### SYSTEM SPECIFICATIONS*

<table>
<thead>
<tr>
<th>FOIL AREA</th>
<th>SPAN (mm)</th>
<th>CHORD (mm)</th>
<th>Max. Underway Lift Force (20° @ 16 knt)</th>
<th>Minimum Design Roll-Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Foil 1.0</td>
<td>1.0 m²</td>
<td>2000</td>
<td>500</td>
<td>43 kN</td>
</tr>
<tr>
<td>D. Foil 1.5</td>
<td>1.5 m²</td>
<td>2450</td>
<td>610</td>
<td>65 kN</td>
</tr>
<tr>
<td>D. Foil 2.0</td>
<td>2.0 m²</td>
<td>2830</td>
<td>710</td>
<td>88 kN</td>
</tr>
<tr>
<td>D. Foil 3.0</td>
<td>3.0 m²</td>
<td>3460</td>
<td>870</td>
<td>131 kN</td>
</tr>
<tr>
<td>D. Foil 4.0</td>
<td>4.0 m²</td>
<td>4000</td>
<td>1000</td>
<td>175 kN</td>
</tr>
<tr>
<td>D. Foil 6.0</td>
<td>6.0 m²</td>
<td>4900</td>
<td>1230</td>
<td>264 kN</td>
</tr>
</tbody>
</table>

*All specifications and information is subject to change without notice. Please see a Quantum representative for more information. © Copyright Quantum Marine Stabilizers 2017.
The DYNA-FOIL™ is a NEW dual purpose fully retractable ship stabilizer system that provides exceptional roll reduction for vessels at both Zero Speed™ and underway.

The stabilizer system utilizes a unique foil design that allows for a dynamic self-induced lift for outstanding Zero Speed™ operation. The design features a highly efficient lift to drag coefficient for superior underway operations. These desirable characteristics coupled with Quantum’s unrivaled SMC4000 series control system, provides the most technologically advanced stabilizer system in the world.

THE POWER BEHIND THE FORCE
At the heart of every Quantum system is the hydraulic power source. For the DYNA-FOIL™, Quantum has developed an all new CHPU (Compact Hydraulic Power Unit) that brings together tested and proven hardware with a new approach to power management and power shaving. Through the stored energy accumulators and variable motor control the CHPU can provide power to the DYNA-FOIL™ with extremely low power cycling on the ships net. By use of in-tank (submerged) pumps, airborne noise is reduced without the use of sound shields. Structural borne noise is handled with both mechanical absorption and hydraulic suppression hardware.

Each individual hull unit receives its own stand-alone CHPU complete with touch screen. The touch screen can serve as a user friendly portal for any diagnostic activities that may be required allowing for local and remote control through any Quantum interface on the ship. The system also allows for complete redundancy between hull units.
DESIGN AND TESTING
As with all Quantum products, extensive design, development, and testing are critical benchmarks in the process. The development of the DYNA-FOIL™ is no exception.

To begin, Quantum performed preliminary tests at 1/5 scale using an in-house test tank. Quantum then translated an independent third party model test program at the MARIN (Maritime Research Institute Netherlands) an independent third party model test program at the MARIN (Maritime Research Institute Netherlands) to that of a fixed fin system are noted below:

1. The unique profile of the foil allows a substantial lift force to be generated at low angles of attack where the drag developed is at its minimum; hence maximum lift efficiency is realized.
2. The advanced control algorithms unique to the DYNA-FOIL™ are designed to provide for an almost instantaneous positioning of the foil, thus improving lift force timing. This timing in turn, is critical to maximizing the roll reduction with minimal effort.

THE PRINCIPLE OF OPERATION
Zero Speed™
For Zero Speed™ stabilization, the fundamental operating principles of the DYNA-FOIL™ depart from that of traditional Zero Speed™ stabilizer systems.

A typical low aspect, fixed fin system uses the fin in a paddling action, effectively pushing water to create drag, which when applied at the correct time can provide a counter force to the roll motion of the vessel. Working outside of this paradigm and counter to that of the fixed fin systems, the DYNA-FOIL™ uses the hydrodynamic lift generated by water flow over the profile of the fin to generate force at Zero Speed™.

The foil is positioned at a dynamically adjustable angle of attack, up to 150° relative to the hull. Where the directional swing determines the direction of water flow and generating lift. Where the foil is deployed at 90 degrees to the hull center-line, lift is generated much like a traditional fin system, by articulating the foil thus changing it’s angle of attack relative to the hull center in commanding the most precise roll movements critical to handling the lift force requirements with real-time feedback.

TOTAL PERFORMANCE
In summary, compared to a traditional Zero Speed™ stabilizer system, the DYNA-FOIL™ system offers significant advantages.

1. The system is always in place, 24/7, offering an endless opportunity to roll stabilization.
2. The system takes up no room in the vessel, significantly reducing weight and drag.
3. The system takes up no room in the vessel, significantly reducing weight and drag.
4. The installation can be completed in a day.
5. The system can be deployed at any speed from Zero Speed™ to 150 Knots.
6. The system is easily adjustable on the go.

THE INSTALLATION

INSTALLATION FLEXIBILITY
To accommodate multiple types of hull designs and various mission profiles, the DYNA-FOIL™ is available in both a full pocketed version and also a non-pocketed version.

Pocketed Version:
For high speed hard chine vessels where space and weight in the vessel is critical the DYNA-FOIL™ can be supplied in a non-pocketed version. To make this version suitable for high speed applications, Quantum has optimized the profile of the unit up to 30 Knots by way of CFD testing.

Non-Pocketed Version:
For high speed hard chine vessels where space and weight in the vessel is critical the DYNA-FOIL™ can be supplied in a non-pocketed version. To make this version suitable for high speed applications, Quantum has optimized the profile of the unit up to 30 Knots by way of CFD testing.

PERFORMANCE AND EFFICIENCY
Performance efficiency at Zero Speed™ can be measured by the lift force generated in kN (kilonewton) relative to the area of the foil. It can then be compared to a standard or XT™ fin for bench mark reference.

Installation
In the case of the DYNA-FOIL™ there are a number of factors that contribute to the performance and efficiency of the system. Some of the key advantages of the system relative to that of a fixed fin system are noted below:

1. The lever arm is much larger than that of a fixed fin.
2. The down angle positioning of the foil unit is not governed by the hull profile therefore attaining the most efficient down angle is generally possible with the DYNA-FOIL™ when it is not with a fixed fin.
3. Higher lift coefficient of the foil compared to that of a standard fin.
4. When compared the DYNA-FOIL™ to a fin in terms of lift area to that of a standard fin at Zero Speed™, one needs to include the mechanical advantage the DYNA-FOIL™ has over the finned system in terms of lever-arm and optimized down angle. While the lift force to foil area of the DYNA-FOIL™ is greater than that of the finned fin the net result as a stabilizing force can be greater still when all factors are considered.

Above: Full pocketed version of the DYNA-FOIL™
Non-Pocketed Version:
For high speed hard chine vessels where space and weight in the vessel is critical the DYNA-FOIL™ can be supplied in a non-pocketed version. To make this version suitable for high speed applications, Quantum has optimized the profile of the unit up to 30 Knots by way of CFD testing.

Above: Extensive CFD testing was also used to supplement the traditional tank testing to assess the foil performance.
CUTTING EDGE CONTROL TECHNOLOGY

The DYNA-FOIL™ hull units can be a dedicated compact hydrofoil power unit (CHPU). The units are designed to have the ability to start, deploy and activate each hull unit independently. Each CHPU has an LED indicator that shows for maintenance or repair if the unit is free to operate allowing for more flexibility. The touchscreen interface utilizes the same status of each hull unit as well as the standard monitoring conditions of each CHPU.

Zero Speed Image: Shown above is the operator control screen set for action in the Zero Speed mode. In this screen both the foil position (angle) and speed are highlighted in blue to indicate that both functions are active. The Zero Speed active mode is set for action in the Zero Speed mode. In this screen both the foil position at 20 degrees +/- and the speed are highlighted in the zero speed line. This is set at 90 degrees when the system is deployed: when the unit is deployed the fixed fin is deployed the fixed foil is deployed. In this mode the profile shown is inverted and shows the foil angle. This is set at 90 degrees when the system is deployed: when the unit is deployed the fixed fin is deployed the fixed foil is deployed. In this mode the profile shown is inverted and shows the foil angle.

This screen also displays the active mode in use as well as the inactive grey color but the indicator is highlighted in the foil angle and speed through the water.

PRECISION ENGINEERING

In order for the DYNA-FOIL™ to be fully retractable and yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range. To attain this range of mechanical travel yet have the capability to deploy and swing through 180 degrees, the mechanical system must have 165 degrees of swing range.

Actuation for the foil is yet another Quantum innovation. Quantum employs their specialty expandable spherical bearings with a unique design that positions a spherical bearing at both connections points to the cylinder to increase bearing life and wear properties. As with any underwater appendage, minimizing drag efficiency of the cylinder provides for instantaneous and extremely accurate positioning of the foil.

APPENDAGE AND POCKET DESIGNING CRITERIA

In order for the DYNA-FOIL™ to be fully retractable and soon be operable allowing for more flexibility. The touchscreen interface utilizes the same status of each hull unit as well as the standard monitoring conditions of each CHPU.