A TECHNICAL AND COMMERCIAL VIEW OF THE WATERJET PROPULSION MARKET

JetTorque from HamiltonJet

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Special Points of Interest:

- Hamilton Jet chosen for new Greek and Singapore Coast Guard Patrol Craft Fleets.
- Keels and tabs for directional stability.
- Effect of Bottom Appendages and Hull Design on Aeration.
- More new Hamilton Jet powered Passenger Craft.

Coast Guard Fleets Choose Hamilton Jet

The world over, Coast Guard operators are turning more and more to waterjets as the preferred propulsion option for high speed patrol craft. And Hamilton Jet is the preferred waterjet. Two recent examples are fleets of new patrol craft for both the Greek Coast Guard and the Singapore Police Coast Guard.

Singapore Police Coast Guard 18m Patrol Craft twin HM521 Jets

Greece

A new 16 boat fleet of 17.4 metre long high speed patrol craft for the Greek Coast Guard are all powered by Hamilton Model HM422 jets. Twin jets in each craft are driven by 993kW MTU V12 diesel engines and produce sufficient thrust to push the craft to a GPS verified to speed of 48 knots at operational displacement.

A single station Hamilton Jet HYRC power-assisted follow-up ahead/astern control system is fitted and, combined with manual hydraulic steering control, gives each craft 360° manoeuvring ability. Infinitely variable speed ahead or astern, sideways motion and on-the-spot rotation are all possible without complex electronic manoeuvring controls.

The craft are of the Lambro 57PB design, a GRP monohedron hull form designed and built by Motomarine SA of Athens. On-going support for the propulsion system is supplied by Hamilton Jet's Authorised Distributor in Greece, Motocraft SA.

Greek Coast Guard 17.5m Patrol Craft twin HM422 Jets

Singapore

In SE Asia, the Singapore Police Coast Guard has commissioned a new fleet of 18 patrol/pursuit craft and 2 command craft variants for coastal duties.

The patrol craft are 18 metres long and powered by twin model HM521 jets driven by MTU diesel engines. This combination provides propulsive thrust for a top speed of 40 knots at 80% MCR. The command craft are longer at 20 metres overall with the same propulsion system as the patrol craft variants providing a constant speed of 30 knots.

All the Singapore craft are fitted with Hamilton Jet's MECS Modular Electronic Control System for propulsion control. The MECS system is software configurable and provides control using an electronic helm and dual single lever controllers for throttle and reverse. Separate back-up control links are provided for each jet and full system status indication is provided on the bridge display panels.

The craft were designed in Australia by Southerly Designs Pty Ltd, and built in Singapore in a joint-venture between West Australian builder Geraldton Boat Builders, and Singapore-based Asia Pacific. Frames and hull plates were kit-setted in West Australia for assembly in Singapore.

Affecting Directional Stability

Directional stability is a function of hull design, but as an ideal boat is an amalgamation of hull, propulsion system, control system etc. it is necessary to consider the relationship of these elements when planning for optimum performance.

In a waterjet installation, the jet intake is flush with the hull bottom and there are no conventional rudders or other appendages such as struts. Directional control is affected by vectoring the jetstream to port or starboard.

A waterjet powered hull is often of moderate deadrise to take advantage of the shallow draft capability which is achievable with this type of propulsion system.

For speeds over 30 knots, monohedron (constant deadrise) hull lines are recommended for directional stability without appendages. However, at slower speeds the absence of underwater appendages can result in such hulls experiencing handling problems in the form of "wandering", particularly in following seas. If not severe, this can usually be compensated for by the helmsman applying small, frequent helm corrections. If this is not appropriate, fitting small ventral fins (also described as bilge keels, sister keels or skegs) will in most cases provide the extra directional stability required to overcome any slow speed handling problems. The size of the fins should be kept to a minimum as they add to overall hull resistance. Typically, ventral fins 1200mm long x 150-200mm deep may be installed centrally about the turning moment of the hull with each located midway between the outboard edge of the jet intake and the chine (see Fig. I). Fins installed in this configuration do not increase the draft or interfere with jet performance. Such appendages should not be placed directly in front of the jet intake as they will interfere with the delivery of a smooth flow of water into the jet, resulting in a loss of thrust (see Page 3).

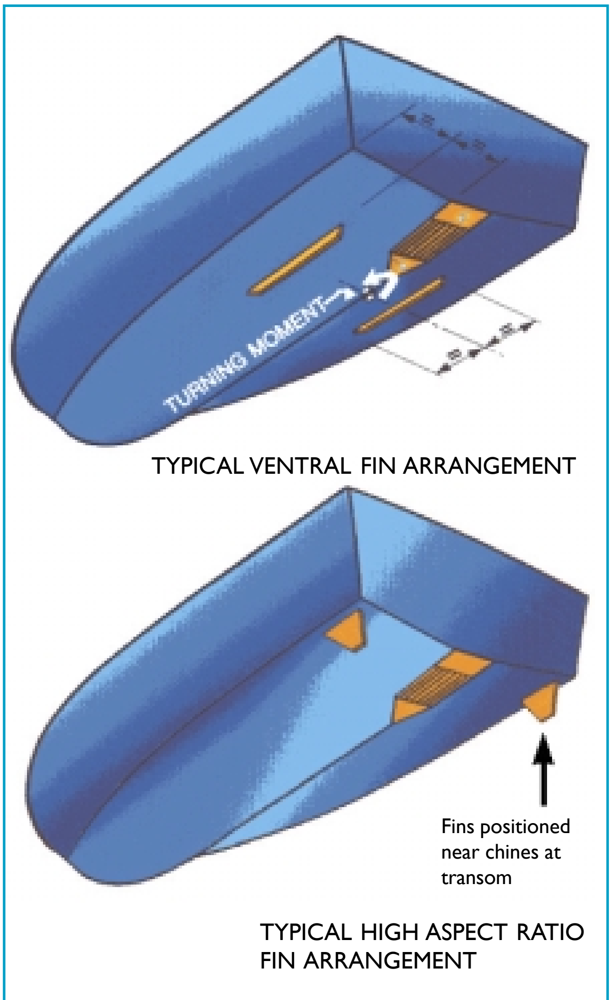

Fig. I Typical Fin Arrangements

More recently there has been a move towards fitting small, high aspect ratio fins near the chines at the transom. These have less drag than longer bilge keel type fins and are more suitable for high speed craft. Such fins can also be set at a slight angle to counter any tendency for the hull to steer to one side.

On warped hulls, or those with the deadrise angle reducing aftwards, the trim angle tends to flatten as speed increases.

At high speed and with a significant degree of hull warp, the bow may tend to "plow in". This not only reduces speed but can also lead to handling problems. If the LCG is located too far aft, the trim will be too high and the vessels may experience difficulty getting onto the plane. If a forward LCG is causing handling problems, the LCG can be moved by adding some form of ballast aft. It is preferable to relocate existing weight aft rather than add additional ballast as additional weight usually has a detrimental effect on the performance of a planing hull. However, in some cases the benefits of correct trim can outweigh the negative effects of extra weight.

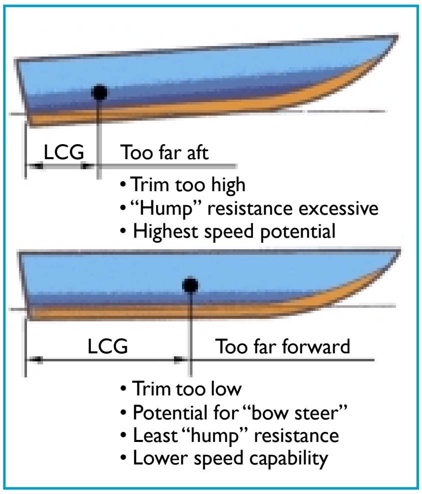

Fig. 2 LCG Effect

Fitting wedges to the underside of the hull at the transom or trim tabs to assist a hull over the planing threshold can also result in a bow down attitude at higher speeds and should be avoided unless absolutely necessary.

The effect of the tabs or wedges is to limit the trim angle to assist planing, but as speed increases so to does the bow-down forces, resulting in a bow-steer effect again. Adjustable trim tabs can overcome this problem.

Some experimentation may be necessary after fitting fins to achieve optimum performance. Fins will reduce the bank angle of the hull in turns. If the fins are too deep, the bank angle will be too flat, resulting in uncomfortable conditions on board. In extreme cases, the boat could "trip over" the keels and even capsize. The optimum fin size will be found when the boat steers straight without effort at all speeds and turns under control with a good bank angle.

Minimising Aeration

Any appendages fitted on the underside of the hull bottom can affect performance of the waterjet. For optimum efficiency, a jet needs to be presented with solid water – if air enters the jet, it can attach to areas of low pressure on the suction side of the impeller blades leaving less area for solid water to pass between the blades. This results in a reduction in water flow and consequently jet thrust. Therefore it is necessary to exercise care in design and building to exclude, or at least minimise, air ingress to the jet.

Monohulls

Aerated water generated by the craft's bow should not pass directly aft to the jet intake(s). Shallow vee hulls with blunt or full bow shapes create a heavily aerated bow wave which is rolled back under the hull. Consequently, a vee'd bow stem in conjunction with a minimum angle of 10 degrees is recommended as this will direct any air outboard away from the jet intake.

Fittings that can cause turbulence (water pick-ups, transducers, keel coolers etc.) and appendages that can direct air to the jet intake (strakes, keels, "plank keels" etc.) should not be fitted in front of the intakes. Figure 3 illustrates the recommended clear area of hull bottom to minimise creation and entrainment of air. Additionally, the jet intake installation should blend smoothly with the hull bottom with no steps or ridges. In multiple jet installations the jets should be mounted as close to the keel line as practical.

Multi-hulls

Hamilton Waterjets provide an effective propulsion option for many multi-hull vessels as they are ideally suited for installation in the long narrow hulls associated with this configuration. However, multi-hulls tend to trap air in the tunnels between the hulls and care should be taken to ensure this does not enter the jet. The hulls should be deep in relation to the air tunnels so the jet intake sits well down in the water, as illustrated in Figure 4. Hull resistance for some multi-hull craft can be very high and typically, long narrow hulls which maintain a relatively flat trim angle throughout the vessel's speed range are most suitable. Asymmetric hull forms with fine entry forward with a constantly diminishing deadrise to relatively flat aft sections appear to "dry out" best and direct least air to the jets. Twin jets are often fitted to catamaran hulls by "staggering" the engine installations fore and aft, but planning should take into account the fact that if the jet is too close to the edge of the hull, the reverse duct could project beyond the sidewall increasing the vessel's resistance.

Engine Exhausts

Engine exhaust outlets should not be located below the waterline near the jets as water containing exhaust gases may be ingested by the jet when moving astern. This could cause loss of thrust and reduce the effectiveness of the jets reversing capability.

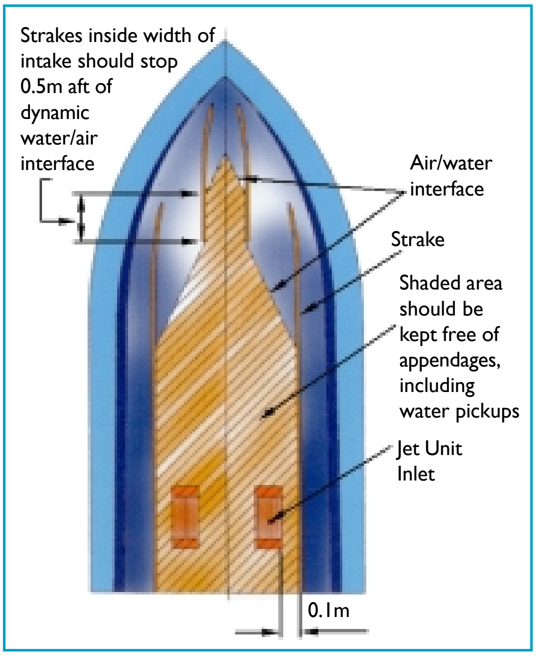

Fig. 3 Recommended Bottom Configuration for Monohulls

Trim Tabs

Trim tabs cannot be mounted directly alongside the jet unit. The astern jetstream is discharged on an angle two ways from the split duct reverse deflector and would be obstructed by the tab, reducing reverse thrust effectiveness. If necessary to fit trim tabs, it is possible to mount them underneath the jet unit with control equipment on either side of the jet, generally as shown in Figure 5 below.

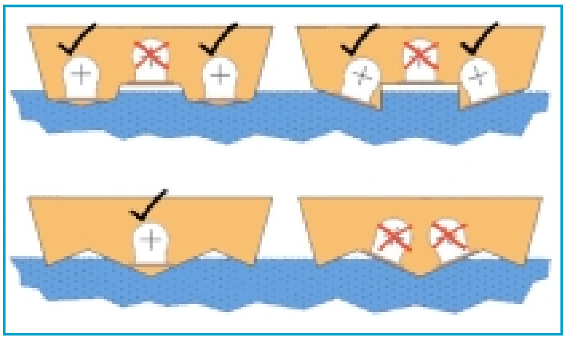

Fig. 4 Recommended Jet Configuration for Multi-hulls

The diagram shows the area which the tab must lie within.

This tapers, from a maximum width "W" at the transom, inwards at 25 degrees per side until it reaches the same width as the reverse duct bottom corners.

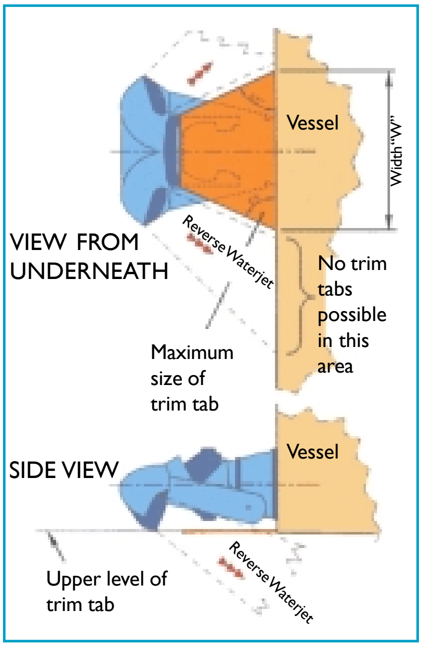

Fig. 5 Trim Tab Configuration

Hamilton Jet has an extensive applications database on most hull and would be pleased to advise on any design proposals.

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Americas Cup 2000

At the time of going to press, sailing in the Louis Vuitton Cup Challenger Series is under way in Auckland, NZ, with the winner going on to challenge Team New Zealand for the Americas Cup in March 2000. And Hamilton Jet will be on the water every day as the

power behind the official tow boat for the French Challenge Syndicate, Le Defi Bouygues Telecom-Transiciel. "Lethal Weapon" is a 15.24 metre aluminium monohull powered by twin Hamilton Jet Model HJ362 jets. Built by Sea Chrome Marine of West Australia, the craft is under charter for the duration of the French campaign and is used daily to tow their yacht to the race course from the downtown Auckland headquarters.

HamiltonJet
The Waterjet Specialists

Passenger Comforts

Waterjet propulsion is now widely accepted as offering substantial benefits to patrons on fast passenger carrying vessels. Shallow draft capability allows access to areas out-of-bounds for propeller driven craft and superior manoeuvrability ensures high levels of safety. Without propeller induced vibration, comfort levels are enhanced.

Manoeuvring with a jet is achieved simply by vectoring the jetstream, so vibration normally associated with a gearbox shift when going astern is eliminated.

Recent examples of interesting Hamilton Jet powered passenger craft are both associated with the eco-tourism industry. In the North Island of New Zealand, the 10-metre long "Superjet" operating on Lake Taupo is powered by twin Model 241 jets driven by Yanmar diesel engines.

The jets provide sufficient thrust to push the foil-assisted catamaran to a maximum lightship speed of 42 knots, dropping to 39 knots when fully fuelled and laden with 31 passengers. Lake Taupo is the largest lake in the Southern Hemisphere, created by one of the most violent volcanic eruptions in recorded history. The Hamilton Jet propulsion system provides the craft with outstanding manoeuvrability, allowing the operator to turn the craft in any direction around a single pivot point and to "walk" it sideways, giving passengers spectacular views of the many natural features of the area.

In Boston, MA, U.S.A. the New England Aquarium has recently taken delivery of a new 34 metre Hamilton Jet powered ferry for whale-watch excursions in Massachusetts Bay. Based in downtown Boston, "Voyager III" is powered by quadruple Model HM461 jets, each driven by V12 Detroit diesel engines. This propulsion system provides thrust to push the vessel to 31 knots when fully laden with 325 passengers. A 3-station Hamilton Jet CMU Electronic Control System provides thrust vectoring control for steering and ahead/astern functions. Interfaced with the Detroit engine systems, the CMU System features joystick steering at the main and flybridge stations and a hand held Remote Roving Controller for close quarters manoeuvring and docking. Single throttle/reverse levers each control one pair of jets and full back-up is incorporated in the system.

"Voyager III" was designed by International Catamaran Designs of Australia and built at the Massachusetts yard of Gladding Hearn Shipbuilding. In all aspects of performance and operation, the aluminium vessel met or exceeded contract specifications.

34 metre Catamaran Ferry "Voyager 111", Boston Harbour, USA
Quad Hamilton Model HM461 Jets

10 metre "Superjet", Lake Taupo, New Zealand
Twin Hamilton Model HJ241 Jets