



HIGHLIGHTS

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PHOTO: ANDERS LARSSON/GÖTEBORG UNIVERSITY

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Some months have passed since the terrible Tsunami hit the Southeast of Asia and the world is still counting the losses. For those of you who are affected by the disaster I would like to express my deepest sorrow and to offer heartfelt condolences.

Natural forces cannot be controlled but still we want to make a difference. The Tsunami disaster has made our experts in the field of Sustainable Coastal development, Disaster Preparedness Management, Risk Management in Community development Planning and Maritime Safety Management even more motivated to continue their work.

This edition of Highlights, planned before the catastrophe in Asia reflects other activities at SSPA originating from our core competences hydrodynamics and hydroacoustics. The applied services are on a regular basis used in design, development and operation of maritime vehicles. Please feel free to contact the authors if you are interested in further information.

Susanne Abrahamsson

Noise comfort

Every problem in noise and vibration control consists of three basic elements: a source, a transmission path and a receiver. These three elements do not necessarily act independently. To understand a complex noise problem successfully a comprehensive view in combination with expert knowledge is therefore necessary.

In a new building project it is important to provide the project team with information at an early project stage. Determining critical areas of the design and recommending economically and technically beneficial solutions is an essential role in that work.

Noise sources

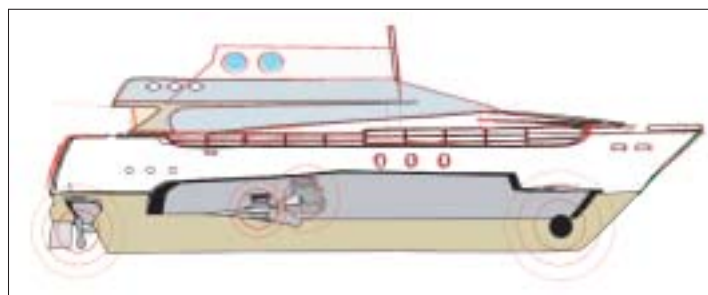
Propulsion, machinery and transmission systems are the major sources of noise and vibrations onboard a ship. Due to demands on efficiency, robustness, speed and manoeuvrability amongst others, the choice of propulsion system in combination with hull design is a primary issue.

HVAC (heating ventilation and air conditioning) system with fans, inlets and outlets together with pumps and hydraulic equipments are sources to be taken care of especially for passenger ships and yachts where high noise comfort is required. Efficient exhaust silencers are important to keep the outdoor noise low.

During the later years the class societies have introduced noise comfort rules intended to benefit both ship operators and passengers. The rules are principally concerned with passenger ships, high speed craft and yachts. There are slight differences between the class societies concerning noise comfort rules. However noise comfort much better than stipulated by the may be better known IMO recommendations for merchant ships are achieved by utilizing these rules. The specified noise level in cruising conditions at highest comfort class in a passenger top grade cabin is 45 dB(A) and in harbour mode the lowest specified noise level is 35 dB(A).

Vibrations

Manufacturers of machinery and gearboxes are providing data of vibration and noise levels. These levels are often measured under conditions that are not the same as in the final location in the machinery room. For instance, a gearbox is most often measured during a spin-up test placed up on a fundament that most likely has widely different dynamic properties than its fundament onboard



*P*imento provides multichannel data acquisition and powerful signal processing and analysis functions.

the ship. Vibration measurements of the equipment mounted onboard a ship with a similar design is often more useful. So a probable vibration level is often worth more than a guarantee that the manufacturer can't fulfil at the end at the SAT (Site Acceptance Test) when the equipment is mounted onboard.

The vibration levels are specified in standards for frequencies from 1 Hz up to 100 Hz. These vibrations affect big areas of the ship and the lowest frequencies more or less the entire ship. Vibration requirements in merchant ships are stated in ISO 6954:2000 which replaces the first edition ISO 6954:1984. Besides the class societies are providing recommended vibration levels to achieve high noise comfort.

Propulsion

Ship vibrations caused by propulsion mainly originate from pressure pulses and noise from the propeller that act on the hull or are transmitted by paths such as the shaft in to the hull. For a modern vessel with increasing speed and engine power output there is a lot of interest in propeller design, usually of the high-skew type combined with unloaded tip and a good propeller tip clearance to the hull. The noise signal generated by a propulsion unit consists of two types of noise: broadband noise and tonal noise. The former consists of random pressure pulses whereas the latter consists of periodic pressure pulses. The following phenomena can be found responsible for generation of propulsion noises onboard:

*I*n all power-driven vessels, no matter what type or style, the machinery, the gearbox, the shaft system and the propulsion are the major sources of noise. Each and everyone requires special efforts to be toned down. Also the bow thruster is a source of high noise levels but on the other hand it is normally used only during short periods of time.



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- Cavitation induced tonal noise at harmonics of the propeller blade frequency
- The non-uniform wake in front of the propeller which causes tonal noise
- Cavitation induced broadband noise
- Additional noise sources for waterjet propulsion is the rotor-stator interaction that gives rise to tonal noise at certain blade frequency harmonics

Vibration reduction

Solutions as additional stiffeners at the hull sheet in the area above the propeller or a dynamic stiffer machinery foundation with low mobility might reduce the vibrations. Our experience is that even if the solution seems simple the way to figure it out sometimes is complex.

To solve a ship vibration problem a careful study including

- vibration measurements
- dynamic structure analysis of hull and machinery foundation
- and a hydrodynamic analysis

is the most time and cost efficient way.

To achieve low propulsion induced vibration levels, hull shape, propeller tip clearance and blade design should be considered. Modifications of the blades and changes of the wake ahead of the propeller can be sufficient. Otherwise a complete redesign of the propeller might be necessary to solve the vibration problem. To avoid problems like that a successful noise design must necessarily be undertaken in the early project stage.

Magnus Källman

EIA (Environment Impact Assessment) for two proposed fairway projects in the Stockholm archipelago were carried out by SSPA.

Noise measurements showed that modern ferries equipped with efficient silencers have low noise emission. Noise levels of ships without or with poor silencers were up to 15 dB higher and these vessels were in great extent annoying to people living by the fairway. Tynningö, October 2001.



Noise reducing measures

In the following table examples of noise reducing measures are presented.

Noise reducing measures at the source

Source	Type of noise reducing measure
Propulsion	Low-noise design, propeller with low pressure pulses.
Main machinery	Resilient mounting, dynamic stiff machinery foundation and efficient silencer.
Auxiliary machinery	Resilient mounting, dynamic stiff machinery foundation and efficient silencer. Acoustic enclosure might be necessary.
Gearbox and transmission	Low-noise gearbox, resilient mounting and dynamic stiff foundation.
Hydraulics and piping	Low-noise components and resilient mounting of equipment and piping.
Pumps	Low noise components and resilient mounting.
HVAC (Heating, Ventilation and Air Conditioning)	Low-noise components, low air flow speed and resilient mounting of equipment. Absorption silencers where appropriate.

Reducing measures in the accommodation

Component	Type of noise reducing measure
Floor	Floating floors and viscoelastic deck covering system.
Bulkheads	High sound reduction panels/elements.
Ceiling	Perforated ceilings. High sound reduction panels/elements.
Windows	Low-noise laminated windows or inner windows.

Frictional effects from bio-fouling and coatings



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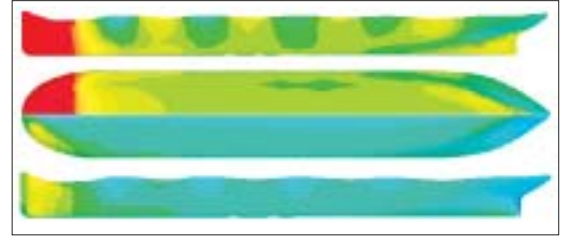
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Viscous resistance is the main resistance component for most types of ships, ranging from about 50 percent of the total resistance for high-speed craft to 90 percent for slow displacement ships such as tankers. The significant part of the viscous resistance is the skin friction and to add to the misery, skin friction is difficult to decrease by modifying hull shape as the most important factors are wetted surface area and speed.

Therefore "to decrease frictional resistance" the only remaining viable option for an optimised hull shape (except more specialised ships such as hover craft or SES) is to modify the surface itself. A hydraulically smooth surface is a surface which roughness is so small that no further smoothing of the surface will benefit a frictional decrease. But - almost no commercial or military ships, even when newly built, have a hydraulically smooth surface. The roughness of the steel plates and the roughness of the coating itself are too high, for which reason a roughness allowance must be added to predict the total resistance. Fouling and damage to the coating will further increase the roughness allowance with time. Therefore, it is important to know how large effect the roughness has on frictional resistance. To be able to investigate this SSPA has devised different methods, both experimental and computational.

Evaluating methods

Skin friction on surfaces typically encountered on hull surfaces, can be evaluated using several methods. The simplest method would be to use empirical relations linking the surface geometry to the skin friction, using one or several parameters, as for example equivalent sand roughness. The drawback of this approach is that poor accuracy can be the result, if the rough surface does not have a surface geometrically similar to measurements which the empirical model is based upon. CFD (Computational Fluid Dynamics) computations are also a



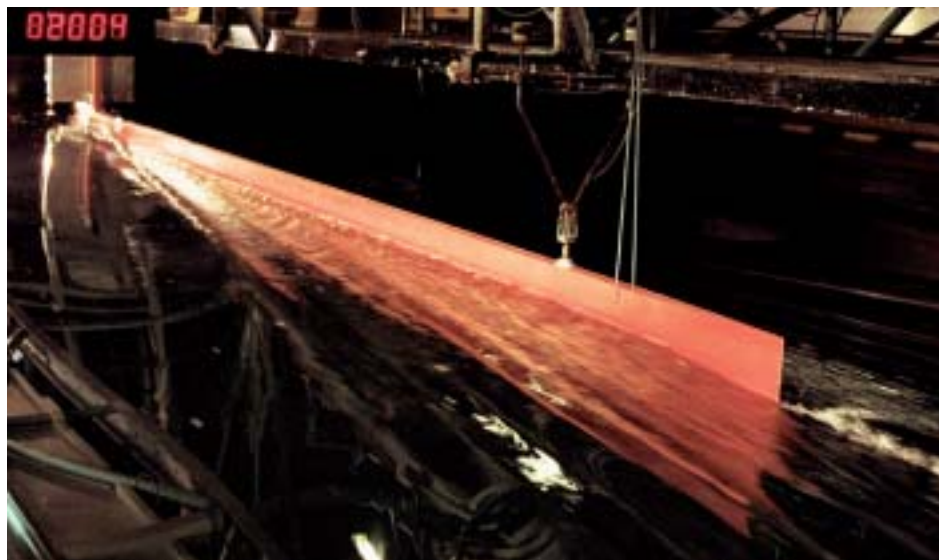
Example of full scale computation of the frictional resistance on the Dyne tanker for a barnacle surface (top) and hydraulically smooth surface (bottom). Red contour is the highest frictional coefficient decreasing towards blue.

possibility, but is a difficult venue as the roughness more often than not must be considered irregular in shape.

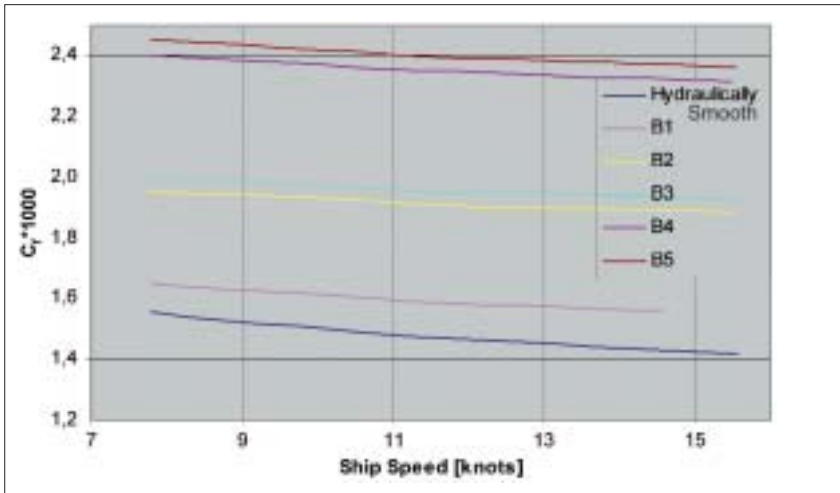
Measurements are the final option. Several methods can be used, such as Pipe flow, Flat plate flow, Cavitation tank or Couette cell measurements. The first 3 methods have been designed, built and tested at SSPA in recent years, each with their unique advantages and disadvantages. The Pipe flow device has been used for measuring friction coefficients for a number of different bio-fouled surfaces, more specifically barnacles of different sizes and densities, whereas the plate has been utilized for surfaces with smaller added frictional resistance, such as newly applied coatings requiring a higher accuracy of measurement. Cavitation tank measurements will not be covered further.

Pipe Flow

For surfaces with a large increase in friction coefficient, the pipe measurement device is sufficiently accurate. The principle is simple. Water is forced through a pipe with a known flow rate, coated or bio-fouled on the inside, and the pressure drop due to the friction on the inside of the pipe is used to obtain the friction coefficient.



The SSPA Flat Plate flow measurement device in the towing tank. The plate is 1m deep and 6m long, and is as thin as practical to keep the wave resistance as low as possible.

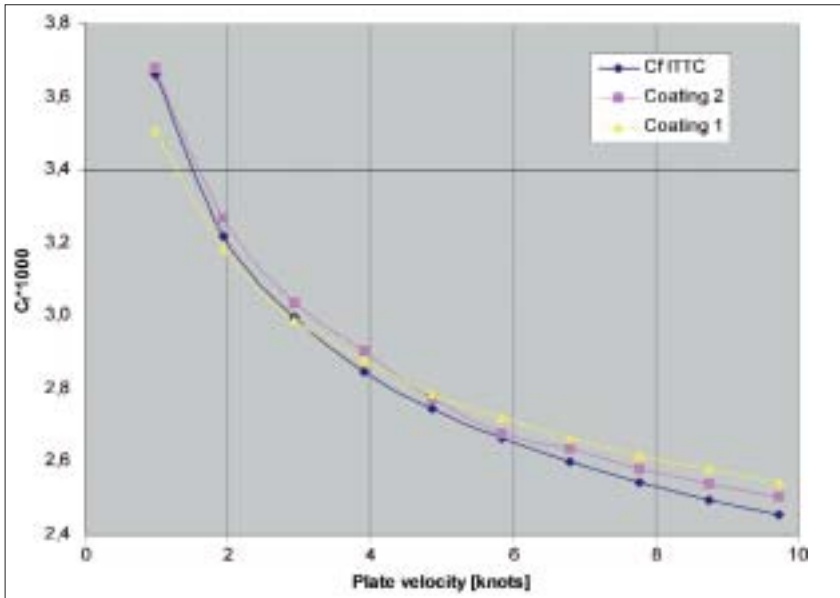


Pipe flow measurements converted to full-scale flow over a tanker for different barnacle surfaces ranging from a badly cleaned barnacle covered surface with a roughness height of approximately 4 mm. The lowest line is the hydraulically smooth surface.

Plate Flow

Comparing two different newly applied coatings requires high accuracy as the difference must be expected to be quite small. Therefore, the SSPA Flat plate flow measurement device is used for those kinds of measurements in the towing tank.

As an example a comparison of the frictional resistance for two similar self-polishing coatings, applied under different conditions, is shown in the figure below. Both coatings are from market leading manufacturers and



Example of friction measurement on two coatings. Residual resistance based on measurements on hydraulically smooth plate has been deducted from the measured total resistance.

were applied to the plate by the manufacturers themselves.

The roughness height of the coatings was measured using a BMT roughness measurement device, and the result was 76µm to 33µm for the first and second coating respectively. The higher velocities in the measurement clearly indicate a correct behaviour of the measurements



Pipe friction measurement device for surfaces with expected high increase in friction.

and also detect a clear difference in friction coefficient, consistent with the difference in roughness. For a full scale tanker the difference in resistance between the two coatings will be approximately 1 percent, which is not a trivial difference.

From measurements to full scale

Increase in friction due to rough surfaces also changes the boundary layer near the hull surface by decreasing the flow velocity compared to a hydraulically smooth surface. This is known as the velocity shift, and can be utilized in connection with the measurements to simulate the local skin friction on a hull surface using CFD. Having obtained the local full-scale friction, it is a small matter to extract the total skin friction of the ship due to the experimentally measured surface.

Each surface is described using an average roughness height and an efficiency number which are experimentally obtained. Using this approach it is possible to scale the roughness for geometrically similar surfaces.

Benefits

Knowing the frictional effects of common surfaces on hulls offers a number of possibilities: Better estimate of roughness allowance for full-scale prediction of total resistance, monitoring of the hull surface as a decision tool for timing of cleaning or recoating for resistance reasons, or finally as a tool to decide the economical advantage/disadvantage of using a better but more expensive coating.

Michael Leer-Andersen
Henrik Andreasson

SSPA OnBoard



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Bad weather conditions on the North Sea are most appreciated as they provide very valuable test results. Evaluation and improvement of the ShipMafe code is currently carried out through an installation onboard the Tor Line vessel Magnolia.

PICTURE: LARS-OLOF ALBERT

Introducing the new business concept *SSPA OnBoard*, SSPA is offering a number of services which will increase safety, save fuel, predict travel time, assist in emergency situations etc. These services are mainly based on SSPA's knowledge and competence within manoeuvring and seakeeping combined with a long experience in advanced calculation, simulation and modelling.

Whether the presence onboard is in the form of personal appearance, e.g. for performance and analysis at sea trials, or in the form of advanced technical systems, it is primarily a concept where services are delivered to the end user in a more refined form. Although it includes services based on analysis and investigations of a ship, its cargo and/or a route, it is resulting user friendly in e.g. a wheelhouse poster, lashing guides or a set of operational windows, all normally delivered as reports or manuals also available in electronic format. Other delivered services are software components, containing dynamic control made available by implementation in existing onboard systems that are normally used in daily operations.

SSPA OnBoard has grown from SSPA's involvement in research activities, covering a wide range of operational applications. The following short summaries are examples of OnBoard services, having their origin in such activities, some still in the development phase and others fully commercialised. They are all examples of functions, suitable as additional features in existing manoeuvring aid equipment. Hidden behind are parts of SSPA's manoeuvring and seakeeping algorithms wrapped into software components.

SSPA HdP

The SSPA HdP (Hydrodynamic Predictor) is a software component which predicts the ship's behaviour manoeuv-

ringwise up to a few minutes ahead in time. The component is designed for implementation in integrated bridge systems and preferably as a function on the electronic chart display. The SSPA HdP is different from most other more common prediction functions due to its more advanced algorithms and use of larger amounts of dynamic sensor data. The predictions are based on a simulation model of the ship where sensor data taken into account includes steering and propulsion parameters, wind and depth, ship particulars and information from the GPS representing position, speed and heading.

Easy to use

The SSPA HdP is a very useful aid in most manoeuvring situations. It will not only increase the level of safety, but also increase accuracy as well as save both fuel and time in e.g. berthing and unberthing operations. Existing installations do all have the HdP implemented as a feature on the electronic chart display unit, where the presentation of the actual as well as future predicted positions are visualised as ship contours, enabling the user to get a clear picture of coming positions of the own ship in relation to other objects in the vicinity.

ShipMafe

ShipMafe (Ship Motion and Fuel Economy) is developed from SSPA's main seakeeping and manoeuvring program SeamanII with a design for more general purposes.

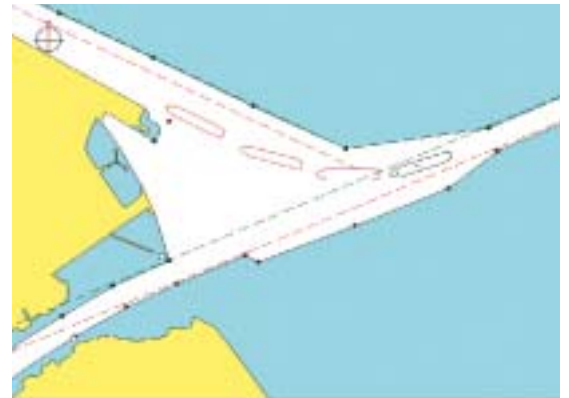
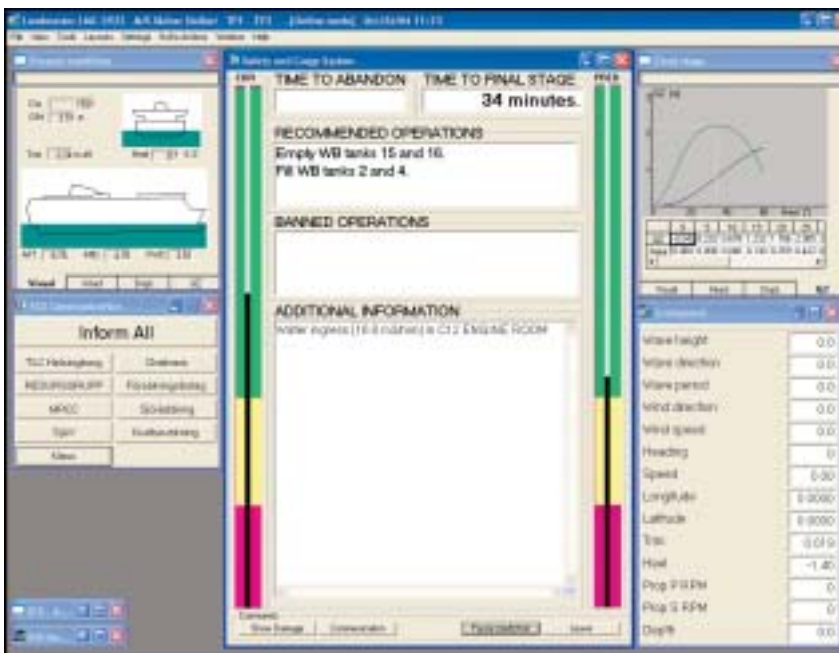
The first application in which the ShipMafe code was used was within the EU funded research project Wings for Ships, where the ShipMafe code represented an important part of a weather routing system, carrying out predictions of travel time, motions and accelerations, fuel consumption and even sea sickness probability. The large





An example of an SSPA OnBoard service is the Graphical Conning Display. The picture shows a customised Conning, installed onboard the Swedish Coast Guard vessel 202. The design is a result of a close cooperation between SSPA and the Client.

A screen dump of some of the graphical interfaces available in the SCS system. The system provides the operator with information and recommended actions. The picture is taken onboard the Scandlines passenger ferry "Skåne".



Predicted positions presented as ship contours increase the user ability to identify and avoid hazardous situations well in advance.

amount of variables calculated inside ShipMafe is easily accessed by a host system. ShipMafe can increase the quality of the service due to a very flexible design of the software interface, which therefore opens up to further implementation into host systems representing a wide range of applications.

SCS

SCS (Safety & Cargo System) has been jointly developed by SSPA and Kockum Sonics, initially started as a research project in 2003. SCS is an active safety system that responds to water entering the vessel by automatically calculating the vessel's stability and predicting its condition at various intervals and above all, the vessel's final condition. The basic seakeeping and manoeuvring algorithms used in the SCS system are built on the SSPA ShipMafe code. The system includes a number of functions, including:

- Constant monitoring of fluid levels in all relevant spaces, including tanks and void spaces.
- On line calculation of the vessel's dynamic stability.
- Prediction of intactness and damage stability in case of accidents or incidents.
- An advisory tool that can be used for improving and optimising normal operation as well as assistance in emergency situations
- Automatic transmission of the vessel's current condition to land-based organisation.

A prototype version of the system is installed on the Scandlines passenger ferry Skåne, travelling between Trelleborg, Sweden and Rostock, Germany. A final version of the system is planned to be fully operational in mid 2005.

A Decision Support Tool will in the near future be implemented into the SCS system. The ShipMafe program will continuously simulate a number of manoeuvres and instantly warn if any limits are being exceeded as a result.

Karl-Johan Ragg

Washington State Ferries

The new auto-passenger ferries for Washington State Ferries (WSF) have recently been model-tested at SSPA on behalf of Glostren Associates Inc., who acts as coordinator of a consortium working with the development of the ferries. Other members in the consortium are Elliott Bay Design Group and Jensen Maritime Consultants.

The new ferries, which have a capacity of 130 vehicles and 1200 passengers, will replace some of the existing ferries that are over 75 years old.

The new boats will be similar to the Issaquah class, the most reliable, popular and versatile vessels in the fleet. Using the Issaquah class as a base design reduces costs and helps with the goal of standardizing the fleet. As a result, WSF will have greater flexibility in shifting vessels among various routes and rotating vessels for maintenance and preservation work.

New technology and lessons learned from years of operating the Issaquah class are being incorporated into the new vessels. The hull is wider than the Issaquah class vessels, and will prevent fuel spills. The vessel features a closed-loop cooling system, which minimizes risk of water discharges, automatic on/off lighting to reduce use during inactive periods, engine emissions that meet the latest environmental standards, and can run on alternative fuels, including Biodiesel.

The new ferries will be equipped with new safety equipment and systems. The vessels remain stable even with two watertight compartments flooded.

The new vessels have better heating and ventilation, and more internal seating and flexible seating configurations. Other improvements include quieter operations, improved restrooms and wireless Internet.

The ferry is double-ended with conventional propeller propulsion, and is operated with a feathered bow propeller. Since some existing docking areas are located in narrow passages where currents must be considered, manoeuvring properties at docking is an important design element, as well as environmental considerations, such as wave wash restrictions. Extensive tests were carried out with different types of

rudders, in the towing basin, and in the manoeuvring and seakeeping laboratory. CFD calculations have been made to calculate the wash wave far from the vessel. A good agreement with model test measurements was found.

Construction is expected to begin in 2006, with delivery of the first vessel in 2008.

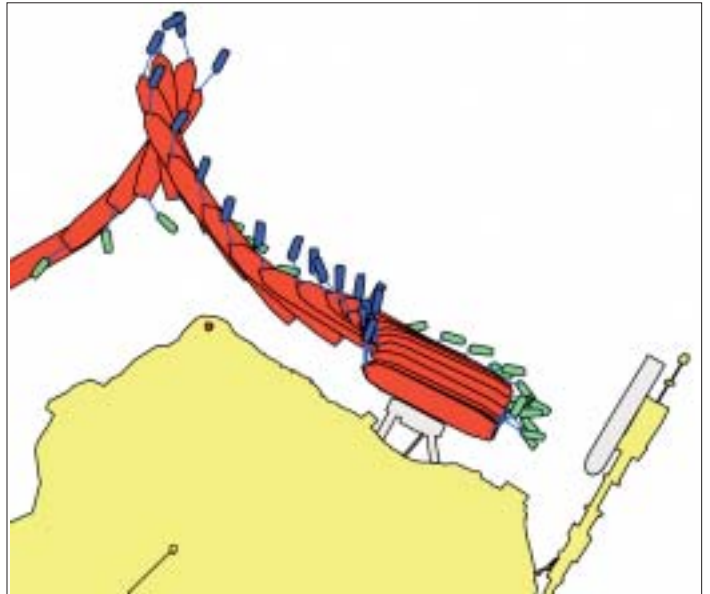
Ted Rosendahl

Coastal disaster management

Coastal areas are very exposed to natural hazards as the recent catastrophe in South East Asia has proven. Since 1992 SSPA has performed international training and education on coastal management and sustainable development in coastal areas. SSPA has also arranged a regional workshop and training programme for Latin America on disaster reduction management focusing on how to mitigate the impact from natural hazards such as hurricanes, earthquakes, tsunamis, and so forth. The most exposed part of society is very often the poor fishing communities. Large parts of coastal areas were wiped out by the tsunami in South East Asia. The coastal fishing communities will need a very long time to recover.

For several years SSPA has been active in risk management and risk reduction in society. This experience combined with our broad knowledge in sustainable coastal development, gives us a good background for our future work on coastal disaster management. There is a worldwide need for training and education in the field of disaster management in coastal areas. SSPA will focus more on coastal disaster management training as a tool in the sustainable development of coastal areas around the world.

Per Danielsson



SSPA helps Preemraff optimise new quay

As a basis for the design of a new quay layout at the Preemraff Lysekil oil refinery in Brofjorden on the Swedish west coast, SSPA has been asked to carry out a simulation study comprising three parts:

- Positioning of the quay
- Mooring arrangement
- Definition of weather restrictions

The introductory study was carried out in order to establish the suggested position of the quay from a manoeuvring point of view. This was done by simulating a 90 m long LPG Carrier into one of the existing quays, taking into consideration the possible disturbances that the new quay may introduce. Manoeuvring of a max size Product Carrier to the new quay was also carried out.

The second part of the study is comprised of suggestions related to the choice of fenders as well as to mooring arrangement, with focus on forces that may occur in different wind and current conditions.

The last part of the study was a real time simulation of different types of ships entering the harbour. This was done in order to establish possible weather limitations for safe entrance.

Peter Ottosson

The picture above shows the entrance of a 40 000 dwt Product Carrier with the assistance from a 60 ton bollard pull Voith Schneider tug and a 65 ton bollard pull tractor tug. The prevailing wind in this case is North 20 m/s.

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