SSPA HIGHLIGHTS

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Contents



PHOTO: Shutterstock

At SSPA, we have a passion for sustainable maritime development. In our desire to make our clients' businesses prosper, we offer them knowledge-based solutions.

Development work should begin by reviewing the business concept, in order to fully understand and build in-depth knowledge of the overall context. The information gained from this review will be essential at the stage when potential areas of improvement are identified, prioritised and developed. Success can be attained in many different ways.

A good example is the shipowner who made the decision to go green by reducing fuel consumption and thereby the impact on the environment. He found major advantages by implementing a systematic approach to energy management with the help of SSPA consultants.

For other maritime stakeholders, the success stories lie in the detail. For example, developing propeller design to increase efficiency and performance using advanced knowledge of micro-scale hydrodynamics. Putting the right focus on details can lead to great achievements.

Another example is a client who is active in the Arctic area, and where trustworthiness was reinforced when a proactive management strategy was implemented. The strategy focused on preparing for and preventing low probability events in order to eliminate or reduce environmental risks.

Are you looking for new sustainable maritime opportunities? Contact us! We have the skills, the experience and the passion to support you throughout the process.

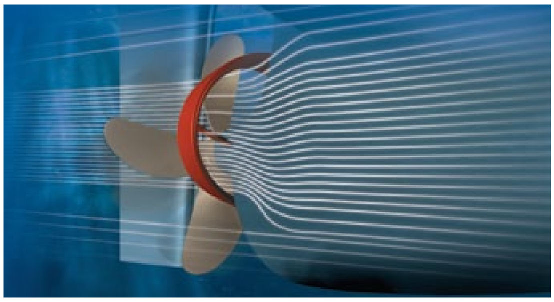
*Susanne Abrahamsson*

# A ship-owner taking the decisions to become GREEN

**Almost all shipowners in the world are currently faced with two major targets: to reduce the impact on the environment and to reduce costs. Reducing fuel consumption will help shipowners to reach both goals. However, there are many decisions to be taken in order to reach the best possible solution or combination of solutions. The appropriate measures and decisions that will lead to success are dependent on ship type, speed, trade etc.**

Laurin Maritime AB is a Swedish shipowner and operator of modern tankers trading mainly from the US Gulf to the eastern seaboards of North and South America and transatlantic to Europe. Laurin´s core fleet consists of 10 modern 46,000 dwt IMO II chemical class tankers that can switch between clean petroleum products and large parcels of chemicals to provide maximum flexibility of operation.

Laurin have taken the initiative to devise and implement an energy management scheme, which is a valuable tool for ensuring the correct process. This is being done in order to introduce a systematic approach with a plan–do–check–act cycle rather than making ad-hoc decisions. Nevertheless, it is necessary to decide *which* systems to implement and to evaluate. This is where the difficult process starts!



*A Mewis Duct® consists of a number of stator fins and a duct, placed in front of the propeller. The stator blades create a pre-swirl and the duct increases the flow velocity towards the propeller. Together they improve the propellers performance.*

PHOTO: COURTESY OF BECKER MARINE SYSTEM

## Seeking the right advice, taking the right decisions

Being an independent consulting company, SSPA has been contracted by Laurin to evaluate the different possibilities

*Laurin's Medium Range tanker "Tintomara", sister ship to "Tambourin".*

PHOTO: COURTESY OF LAURIN MARITIME AB

*Lars T. Gustafsson, Vice President and Head of SSPA Ship Design received his M.Sc. in Naval Architecture at Chalmers University of Technology in 1993. His earlier work was mainly with model tests and CFD calculations. From 1999-2003 he was Market Manager at SSPA Ship Design and has been Vice President and Head of SSPA Ship Design department since 2004. From 1996 to 2002 he was a member of technical committees within the 22nd and 23rd ITTC.*
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*Installation of a Mewis Duct® on MR tanker "Tambourine" in November 2009.*
PHOTO: COURTESY OF LAURIN MARITIME AB

and options for their fleet. The work ranges from general advice to evaluation by theoretical investigations and model tests of different concepts suitable for Laurin´s fleet. Furthermore, SSPA will assist in the implementation of the chosen concepts and the evaluation of performance on board. Some of the concepts and ideas that have been investigated so far are trim optimisation for running the ship in on optimum trim condition, different energy saving devices and different rudder concepts.

## Mewis Duct

A major step towards a green ship was taken when Laurin decided to evaluate a Mewis Duct® (MD) on their Medium Range (MR) tanker. The MD belongs to the group of energy saving devices that is placed forward of the propeller with the purpose of improving the flow to the propeller. The advantage of the MD is that it combines two positive devices: a pre-swirl stator and a duct. The stator blades are non-movable wings that create a pre-swirl, i.e. they change the angle of the flow towards the propeller in such a manner that it operates with a more favourable angle of attack. The effect of the duct is to increase the flow velocity towards the propeller, which is again an improvement in the propeller's working condition. The properly designed duct itself creates a forward directed force due to its wing section shape.

The MD was presented for the first time at the SMM International Trade Fair in September 2008. It was developed by Friedrich Mewis and is manufactured and retailed by Becker Marine System. It has already been implemented on a number of ships world-wide. As an independent consultant with lengthy experience of testing energy saving devices, SSPA was asked to evaluate the benefit of the MD on Laurin´s MR tanker.

After a thorough design phase using Computational Fluid Dynamic computations, Becker Marine System was able to deliver an MD especially adjusted for the actual hull form and propeller. A model scale MD was then manufactured by SSPA according to Becker's specifications. The stator blades were made rotatable so that their pitch angles could be optimised further in model tests.

Mr. Mewis himself took part in the four days of optimisation and evaluation in the towing tank at SSPA. By systematically varying the stator blade angles and carrying out short self-propulsion tests, a final optimised MD could be derived. The gain of the device was then evaluated according to SSPA's standard by resistance and self-propulsion tests with and without the MD. The result revealed to Laurin that this would be a good investment: 6 percent reduction of delivered power. According to SSPA's experience of similar devices this is a very good result.

## Evaluation

The MD has now been installed on Laurin's Tambourine and will, together with other measures, now undergo a full scale trial period in order to complete the plan–do–check–act cycle and provide important feedback into the loop of strategic decisions. As part of this process, SSPA will provide support through evaluation and independent advice.

*Lars T. Gustafsson*
*Sofia Werner*

*"We make many strategic decisions that will impact the company for many years to come. It is important to get these decisions right and working with an independent consulting company like SSPA Sweden AB has been a major advantage when evaluating different concepts and getting unbiased advice."*

MIKAEL LAURIN
CEO Laurin Maritime AB

# The never ending battle with propeller cavitation

*Mikael Grekula, Project Manager at Ship Design at SSPA, received his M.Sc. degree in Mechanical Engineering in 1997 and defended his Ph.D. thesis in Naval Architecture at Chalmers University of Technology in April 2010. He joined SSPA in 2006 and works mainly with propulsion related projects.*
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*The article here is based on his Ph.D. thesis "Cavitation Mechanisms Related to Erosion, Studies on Kaplan Turbines, Foils, and Propellers", Chalmers University of Technology, Gothenburg, Sweden, 2010.*

**Even though propeller cavitation and its downsides, e.g. noise, vibration and erosion, could be suppressed in many cases for a conventional propeller, the absence of cavitation indicates that the design could be pushed further to gain higher efficiency and performance. This means that where high efficiency and performance are required, cavitation is unavoidable, which calls for silky skills at the design stage to manage the downsides of cavitation. Despite the considerable progress made during the last ten years in Computational Fluid Dynamics (CFD) on simulation of cavitation dynamics, experimental model testing is still the most reliable and cost-efficient way of making the final assessment of the cavitation behaviour for commercial ship projects. However, CFD simulations can be a very valuable tool during the design process to make several design iterations giving a better design for the model tests.**

As a part of a PhD project at Chalmers University of Technology, extensive cavitation experiments were carried out in order to investigate the mechanisms behind the formation of potentially erosive cavitation. Many of the experiments were designed to generate different particular types of cavitation and to study their behaviour, whereas other experiments were used to identify the existence and development of different types of cavitation. The focus has been on examining different behaviours that might appear, and try to understand why and how they can be erosive.

## Complex micro-scale processes

Cavitation damage is ultimately caused by complex physical micro-scale processes resulting in high pressure pulses, velocities and temperatures in the fluid. This will cause highly localised transient surface stress in the body material if the cavity collapses close enough to the body surface. The micro-scale processes are usually extremely rapid and very difficult to observe. The focus in the PhD project has been on processes of observable scale controlling the initial conditions for the micro-scale events.

## Coupling large scale to micro scale hydrodynamics

Having early large-scale hydrodynamics related to subsequent erosive processes enables the identification of the importance of global parameters for the cavitation development, which can be useful knowledge at the design stage,during the experimental assessment of cavitation and during the analysis of CFD simulations of cavitation. The approach to and concept of relating large-scale hydrodynamics to the micro-scale, combined with a consideration of energy focusing during the cavity collapse, was developed as a tool for the analysis of high-speed video recordings of cavitation observations in the Erocav project. The concept, presented in the Erocav handbook, has been used and developed further in later EC projects (Virtue and HTA).

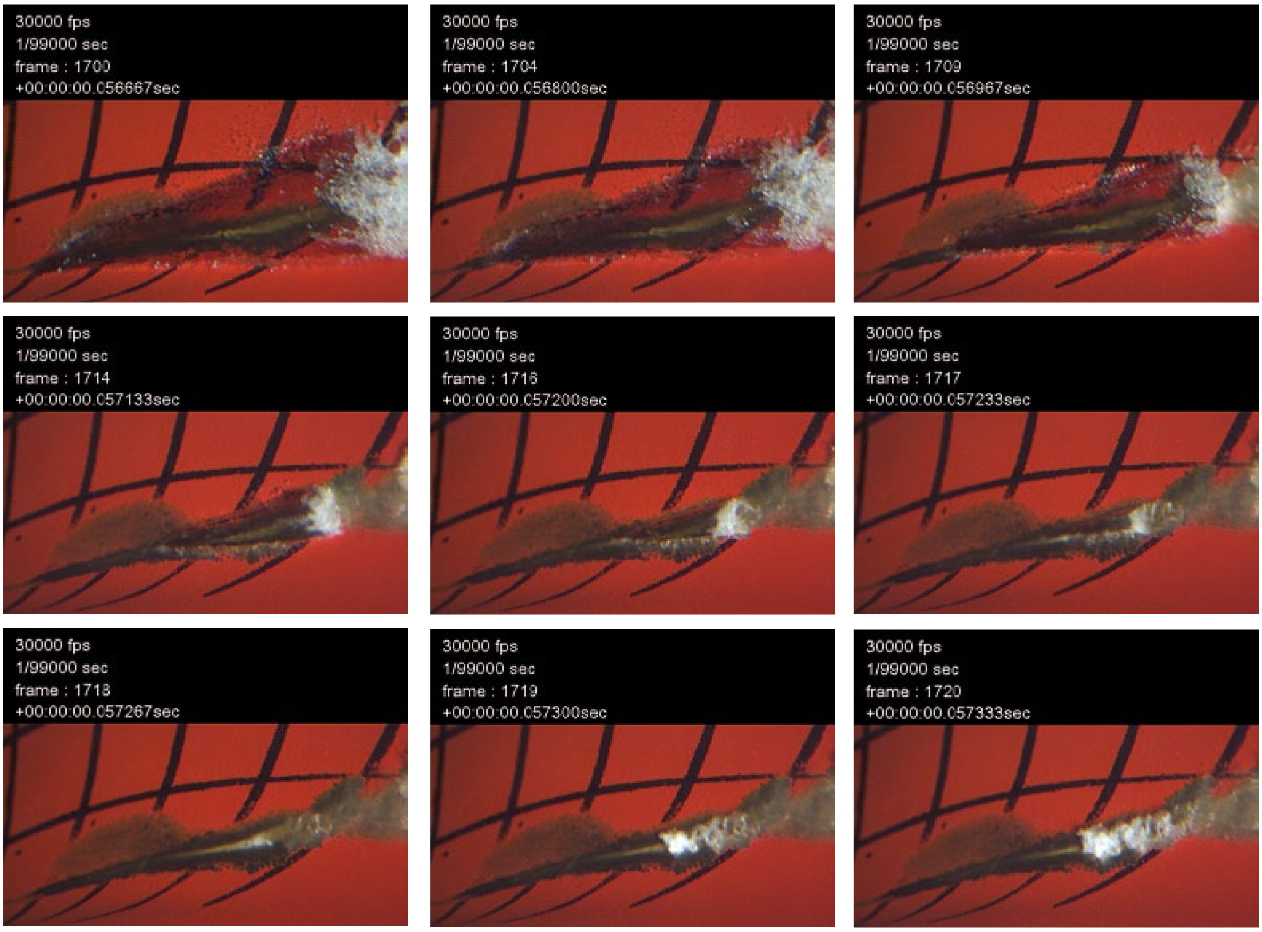
## Selecting tools for experimental assessment of cavitation

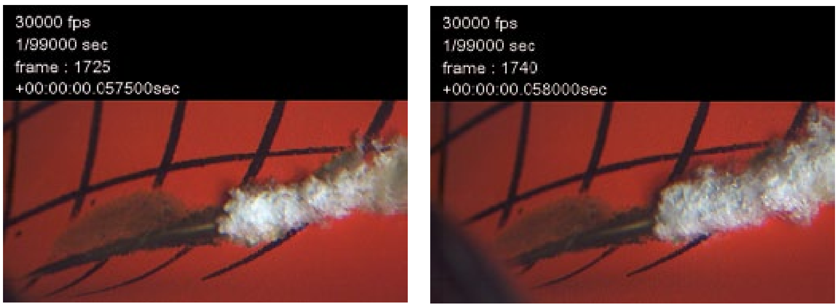
Experimental cavitation assessment normally involves judging the risk of erosion as regards the corresponding full-scale device as well as a statement of possible underlying physical causes, which can be a difficult task. One of the main problems when analysing cavitation is the wide span of the spatial and time resolution that needs to be covered to reveal important properties to understand why and how a potentially erosive cavitation collapse develops. Standard video recordings using stroboscopic lighting and noise measurement can be very effective tools to cover long time statistics and the largest scales of cavitation.

## The need for extreme frame rates and optics…

However, when it comes to understanding the continuous development of a particular cavitation behaviour during its collapse, one may need extreme frame rates and optics to resolve the motion of the most violent collapses. As an example, it can be mentioned that a frame rate of 90 000 fps (frames per second) can be insufficient to resolve the late stage of a violent cavitation collapse, the collapse motion is simply too fast and also too small.

*One of the set-ups used in the cavitation tunnel at SSPA Sweden AB to investigate mechanisms behind the formation of potentially erosive cavitation. The upstream foil, to the right, oscillates and generates gusts on the stationary downstream foil to generate transient cavitation. Transducers for acoustic measurements are installed in the support seen in front on the foils.*






*Images from a high-speed video showing the collapse of a very erosive mixed glassy and cloudy cavity at the blade root of a propeller blade. There is erosion even in the bronze on the propeller model. The energy focused at the collapse of the glassy sheet (frame 1700–1717) is cascaded to the cloudy part, which is forced into a very violent collapse. An extensive rebound, as is seen here, is an important sign to look for when performing cavitation erosion assessments.*

From noise measurements, it was seen that, for the most violent cavitation collapses, a noise measurement system having a rise time less than 0.5 μs and a sampling rate of 5 MHz is not fast enough to measure the real pressure pulse generated at the cavitation collapse. Even though the real shape of such a pressure pulse cannot be resolved, noise measurements can be very useful in revealing the focusing in time of the collapse, which is an important parameter when judging the risk of erosion.

## … and standard video

Even though a high-speed video recording with a frame rate of 90 000 fps may be unable to resolve important dynamics of a collapse, a standard video recording (30 fps) can be very useful for analysing the statistical properties. This may seem contradictory but the fact is that the information obtained by means of both these techniques does not overlap; they are complementary to each other, providing different pieces of information for an analysis according to the approach in the Erocav handbook. Complementing visual observations with, for example, noise measurements and erosion tests by SSPA's standard paint coating method increases the certainty of the cavitation assessment and increases the knowledge of the particular cavitation process. Since the available tools gives different pieces of information, it is important to make a selection of tools based on the requirements and circumstances for each particular case.

*Mikael Grekula*

# Oil in Ice – a challenge in oil spill response?

Jim Sandkvist, Lic. Eng., Vice President, SSPA Maritime Operations. He graduated from Lund University of Technology, Civil Engineering, in 1975 and was then employed as a research engineer, dealing with arctic engineering at Luleå University of Technology, where he also presented his thesis focusing on accelerated ice growth in ship channels. Since 1984 he has been employed at SSPA, working primarily in the marine environment field.
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Björn Forsman, Senior Project Manager, M.Sc. Mech. Eng. From 1980, when he joined SSPA, Mr. Forsman has been active in areas related to marine environment, oil spill prevention and spill clean-up. For the last ten years, maritime safety and risk analysis have also become important fields of expertise in his projects as well as in the research projects that he is engaged in. He has also been programme manager for a number of advanced international training programmes.
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**Within the last few years, SSPA has seen an increase in activities in the Arctic areas, and, along with this, come new risks and new challenges. Much focus is put on the risk of oil spills and the potential problems these may cause in cold climates, especially since the environment in the Arctic is highly vulnerable and, to a great extent, unexploited. Even though the risk of oil spills is minimised, we still have to deal with the consequences if it happens**.

The oil blowout accident from the Deepwater Horizon rig in the Mexican Gulf has put considerably more focus on safety and the environmental risks associated with all offshore activities. This accident further emphasises the importance of minimising risks and showing that there are effective response organisations and plans for all planned and forthcoming exploration operations.

## Ice Management

Oil spills in ice and cold climates are completely different from spill situations in thermal waters. The presence of often drifting pack ice in high concentrations and low temperatures rule out ordinary spill response strategies and techniques. Oil booms are hindered by pack ice; the oil may be frozen and captured in growing ice or spread below a solid ice sheet. The ice conditions more or less fully dominate the situation. Still, all parts of the well established operational and logistical strategies for handling oil spills in water must be fulfilled including detection, control, recovery, storage and destruction of recovered oil.

The key factor in all winter spill operations in the Arctic, and also in the Baltic Sea, is the requisite access to capable transport and operational resources. Oil spill recovery operations in ice require effective ice management resources and you must be able to reach the spill site! It is, therefore, strongly recommended that a well-prepared spill contingency plan is fully integrated in the ice management plan set up for a drill site operation or in other remote arctic operations. Powerful, modern ice breakers also operate as supply vessels, providing storage capacity for equipment and recovered oil. Emergency plans are implemented by professional and trained crew onboard. As described in previous SSPA Highlights, SSPA is very active in this area, providing decision support tools for the offshore and oil industries.

## The ice – exercises, experiences and the need for know how

SSPA has been active since the 1980s in the field of oil in ice. SSPA's experts actively participated in the European Union funded SPREEX, Spill Response Experience, with a special focus on the need for developing of winter spill response methods and techniques. This Concerted Action finalised its work during 2009. Today, SSPA can provide a wide range of expertise in marine pollution and can offer risk analyses, training courses and operational advice.

In April this year SSPA took part in a workshop and exercise on oil in ice arranged by the Swedish Civil Contingencies Agency (MSB) in cooperation with the Swedish Coast Guard. The focus was on near-shore oil contamination and SSPA provided lectures on available techniques and presented a new updated manual on shoreline clean-up, including recommendations and methods applicable in winter conditions. About 40 officials and employee from various organisations attended the workshop and took part in the field demonstrations and exercises in the 60 cm thick ice outside Umeå on the Baltic coast of northern Sweden.

## The ice demands advanced strategies and methods

The total number of oil spills per year has declined drastically over the last thirty years, but nonetheless serious accidents are still a common reality that which can happen at any time. In fact, most large oil spills have not occurred in icy conditions, as yet. This makes the actual experience of responding to oil in ice rather limited, and only relatively small spills can be referred to as good

PHOTO: VAN HOOKER V AND G PHOTOGALLERIES

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examples of how to handle oil in ice. However, known winter spills clearly emphasise the need for winterised response strategies and methodologies to be developed.

The oil recovery equipment available in almost every modern spill response organisation is basically designed for open water use and only a few pieces of equipment are considered to be effective in ice conditions. Thus, more designated winter equipment and training are needed in order to be able to handle spills with the presence of ice.

## Oil in Ice Code

In order to design an effective spill response organisation, the main design criteria must be defined and operational conditions identified. SSPA has set up an Oil in Ice Code. This code is a decision backing support system that systematically structures expected ice conditions, concentrations, thermal regimes, spill types, the logistical resources available, expected weather conditions and the expected oil types to be handled. In accordance with regional conditions, statistics and other input, the response team will be prepared with efficient tools and strategies. It is recommended that the code approach becomes an integral part of operational planning, also based on ICE MASTER support, see Highlights 47/2009.

## The icy water and dispersants

The latest developments regarding oil spill responses in ice conditions have mainly been related to the use of dispersants in cold climates. While dispersants were previously seen as inefficient and hence not to be recommended in icy conditions, recent tests have shown that new products can actually also work in cold climates and, to some extent, also in brackish waters, such as, for example, the Baltic Sea. For instance, it has been shown that one can use the propeller water from vessels to mix the dispersant into the mix of oil and ice, which increases the effectiveness of the dispersant.

Oil in ice may well also remain a challenge for those responding to oil spills in the future. Depending on how the development of oil drilling in the Arctic continues, the issue could also become much bigger than it is today. As the Arctic ice diminishes in size, the seaborne traffic in the Arctic will increase, and inevitably so will oil spills. It is, therefore, important to establish not only methods and techniques for oil spill responses in cold climates, but also to secure a well planned contingency for future accidents, which also involves training and building up an organisation.

*Jim Sandkvist*
*Björn Forsman*
*Edvard Molitor*

### Oil in Ice Code

**F / C / T / D**

iceform / concentration / temperature / dynamics

**F – iceform, -type**

| | | | |
|---|---|---|---|
| 0 | = ice free water | | |
| 1 | = slush | < | 2 cm |
| 2 | = small brash | < | 40 cm |
| 3 | = brash | < | 2 m |
| 4 | = bigger pieces | < | 6 m |
| 5 | = floes | ≥ | 6 m |
| 6 | = large floes / pack ice | | |

**C – concentration**

0 = no ice
1 ≤ 1/10 concentration
2 ≤ 2/10
3 ≤ 3/10
4 ≤ 4/10
5 ≤ 5/10
6 ≤ 6/10
7 ≤ 7/10
8 ≤ 8/10
9 ≤ 9/10
10 > 9/10, incl. ridges

**T – temperature:**

– = freezing
0 = close to 0°C
+ = melting

**D – Dynamics**

0 = calm
1 = oil and ice drift
2 = severe movement, ridging, waves

SSPA has set up an Oil in Ice Code.

*One spectacular field experiment was conducted in sea ice outside Gävle, where blasting techniques were used to create a hole in ice to facilitate the recovery of oil trapped under level ice. Blasting is a quick method but conventional hole cutting using a chain saw creates smoother edges and an ice free surface with more favourable conditions for mechanical recovery.*
PHOTO: JIM SANDKVIST


*In April this year SSPA took part in a workshop and exercise on oil in ice. The focus was on near-shore oil contamination and SSPA provided lectures on available techniques and presented a new updated manual on shoreline clean-up, including recommendations and methods applicable in winter conditions.*
PHOTO: BJÖRN FORSMAN

# Short comments

## Unique ship prototype named in Gothenburg

On the 30th of March, what is nowadays an unusual event occurred – the naming of a new Gothenburg built ship, "STENA AIRMAX". The latest such event was in 1989, when the ODEN polar icebreaker was delivered by Götaverken, marking the end of the Swedish shipbuilding era.

Ship owner Stena Bulk took delivery of a very modest vessel with only a 35 tonnes displacement, built by the consultancy company SSPA Sweden AB.

So, what is the purpose?

As is so often the case today, it is about CUTTING FUEL COSTS.

For years, the Technical department of Stena Rederi AB has looked into fuel saving devices, among them hull friction reduction, applying non-polluting air "lubrication". The Air Cavity concept has been investigated in applications for various types of hull, the most recent of which was a product tanker similar to Stena's P-MAX concept (10 ships owned by Concordia Maritime). Hull friction – which is by and large proportional to fuel oil consumption - is the dominating part of the hull resistance for such a vessel.

Model testing of the Air Cavity concept, an air filled recess in the flat bottom of the hull, has been going on at SSPA's facilities for some years. The results have mainly been promising. But, ordering a 180 m product carrier with an Air Cavity is risky, as the application is new. It was, therefore, desirable to confirm the power reductions achieved in the laboratory by means of a large scale test platform; and also to understand how the vessel behaves on cushion and how the air system will be controlled in various environmental conditions. It would also be desirable to know whether the scaling laws hold.

Accordingly, a 1:12 scale outdoor demonstrator model was constructed, built and instrumented by SSPA. In April, a test program commenced in the Gullmaren Fjord on the Swedish west coast. At the date of writing, the intact hull (without air chamber) is run for reference at ballast and laden conditions.


The outcome is astonishingly good for an outdoor test and all equipment work properly. Propeller load is measured by combined thrust and torque hub dynamometers, speed over ground by GPS, wave data (height, period, direction) by a wave buoy, current by a float with GPS position, wind speed and direction by anemometer onboard; air and water temperatures, air pressure and water density are intermittently measured. Thus the data collected can be thoroughly analysed and corrected to standard conditions for performance prediction.

The investigation program for the summer consists of establishing the power gain on cushion, optimum operation of the vessel in this respect, cushion effects on maneuvering and stability, how the cushion functions in a seaway, etc.

*Lars Gustafsson*

## FSA dangerous goods transport with open-top containerships

A high-level formal safety assessment (FSA) of the transport of dangerous goods with open-top containerships, which SSPA helped prepare, was submitted to the Maritime Safety Committee of the International Maritime Organization for consideration at the May 2010 session (MSC 87). This FSA was conducted as part of the EU Project SAFEDOR. SSPA was the lead partner for the risk assessment step of the FSA and also contributed towards the hazard identification and the cost-efficiency assessment of risk control options. The study focused on assessing the risk of transporting packaged dangerous goods classified for "on-deck stowage only" in the holds of open-top containerships, and comparing it to transport on deck of conventional containerships.

*Joanne Ellis*

## SSPA assists Gotland in port development

In the summer, the Island of Gotland is one of the most visited areas in Sweden, attracting tourists from all over the world, many of them as passengers on visiting Cruise Liners. Due to the lack of on-shore mooring facilities matching the size of modern Cruise vessels, the number of calls has however started to decrease over the last 3–5 years. In order to address this reduction in calls, a project has been initiated for the construction of new facilities for hosting even the largest vessels. As part of this project, SSPA has been contracted to provide a variety of consultancy services, ranging from initial design to manoeuvring simulations and risk identification. The EIA study that is required by law has recently been started and will hopefully continue onto in physical construction and building within a year or two.

*Karl-Johan Raggl*

## Conference on Ship Drag Reduction

On May 20–21, the International Conference on Ship Drag Reduction (SMOOTH-Ships) was held in Istanbul, hosted by Istanbul Technical University. SSPA was represented by Mr. Leer-Andersen and Mr. Allenström. Mr. Leer-Andersen presented results obtained within the EU research project SMOOTH, specifically results on Air Cavity Ships and microbubbles, both with the aim of reducing skin friction resistance. The conference was organised by the SMOOTH consortium, but several other researchers in the field of Air Lubricated Hulls attended and presented many interesting papers. The EU project SMOOTH is still ongoing, but will come to a conclusion at the end of this year.

All papers presented at the conference are available at http://www.smooth-ships.itu.edu.tr/conference_programme.htm

*Michael Leer-Andersen*

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