New Zealand Naval Architect

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INSIDE

Project Protector

The Minister of Defence announced in April that the Australian firm Tenix Defence Pty Ltd has been chosen as the preferred tenderer for the Project Protector Patrol Vessels and, subject to clarification of a number of technical issues, also for the Multi Role Vessel (MRV). Damen Schelde ADI was announced as the second preferred tenderer for the MRV only.

The Ministry of Defence has now entered an Offer Definition Process with Tenix to clarify these MRV technical matters, and concurrently a study is being undertaken in conjunction with the Civilian Agencies regarding the number of vessels and fleet mix that is required to meet the overall requirements. Once the Offer Definition Process has been completed and the final decision on the MRV supplier made, and fleet mix analysis has been completed, then the MoD will enter into final contract negotiations with the preferred supplier(s).

Tenix's proposed Multi-Role Vessel. This 8000 tonne displacement design is 131m long x 23.4m beam with diesel propulsion and a max speed of 19 knots. The MRV would have accommodation for a total of 360 personnel, which includes a core ships company of 53, a flight of 10, four government agency officers, a permanent team of 7 Army personnel plus provision for 35 trainees and 250 embarked troops. The MRV is intended to provide a sealift capability for the transport and deployment of equipment, vehicles and personnel and be capable of transferring cargo and personnel ashore when port facilities are not available

At the conclusion of contract negotiations, the Minister of Defence will take a final proposal to Cabinet for approval. Deputy Secretary of

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A Word from the President

Thanks to those of you who made the effort to attend our Annual General Meeting in April at the National Maritime Museum. The board room venue was certainly in keeping with our prestigious image, the formalities were brief and the company excellent. I even received some positive feedback regarding my bartending skills. I believe the fact that we had such a good turnout is an indication of the health of the NZ division (and the fearlessness of the members to being elected onto council).

I am pleased to announce that Brendan Fagan having resisted an impassioned request for new council members has decided to join up and bring his considerable industry experience, not to mention wit, to the running of the NZ division. Martin Hannon is another new addition to council, also bringing experience and

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youthful enthusiasm to the team. Please join me in welcoming Brendan and Martin to the NZ division council.

Our first attempt at a "breakfast briefing" meeting proved to be a great success. To get 18 members to a CBD address before 8.00am, with all the traffic and parking issues was very encouraging. Equally stimulating was the questions, queries and past experiences shared amongst the members, excellently facilitated and answered by James Carne, a partner at Clendon Feeney specialising in contracting issues in the professional services arena.

Looking to the future, Michael Eaglen has held the first planning meeting for the next High Performance Yacht Design conference scheduled for March 2006. On a slightly more immediate timescale we have been invited to contribute to the running of the next Yacht Vision conference which is scheduled for March 2005. Last month I attended a meeting at the Marine Industry Association which brought together interested parties to discuss establishing a "marine month" of activities focussed around the Auckland-on-the-water Boat Show. The concept is to combine the boat show with other marine focussed activities, such as Yacht Vision, dragon boat races, the Auckland Festival etc to create a co-ordinated sequence of exciting and stimulating activities around the downtown and viaduct area. Funds are being sought from the Auckland City Council and NZ Trade & Enterprise to help market the event internationally. I believe that it is important to develop such events that will continue to attract international visitors following the temporary departure of the America's Cup.

By the time this edition reaches your desk the Ministry of Defence should have signed the $500M Project Protector contract with Tenix to build a total of seven new ships for the New Zealand Navy. Hopefully this will provide at least some of our members the opportunity to utilise their marine engineering skills for monetary advantage.

I would like to thank Helen for putting together another excellent issue of the Naval Architect and look forward to seeing you at the next RINA function.

Graeme Finch

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Defence Bruce Green said, "Subject to a successful outcome of the technical discussions and Government approval of the fleet mix, a contract could be signed within the next few months."

Project Protector fleet requirements were outlined in the 2002 *Maritime Forces Review*, conducted by Defence in close cooperation with MFAT, the Ministry of Fisheries, Customs, Treasury, the Maritime Safety Authority, and Police among others. The Project Protector vessels will be built to the standards and specifications required to meet the capabilities identified in the *Maritime Forces Review,* including sealift, coastal and offshore patrol, and at-sea training for the RNZN.

New Zealand's approach to the Protector ships is consistent with other navies. The RAN is acquiring replacement patrol boats that will be designed, built and maintained to commercial standards. The RN is acquiring four Landing Ship Dock Auxiliary (LSDA) and Offshore Patrol Vessels which are being built to Lloyd's Register commercial standards.

Much of the work would be done in NZ, and Tenix Chief Executive Robert Salteri told 'Morning Report' that possibly up to $300 million of the $NZ 500 million project could be spent in NZ. Tenix had subcontracted much of the work on the Anzac frigate project to New Zealand firms and plans to do the same this time.

The Multi Role Vessel (MRV)

Tenix spokesman Liam Bathgate described their proposed MRV as a design based on a commercial Ro-Ro ship in operation in the Irish Sea. The concept is for an 8000-tonne, 131m ship. If Tenix is confirmed for the MRV, Liam

Tenix's proposed 1600 tonne displacement Offshore Patrol Vessel would be 85m long x 14m beam and capable of 22 knots with a range of up to 6,000nm. Accommodation on board for a core complement of 35, a flight of 10, and four government agency officers would be provided. Provision is also made for an additional 30 embarked personnel

Bathgate said they would contract-out building the multi-role ship to Merwede Shipyard in the Netherlands, then it would be sailed to the NZ region under its own power for a final fit-out. Tenix's existing facilities could handle building the ship, but the Dutch yard offered the best option. The Tenix spokesman said it could be delivered 27 months after the contract is signed, "It makes the best use of the facilities available in order to get the ship to the Navy as soon as possible."

The Offshore and Inshore Patrol Vessels (OPV and IPV)

These ships are required to conduct maritime surveillance, in conjunction with maritime air patrol assets, in the New Zealand EEZ, to assist South Pacific Island states to patrol their EEZs, and in the Southern Ocean. The surveillance tasks are primarily non-military in support of civilian agencies.

- **Inshore tasks** - the area from the shoreline to about 24 nautical miles; the total requirement is for about 950 sea days annually. Tasks in the northern half of our EEZ (north of and including the Marlborough Sounds and Tasman Bay) are almost all inshore, with relatively constant levels of activity during the year.

- **Offshore tasks** - to the limit of New Zealand's EEZ, in the South Pacific and in the Southern Ocean for a total of about 420 days annually. Tasks in the southern half of the EEZ are mostly offshore, but activity in the south almost doubles during winter, coinciding with the worst sea states.

The Tenix spokesman explained that the planned Offshore Patrol Vessels are based on a design already in service with the Irish Navy. The Inshore Patrol Vessels will be based on a Tenix-designed Search and Rescue vessel in service with the Philippines

The proposed Inshore Patrol Vessel is 340 tonnes displacement, 55m long x 9m beam and capable of up to 25 knots, with a maximum range of 3000 nm. The ships will have accommodation for a core complement of 20 personnel plus provision for four government agency officers and 12 additional personnel.

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Coast Guard. The Patrol Vessels are proposed to be built at the Tenix yards in Melbourne and Whangarei. The Offshore Patrol Vessels would be built in Melbourne with modules made in Whangarei, where modules were also built for the 10-ship Anzac frigate project. The IPVs could be built and launched at Whangarei.

"We will be using New Zealand companies to the maximum extent possible," Tenix's spokesman said, indicating that the project could create the equivalent of 2000 full-time jobs over about three years

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Waterjets Versus Surface Drives

The designers of modern work and patrol boats have many options to consider when choosing the most effective propulsion system for their vessels. In the high-speed work and patrol boat market, waterjets have become the preferred propulsion choice. However, surface drives are providing strong competition in many sectors, particularly when very high speed is required.

The following compares the Hamilton waterjet system with a generic Surface Drive system over a range of criteria.

Propulsion Explained

Waterjets work by drawing water from beneath the boat's hull and forcing it out behind as a high pressure jet stream to push the boat forward.

Surface drives work in the same way as other propeller systems – a propeller within the body of water beneath the boat creates a "screw" effect to drive the boat forward. However, a surface drive is positioned aft of the vessel in such a way that at higher boat speeds a propeller blade is out of the water for half of each revolution – hence the "surface piercing propeller".

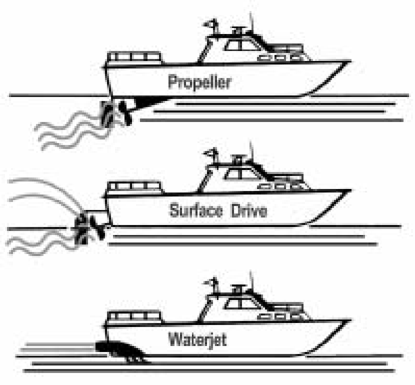

Fig. 1– Three Propulsion Systems

Both waterjets and surface drives have unique characteristics that offer advantages in particular applications…

Waterjet Characteristics

Pump efficiency – waterjet efficiency is equal to or better than propeller systems at high boat speeds, generally over 25 knots.

Single direction pumping – a waterjet unit always pumps in the same direction, whether the boat is going forward, astern or staying stationary. So in many small vessels a gearbox is not required.

Directional jet stream – a waterjet angles the jet stream to steer a boat. Astern mode is achieved by directing the jet stream forward, thus reversing the thrust forces.

Surface Drive Characteristics

Greater propeller efficiency – the surface drive is located aft of the transom so is free of many of the propeller size and efficiency restrictions of conventional propellers, such as vessel draft and blade tip clearance. Also, with only half the surface piercing propeller in the water at a time, half the amount of blade slippage is experienced, giving greater high speed efficiency.

Reduced cavitation effect – a surface piercing propeller begins to cavitate at a much higher speed than a conventional prop. This is due to ventilation – each time a blade enters the water it brings air into the vacuum region to ensure the propeller always operates at atmospheric pressure.

Normally aeration is undesirable, but surface drives are specially designed to operate in this way.

Steering control – some makes of surface drive require rudders for steering control, while with others the whole drive can be angled from side to side. Steering is more responsive with the latter type.

Trim control – propeller submergence can be controlled on some surface drives, to both trim the vessel and control absorbed horsepower, allowing for a flexible payload over a range of displacements.

Project Sizing

Different types of propulsion are sized for a project using quite different methods.

Waterjets are sized based on hull resistance, engine power/RPM and "cavitation margin" – the difference between maximum boat speed and minimum speed at which full power can be applied without risk of cavitation effects (refer Figure 2).

Impeller rating (pitch) is determined from the proposed engine's continuous power and RPM inputs, and will indicate the most appropriate direct-drive waterjet size.

Hull resistance and predicted waterjet thrust are then compared to determine the cavitation margin and expected top speed. If the cavitation margin (which includes a safety margin) is too narrow, a coarser pitched impeller must be used. Usually it is recommended a reduction gearbox is installed to reduce shaft RPM sufficiently to allow for a higher rated impeller.

If desired speed is not going to be achieved then either hull resistance must be reduced or higher powered engines used, generally along with larger waterjets.

Figure 2 shows a typical performance prediction graph for two waterjet options with different impeller ratings. Jet A (coarse impeller and gearbox) gives a slightly lower top speed than Jet B (fine impeller direct drive), but a better cavitation margin. This means Jet A will be more efficient when accelerating and when operating at lower speeds, particularly when heavily laden.

A surface piercing propeller is selected the same way as a conventional propeller – expected boat speed is calculated, then propeller size and pitch is selected to achieve this speed.

Expected speed of the vessel is calculated using a formula such as Crouch's Planing Speed Formula…

$$\textbf{Knots} = \textbf{Constant} \div (\textbf{LB/SHP})^{0.5}$$

Note: Constant depends on hull type and ranges between 150 (average runabouts) and 230 (racing power catamarans).

Propeller size is calculated using…

$$\textbf{Diameter (inches)} = \frac{\textbf{632.7 x SHP}^{0.2}}{\textbf{Shaft RPM}^{0.6}}$$

NB: These calculations make no allowance for propeller slip or blade loading factors.

Figure 3 plots RPM and propeller size for a range of power inputs.

In an example of a 20 tonne fast patrol vessel using twin 1200hp @ 2300rpm engines (plus reduction gearbox), the surface drive propellers will be 30 inches (760mm) in diameter and provide for 48 knots top speed (constant of 190). In comparison, the same vessel fitted with twin HJ391 waterjets

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(390mm impeller diameter) will make 47 knots.

As a rough guide, at 50 knots there is about one knot difference in boat speed between waterjets and surface drives, and the surface piercing propeller diameter will be nearly twice that of the waterjet impeller.

Performance Comparison

Efficiency – surface piercing propellers are more efficient than waterjets at low boat speeds due to reduced cavitation (a problem that affects waterjets at low speed and propellers at high speed). At service speeds above 25 knots waterjets and surface drives offer very similar efficiency.

However, because waterjet size is not based on boat speed, they are more efficient over a wide range of displacements and speeds.

Boat speeds – standard intake design restricts waterjet performance at speeds above about 55 knots. Surface piercing propellers don't have this restriction so are able to achieve speeds above 55 knots. Surface drives are also able to absorb more power at lower RPM than waterjets, which gives them greater acceleration, but will lead to engine overloading problems.

Note: Specialised waterjet intakes can allow for speeds in excess of 55 knots, but at the expense of load carrying ability, cruising efficiency, rough weather performance and reliability. Hamilton waterjets are designed for work and patrol vessels, where the latter performance characteristics are more important than extreme speed.

Engine loading – waterjets are designed to absorb maximum engine power at any boat speed, so engines cannot be overloaded. This results in longer engine life and lower maintenance requirements. Surface drives are sized and pitched for a specific boat speed, so at lower speeds the drive can be made to absorb higher amounts of power than the engine is designed for – overload the engine and reducing engine life.

Load carrying – surface drive performance is limited through propeller pitching and variable craft displacements. Propellers are necessarily pitched to suit a vessel's laden condition (to minimise engine overload) which limits maximum boat speed at reduced displacements.

Engine loading on a waterjet is independent of craft displacement and speed. Therefore, maximum potential boat speed is always available, regardless of displacement.

Manoeuvrability – waterjets out-manoeuvre surface drives at all boat speeds. At high speeds waterjets have a much tighter turning circle and are able to perform an emergency "crash stop" manoeuvre.

The coarse pitch of a surface piercing propeller makes it difficult to maintain slow speeds, and requires constant gear shifts. The steering and astern functions of a Hamilton waterjet provide responsive manoeuvrability at very slow boat speeds, and even when holding position.

Ease of Operator Control – because a surface drive is not fully submerged it is affected by variations in vessel trim caused by sea conditions. Constant changes in the depth of the surface piercing propeller result in engine loading and RPM fluctuations, which make it difficult to maintain the desired vessel speed.

A waterjet's performance is not affected by vessel trim so it pro-

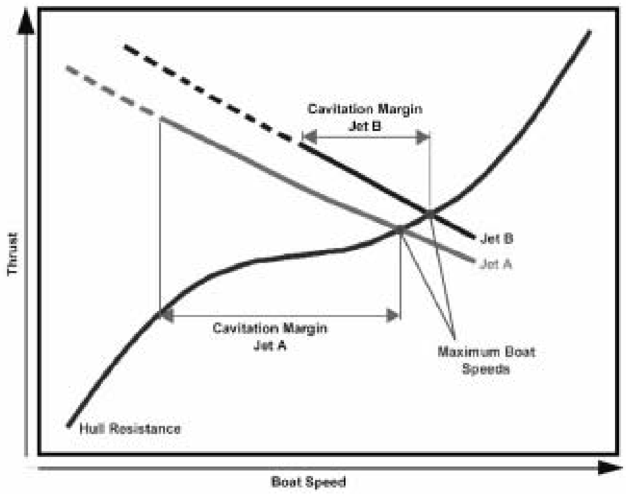

Fig 2.—Hull Resistance vs. Waterjet Thrust

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vides consistent thrust force and steady RPM in all conditions.

Appendage drag – waterjets have no parts exposed below the waterline, so there is virtually no appendage drag to add to hull resistance – and additional jet units can be added without increasing resistance.

Surface drives that use rudders add to overall resistance, so the more drives and rudders you have, the greater the effect.

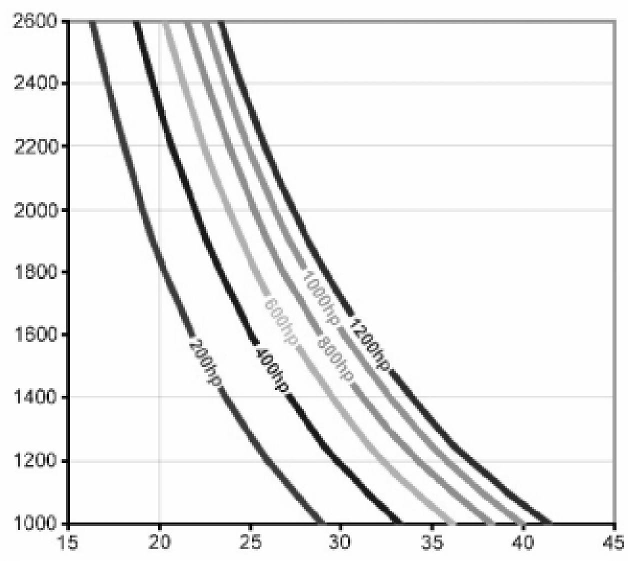

Fig. 3—Propeller Diameter/ HP/RPM

Shallow Draft – a waterjet intake is flush with the bottom of the boat, allowing the vessel to traverse very shallow waterways and even be grounded without significant damage to the drive system.

Surface drives have significantly reduced draft compared to other propeller systems. However, the propeller is exposed below and aft of the hull where it can be damaged. There have even been cases where the entire surface drive has been knocked off a boat.

Safety – waterjets have no exposed moving parts so can remain running around swimmers or marine life. Surface drives require platforms and/or guards above and to the side of the propeller for protection, and for safety the drive must be disengaged when operating around people or animals in the water.

Reliability – waterjets are very reliable in themselves, requiring little maintenance – most of which can be done inside the hull. And because waterjets put less stress on engine, gearbox and drive shaft than other propulsion systems, they increase the reliability of the total drive system.

Cost effectiveness – small to medium sized waterjets will be less expensive to purchase, install and maintain compared to a surface drive for the same project. This is largely due to surface drive and propeller having to be purchased from separate manufacturers and the need to have a gearbox. With larger waterjets the purchase cost for either option is generally similar, but ongoing maintenance costs will be higher with the surface drive.

Conclusions

For work and patrol boats operating over 50 knots, where engine life and risk of impact damage are not significant issues, surface drives could be the preferred option. In the 25 to 35 knot speed range waterjets provide greater flexibility and reliability.

Waterjets and surface drives really only compete in the 35 to 50 knot boat speed range. It is then that you have to weigh up the other pros and cons of each system before making the final choice. In most cases Hamilton waterjets provide more benefits and are the preferred option.

This article was first published in June 2002 in JetTorque 12, the technical publication of Hamilton jets.

Don't forget the RINA Library

To access the library collection contact

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(09) 920 3466

To see a list of the collection via the internet access the site www.irl.cri.nz/infoservice and search the library catalogues

Technical Meetings

Meetings are now held at 6pm, usually on the second Tuesday of the month. These meetings are open to all members as well as interested people from the wider community.

If you have any suitable ideas or wish to make a presentation to the members please contact Susan Edinger.

Forthcoming events

Over the next few months the following events are being arranged.

- Auckland University (East Tamaki site) visit
- Dockyard visit

More information on the following events will be provided in Update.

At the bar — AGM 20th April

Council Changes

In the recent months there have been a few changes to your council. At the AGM Angelo Lavranos tendered his resignation. Angelo is a survivor from the New Zealand Naval Architects Society committee and will be greatly missed for his hard work and his humour. He has been responsible for the production of the Update flyer and this has now been passed on to one of our new committee members Martin Hannon. Jerry Bennett has stood down as secretary but remains on the committee and we thank him for all his efforts, Michael Eaglen will take on his mantle. We also welcome another new member to the committee, Brendan Fagan.

The Royal Institution of Naval Architects (New Zealand Division) would like to acknowledge the continuing support of Clendon Feeney as our Honorary Solicitors.

Don't forget that the NASNZ Standard Terms of Trade and Standard Design Contract are available for free download from the NZ Division website (www.rina.org.uk) as well as www.clendons.co.nz.

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