar (Milk Island), near Hammerfest, in January 2006. Although well within the Arctic Circle at more than 70deg N, Hammerfest is ice-free during winter due to the benign effect of the Gulf Stream, such that the new tankers will not require ice-strengthening. However, in deference to the nonetheless harsh environmental conditions, de-icing facilities will be incorporated on deck and the bridge wings will be enclosed, while the vessel type has been designed for a 40-year fatigue life in accordance with North Atlantic criteria.

The sister is the subject of a 20-year charter to TotalFinaElf Exploration Norge, and has been ordered on a 50:50 ownership basis by Leif Hoegh and Mitsui OSK. Hoegh Fleet Services will be responsible for the technical management and crewing of both vessels. While there is much talk in the industry of alternatives to steam turbine propulsion for LNG tankers, the two Snøhvit LNG carriers will each apply well-proven machinery in the shape of a Kawasaki steam turbine of 27,600kW, arranged to ingest the anticipated 0.15% daily cargo boil-off. The second vessel is due in early 2006, and is being built to dual BV/DNV class, whereas the lead ship will purely reflect DNV requirements.

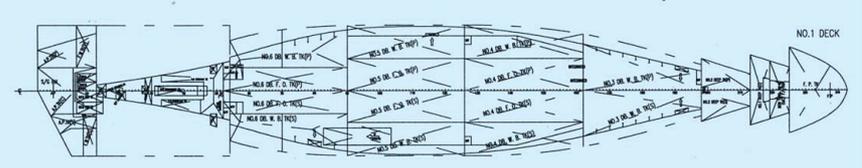
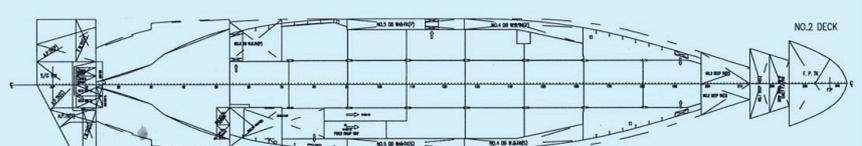
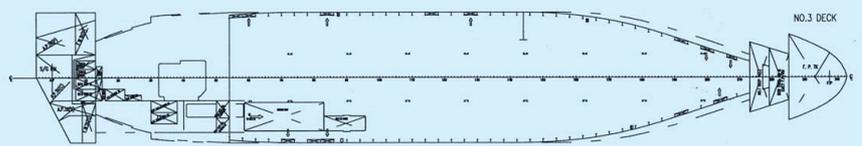
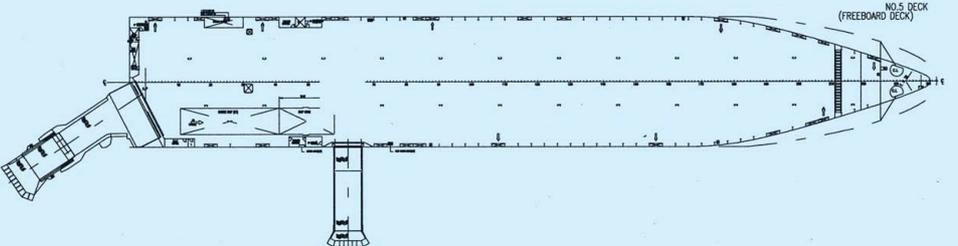
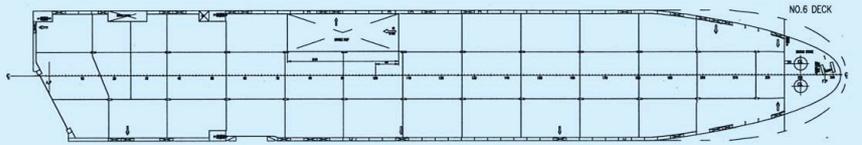
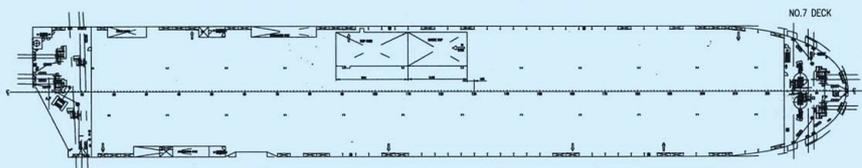
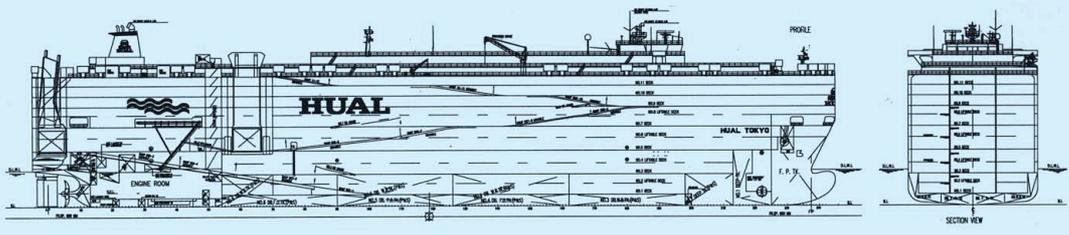
The first Snøhvit LNG production train will sustain export volumes using four newbuildings, comprising two from K Line as well as the two under construction for Leif Hoegh and its associates. Should a second train be brought into being at some stage, additional opportunities would be created for the LNG sea transportation market.

Since the start of 2001, Hoegh has been an active participant in the development of new technological solutions for the LNG logistical chain. The company's shuttle and re-gasification vessel system (SRV) is intended to allow re-gasification of cargo aboard an LNG carrier at an offshore location, for transfer of the gas ashore via pipeline, thereby eliminating the need for traditional land-based receiving terminals. The SRV concept in conjunction with floating production of LNG could form a complete offshore LNG supply chain. ⚓

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Air draught.....	46.90m
Draught, design.....	9.00m
Draught, scantling.....	10.00m
Deadweight.....	20,400dwt
No of decks.....	12
Total deck area.....	54,000m <sup>2</sup>
Load capacity.....	6100CEU
Main engine.....	14,300kW
Speed, maximum.....	21.30knots

General arrangement plans of Leif Hoegh's new 6100-unit car/truck carriers, on order at Daewoo. The 20.70knot designs will be classed to Det Norske Veritas standards with the symbols +1A1 Car Carrier (Ro/Ro, MCDK), Ice C, EO, NAUT-OC, PWDK. Main deck loading is increased to 2tonnes/m<sup>2</sup> throughout.



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# SIGNIFICANT SHIPS OF 2003

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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 off-shore 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.

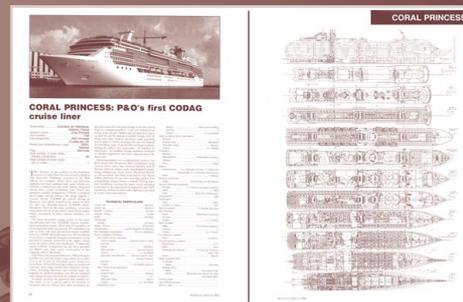
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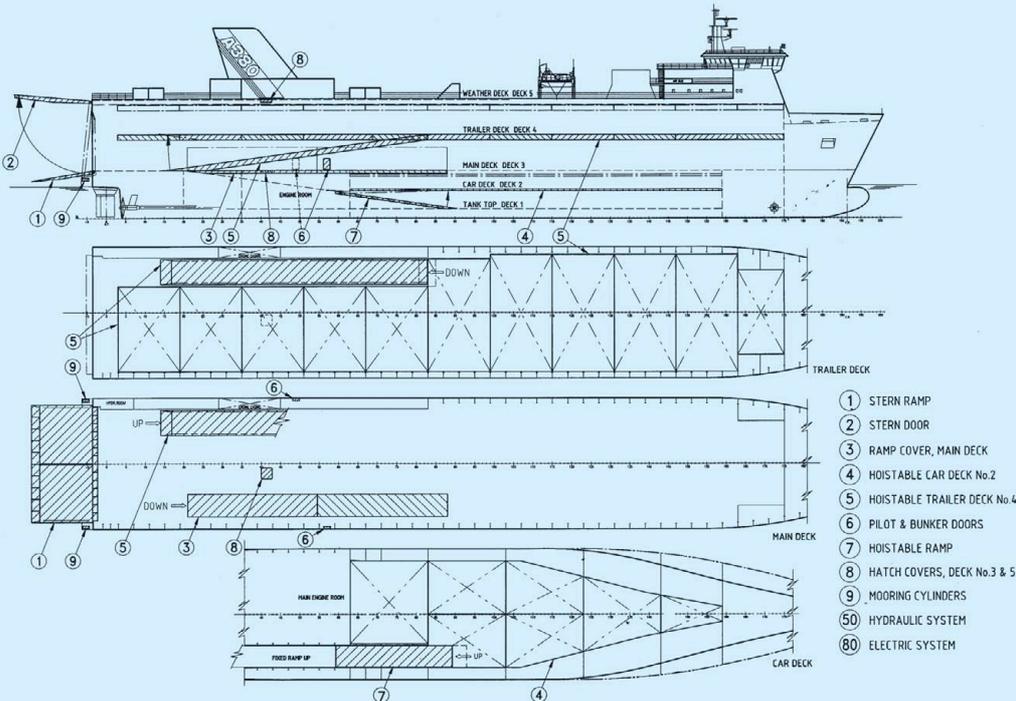


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General arrangement plan of *Ville de Bordeaux*, the recently delivered hybrid ro-ro vessel from Jinling Shipyard in China, for use in the Airbus 380 project. Project and complete basic design work, together with simulation of aircraft loading and discharge, was handled by Deltamarin.



## Airbus hybrid ro-ro ship delivered

At the end of April, the 5200dwt hybrid ro-ro vessel *Ville de Bordeaux*, built specially for the European Airbus 380 project, left the Jinling Shipyard, China. She was then delivered to Fret/CETAM, a subsidiary of French owner Louis Dreyfus Armateurs and Norwegian operator Leif Hoegh. More details of this vessel can be found in *The Naval Architect*, July/August 2002, page 42.

This ship has been designed specifically for the carriage of large aeroplane components. Measuring 154m, the ship has extra large holds to accommodate the components, and a system of internal ramps, doors and hoistable decks help to facilitate the shipment of outsized aircraft parts.

*Ville de Bordeaux*, which has cargo deck space of 6720m<sup>2</sup> and more than 1800lane metres of space, will be deployed on a 20-year contract to ship aircraft components for the new Airbus A380 aeroplane from manufacturing sites in France, Germany, Spain, and Wales to Bordeaux, and then by barge and road transporter (*The*

*Naval Architect* July/August 2003, page 55), in preparation for final assembly in the French industrial city of Toulouse.

The shipment of aircraft components from European manufacturing sites to the ultimate assembly plant in Toulouse has constituted a major logistical challenge. The fore and aft fuselage sections are to be shipped from Hamburg, the tail section from Puerto Real, in Spain, the cockpit and central fuselage from St Nazaire, and the wings from Broughton in Wales.

Following the sea passage to the Port of Bordeaux's Pauillac terminal on the river La Gironne, *Ville de Bordeaux* will berth alongside a special quay with her stern aligned to a 150m floating pontoon. The components will be rolled over the pontoon and on to two purpose-built semi-submersible barges. From there, they will be shipped up river, through Bordeaux to another terminal at Langon. There, the barges will enter a new dock in which the water depth can be

adjusted to enable the barges to discharge their cargoes on to vast new road transporters for the final leg of the journey to Toulouse.

The vessel is equipped with highly sophisticated TTS cargo-access equipment, including what is claimed to be the largest ever watertight stern door on a ro-ro vessel. Altogether, the TTS cargo access equipment weighs almost 930tonnes. The extraordinary configuration and size of the aircraft parts constituted a particular challenge to TTS, and this company developed a unique cargo handling system for this highly specialised vessel.

The TTS cargo equipment, which has been built to Bureau Veritas' requirements, comprises a range of key components, including a stern ramp and door, a ramp cover on the main deck, a hoistable car deck and ramp, a hoistable trailer deck and ramp, pilot and bunker doors, and hatch covers. Mooring cylinders and all of the necessary hydraulic equipment have also been supplied by TTS. ⚓

*Ville de Bordeaux* has a relatively unusual aft end; a top hinged stern door that folds over the two-part ramp for extra protection.



*Ville de Bordeaux* is a new 5200dwt hybrid ro-ro vessel built for the Airbus 380 project, at the Jinling Shipyard, China.



The two-part stern ramp on the 154m ro-ro vessel *Ville de Bordeaux*.



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# The Royal Institution of Naval Architects

## Design & Operation for Abnormal Conditions III

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### First Notice & Call for Papers



For hundreds of years mariners have reported monstrous "freak" or "rogue" waves sinking and damaging ships. These huge vertical walls of water up to 30 metres high were often dismissed as sailors' yarns by scientists and engineers.

Significant work over the last 10 years, particularly in the offshore sector, and recent field measurements has provided evidence of the existence of these "abnormal" waves. While the existence of such waves are now accepted, the conditions that lead to their formation are not always well. Clearly these waves are occurring more frequently than predicted by classical linear wave theory. However, there may be a number of different mechanisms leading to their creation of "abnormal" waves including; specific wave current interaction, wave superimposition, wave focusing effects, non-linear effects, etc. Changes to the global climate are producing more

unstable weather patterns and possibly greater opportunities for generating abnormal waves.

These waves have the potential to damage or even destroy both offshore structures and ships. It is therefore important to understand these waves and their effect on the safety of such structures. This conference aims to provide a multi-discipline forum to encourage greater interaction between researchers, oceanographers and engineers both from the offshore and shipping industry. The Institution invites papers in the following areas:

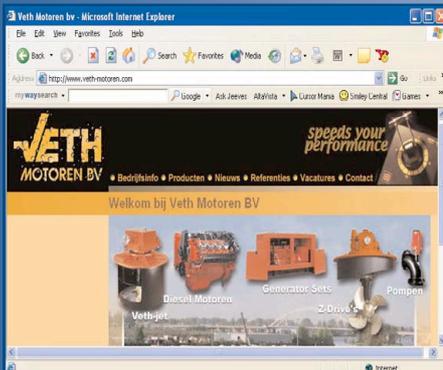
- improve knowledge and understanding of abnormal waves
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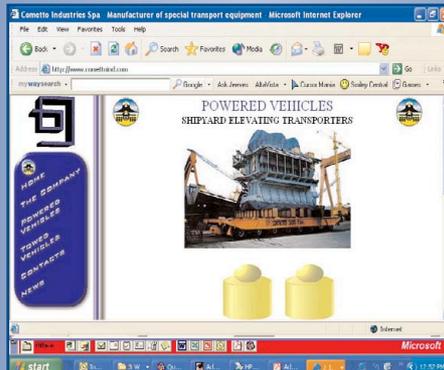
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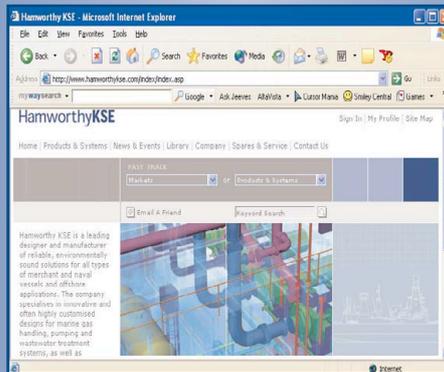
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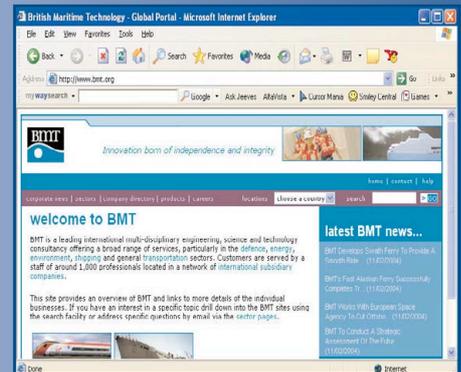
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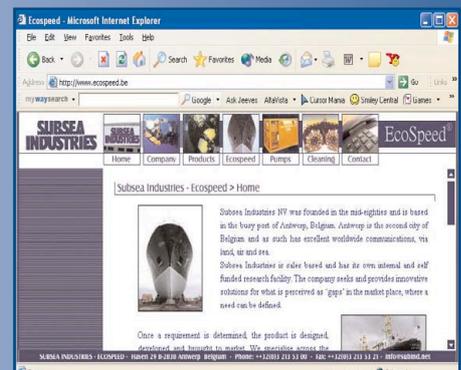
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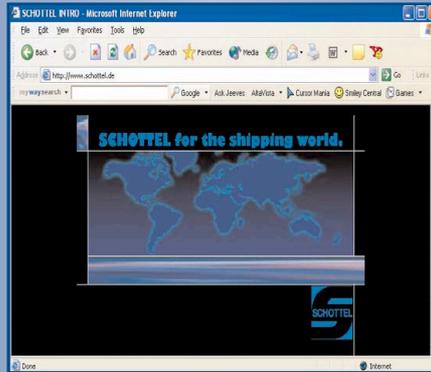
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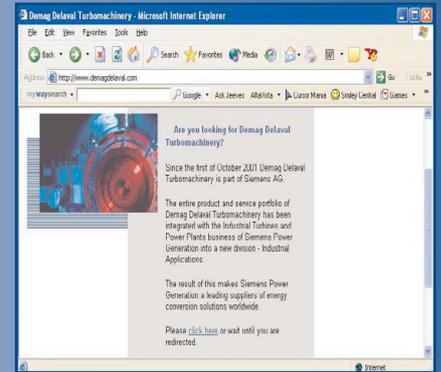
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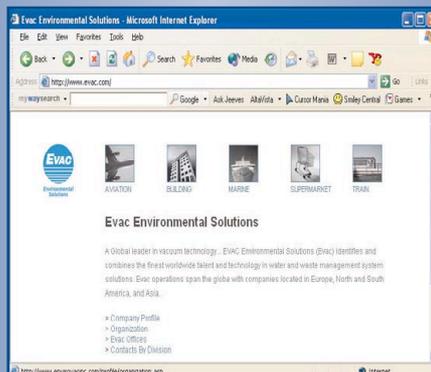
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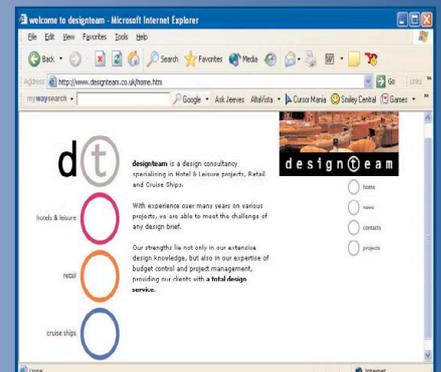
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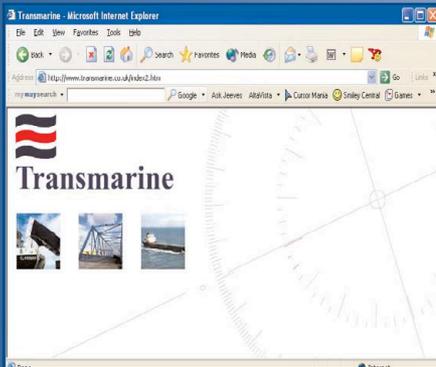
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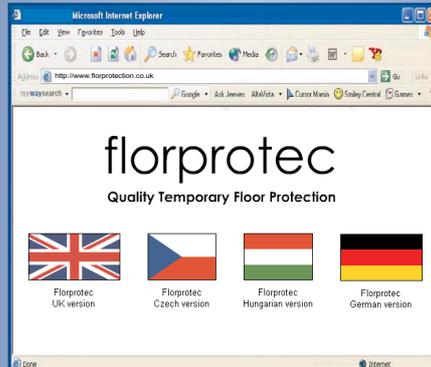
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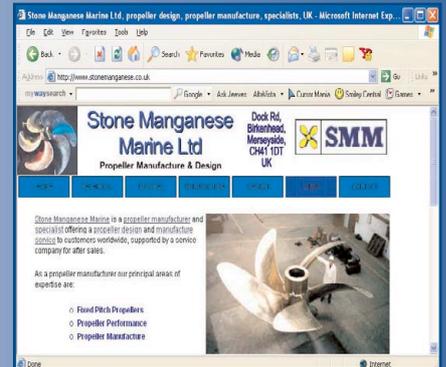
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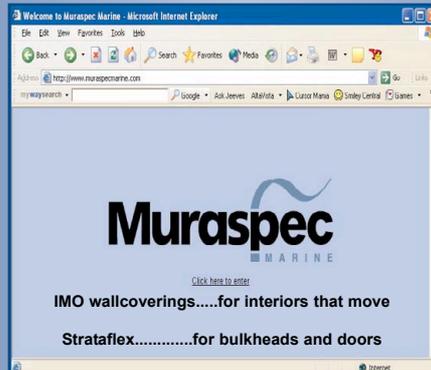
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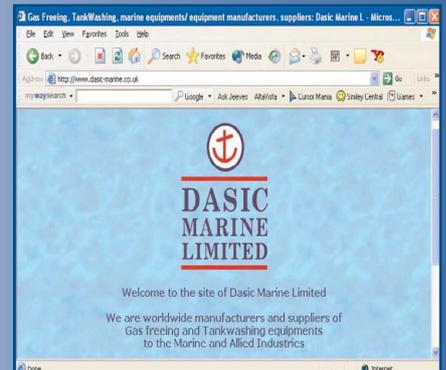
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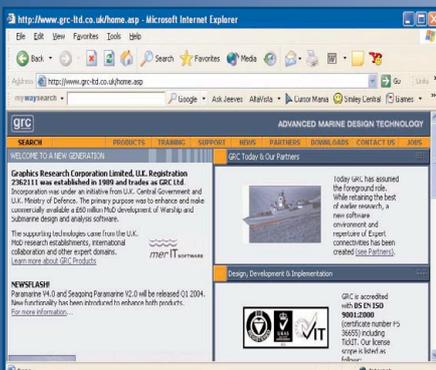
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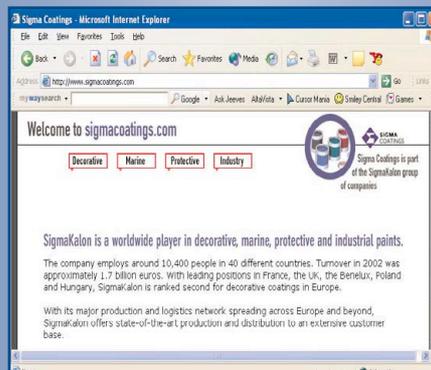
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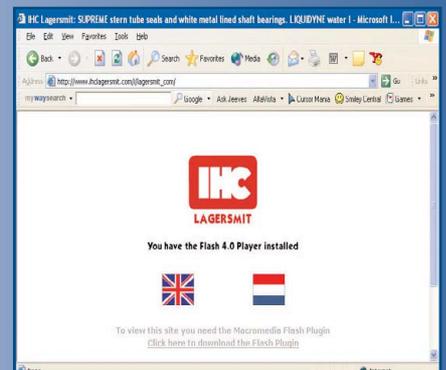
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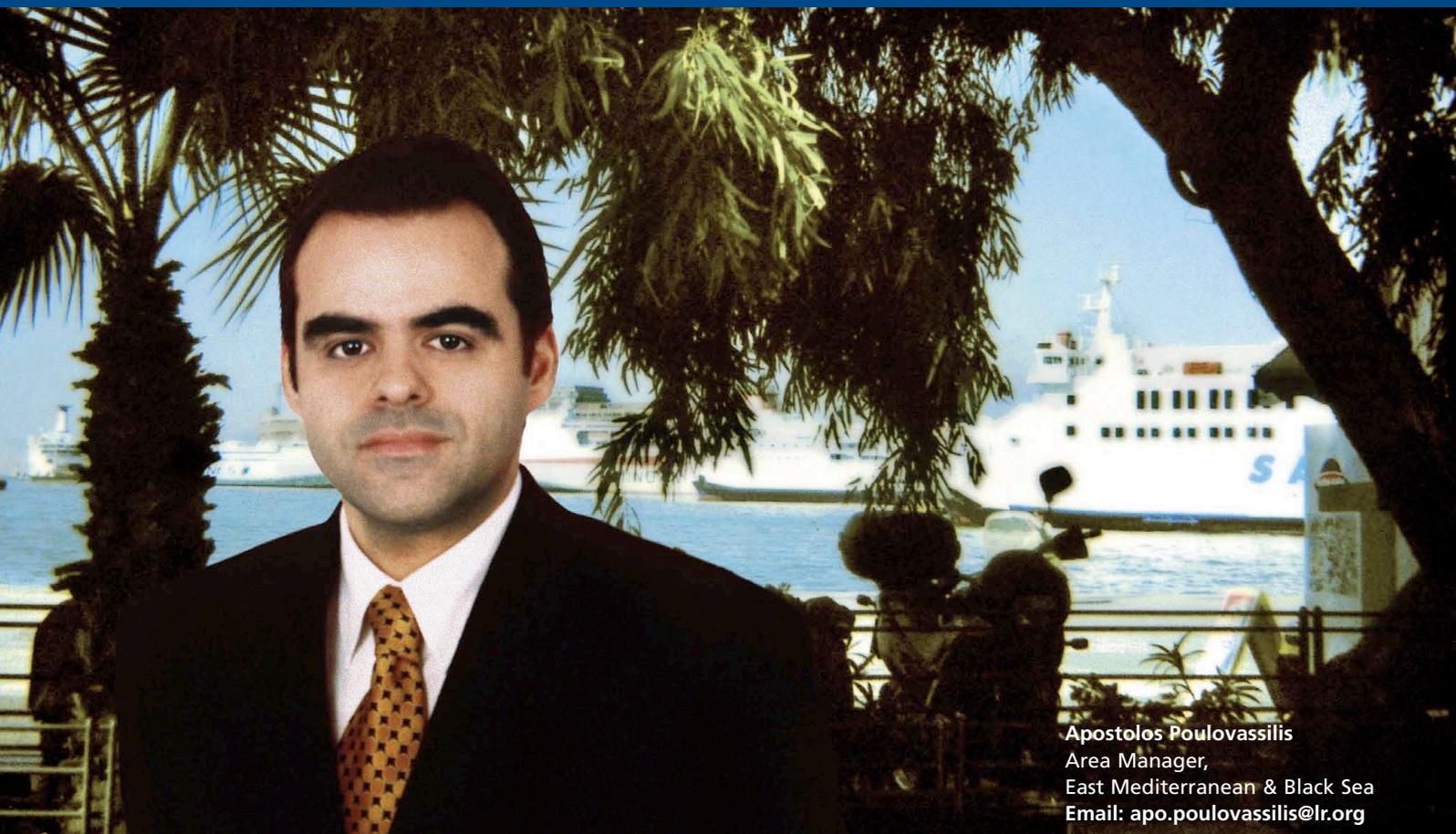
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