PASSION | TECHNOLOGY | DESIGN | PERFORMANCE

COMPOSITE RIGGING | SouthernSpars

EC6 SCIENCE:

The science behind EC6 rigging both on and off the water has been proven.
The opportunity is here, experience a first.

Since its introduction in 2003, EC6 rigging has produced a record number of firsts -
The first reliable carbon rigging product in the market
The first carbon continuous rigging product
And most importantly, the increasingly high number of firsts across the finish line.

The product has opened up a new world of performance and reliability.
With the technology well established on the racecourse, superyachts are also realising the advantages

Less weight aloft translates to more stability while sailing and less motion at anchor.
More flexibility for the designer on ballasting and displacement
Extended service periods

The 52m schooner, Meteor, used EC6 rigging and saved 1500kgs in rigging weight. Performance cruiser, Bristolian saved 700kgs in rigging weight alone by using EC6 over Nitronic rod. Likewise, Velsheda, the classic J-class yacht recently upgraded to EC6 Continuous and saved 700kgs.

Of equal importance is the reliability. The Swan 100 FANTASTICA (ex KORA II) has recently completed a circumnavigation with EC6 rigging that was installed in 2004.

HISTORY MADE:

Carbon composites are known for their:

- High fatigue tolerance
- Stability under environmental exposure
- Exceptional strength to weight

All these features make carbon composites attractive not just for the construction of mast tubes and fittings, but also for **standing rigging**.

EC6 has been installed on a variety of yachts ranging from 11' moths up to 200'+ superyachts. All on and off the water testing has proven that the product will outlast any other rigging product around.

The Open 60 Paprec-Virbac won the Barcelona doubled-handed nonstop round the world race with EC6 Continuous carbon shrouds. Post-race testing confirmed that there was no strength degradation. The boat has now travelled approximately 58,600nm with the original set of rigging.

Most recently, all seven VO70s, including winner Ericsson 4, completed the 2008/09 VOR using EC6 Continuous with no major incidents to report.

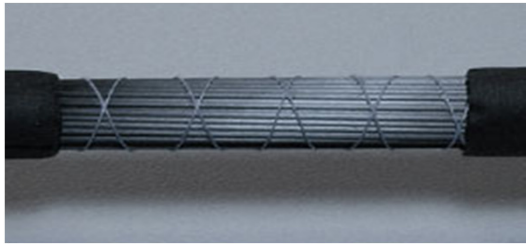
ABOUT THE PRODUCT:

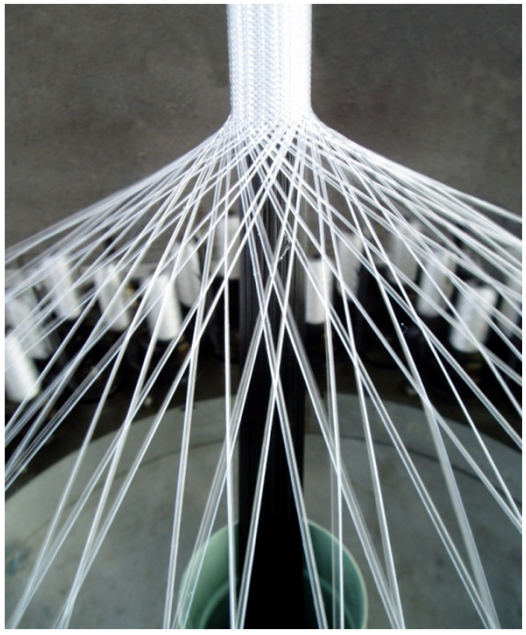
Element C6 cables are constructed from a bundle of small diameter pultruded carbon fiber rods, made from Toray's T800 intermediate modulus fiber that are bundled together to make a cable.

The cables are terminated in a patented cone shape fitting that provides adhesion to each individual rod. The product can be configured as a discontinuous or continuous system. Unlike solid carbon stays, EC6 rigging has a very high impact and chafe resistance.

T800 provides the optimal combination of strength, stiffness and elongation, making it well suited for yacht standing rigging. Each rod has a known tensile strength and stiffness which enables the cables to be customised to each yacht's loads.

In 2009 EC6 Rigging was awarded GL Type Approval, and in 2010 EC6 Continuous Rigging was awarded GL Type Approval. GL is the world's leading marine certification company. Their mission statement is to ensure safety at sea, strive for technological progress and act according to the highest quality approach: Certainly a mission that Composite Rigging embraces.





ABOUT THE PRODUCT:

EC6 CONFIGURATIONS
The product comes in three configurations, EC6 Continuous, EC6 Micro, and EC6 Hybrid.

EC6 Continuous: the shrouds run continuously from the deck to the mast, eliminating all spreader tip connection hardware, creating the lightest and cleanest rigging solution available. The system has been designed for yachts ranging in size from 20 to 135 feet, or up to -320 V1 shroud. It is utilised on both racing and cruising applications.

EC6 Micro: EC6 carbon stays have also been developed for smaller boats. The product is currently available for the International Moth class. Weight savings of 75% have been achieved over the standard wire rigging. The product which is made up of one pultruded rod has a safe working load of 500kgs.

EC6 Hybrid: the new Hybrid system is for superyachts above -320 rod size. The Hybrid system is made up of a continuous vertical shroud with the diagonals attaching at a spreader end that are an integral part of the vertical shroud.

JACKETING
In 2010 Composite Rigging switched to a polyester braiding material that provides customers with options on color choice. Utilizing a proprietary coating system the cover provides additional chafe and UV protection.

RETROFITS

A growing number of the larger performance cruisers and superyachts are now making, in some cases needing to make, the shift away from rod rigging toward composite standing rigging solutions. And with the opportunity to reduce the rigging weight by as much as 70%, it makes sound sense.

The use of carbon rigging is not only restricted to new yachts. EC6 can be adapted to fit nearly all existing masts and rigging hardware. Spreader tips can be modified to accommodate the continuous rigging bundle perfectly, saving on weight and windage.

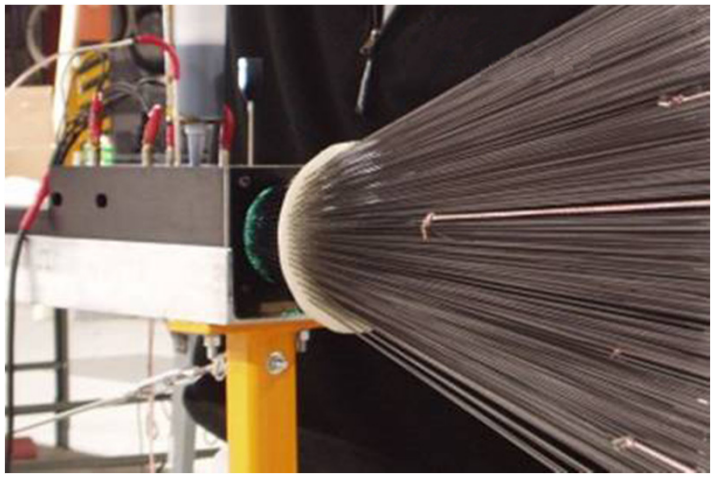
Superyacht Ghost was one of the first to undergo an EC6 Continuous Retrofit. In late 2009 existing spreaders were optimised to accommodate the EC6 Continuous stay, doing away with the weight and windage of the conventional tipcup spreader format.

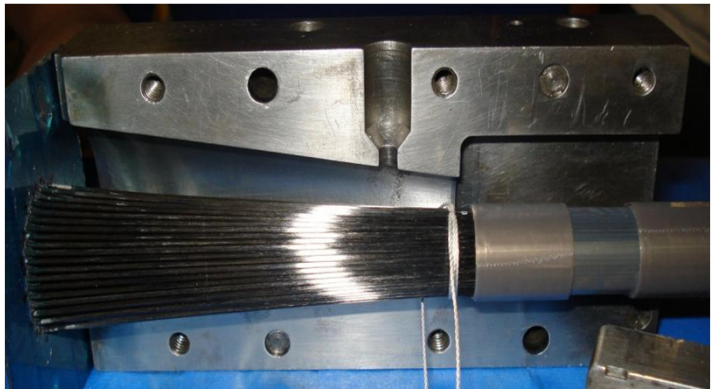
More recently, Icon, a Robert Perry design with Southern Spars mast, was refitted with EC6 Continuous rigging in Seattle. The yacht elected not to do a spreader modification and utilised Composite Rigging's spreader plug. The almost 75% weight savings over rod has helped the Yacht's light air performance.

Two French Yachts, the Swan 601 @robas and Maxi, French Spirit have also converted to EC6 Continuous utilising the spreader plug option.


Superyacht Ghost

CONSTRUCTION:





PERFORMANCE GAINS:

ENVIRONMENTALLY INERT:
The pultruded carbon fiber strength elements are not affected by exposure to moisture or visible light. Unlike PBO or Aramid fibers which suffer strength degradation when exposed to the elements carbon fiber is materially unaffected. In fact we are able to supply cables with essentially no jacketing for additional weight and diameter reduction.

HIGH DAMAGE TOLERANCE:
Chafe tests have shown the carbon pultrusions to be as tough as the jacketing it is encased in. Should the jacket be damaged the structural rods are able to withstand additional abrasion and can remain exposed if necessary. Unlike wound fiber cables which can 'unravel', the EC6 cable retains the strength of each constituent rod that remains intact if there is damage to the strength elements. Additionally the bundled construction allows the cable to dissipate energy from impacts from such things as spinnaker poles.

EXCEPTIONAL FATIGUE CHARACTERISTICS:
Carbon composites exhibit very high fatigue life when subjected to nominal stress levels. Tension-tension fatigue testing performed on EC6 indicates that this is the case in this application. The titanium end fittings are sized to keep the stress levels below the fatigue limit of the material.

PERFORMANCE GAINS:

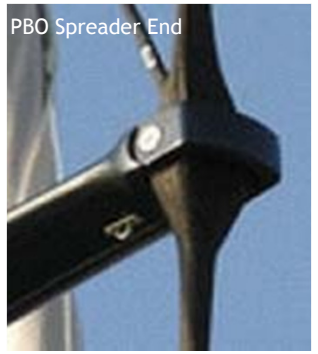
LOW WINDAGE EC6 CONTINUOUS:
No spreader tip connections eliminates frontal area and bulk, and minimizes the junction drag at the tip with the added benefit of being able to reduce the spreader tip size to the absolute minimum. Comparison of EC6 Continuous with other composite rigging products indicates a rigging drag reduction on the order of 12% (ref Windage Study Example pg. 12).

INSPECTION:
EC6 cables can be uncovered and strength elements completely exposed to facilitate inspection.

ELEGANT AND FUNCTIONAL FITTING:
Composite Rigging's line of complimentary hardware incorporate elegant solutions to functionality issues. An example is the ball-lock turnbuckle assembly that does not require tools to unlock for adjustment.

CAN BE REFURBISHED & REPAIRED:
Cables can be refurbished with new jacketing. Minor damage to the structural carbon rods can be repaired by scarfing in new material


EC6 Continuous Spreader End


PBO Spreader End


EC6 LEF Cables

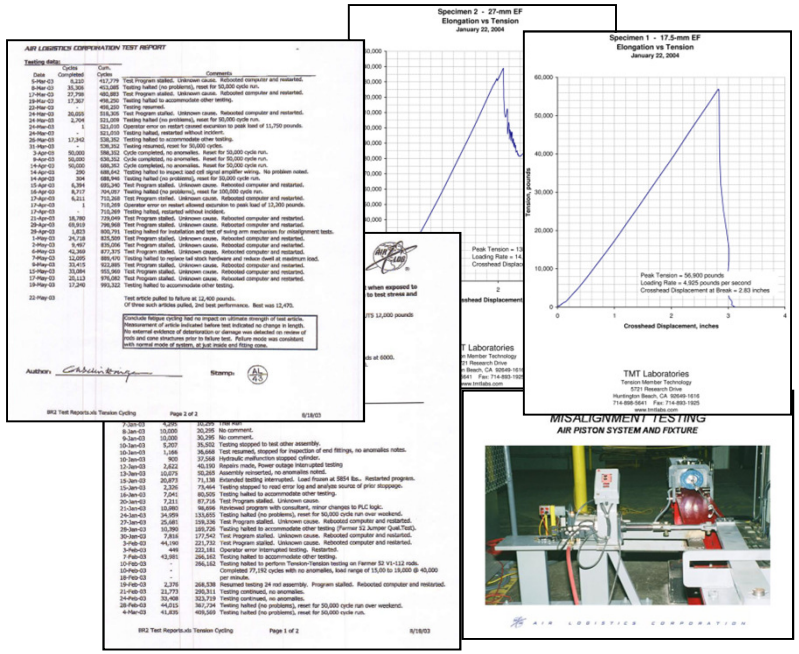

Internal Tangs

RESEARCH & DESIGN:

The EC6 carbon cable technology has been developed in conjunction with an industry leader in the field of high performance composite pultrusion.

Extensive laboratory testing including:

- Tensile testing to destruction of cables ranging from 5 to 265 tonnes.
- Tension-Tension fatigue test to 1 million cycles without failure
- Bending Deflection fatigue test superior to Ni50 rod.
- Spinnaker Pole impact testing.
- Chafe tests on both jacketed and bare carbon rods exceeding Germanischer Lloyd requirement.
- Specialized testing on bent and split bundles for development of EC6 Continuous Continuous shrouds.



RESEARCH & DESIGN: Windage Study

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Drag Analysis of Composite Rigging
for Volvo 70 Yacht Rigs

A theoretical drag analysis has been undertaken on two composite rigging configurations for Volvo Open 70 class yachts. Each rig configuration uses the same spreader layout and essentially the same size spreaders, except for the outboard end detailing.

One of the rig configurations uses EC6+ continuous carbon fiber and the other uses PBO fiber slings. The rods for each configuration are sized for equal EA. (stiffness).

The aerodynamic drag has been calculated for these rigs when sailing upwind in 12 knots of breeze, at an apparent wind angle of 20 degrees, with an apparent wind speed of 22 knots. For simplicity it was taken that each spreader was angled correctly to the apparent wind flow.

The drag has been calculated using sectional drag component data from various sources. The drag calculations included interference effects, but did not include the drag of the mast tube itself. The total aerodynamic drag value was vectored into the direction of travel of the yacht.

The total drag for the EC6 rig was 196.8 N and for the PBO rig it was 219.2 N.

Hence the PBO rig had 22.4 N more drag than the EC6 rig. This is equivalent to the aerodynamic drag of a man with snug fitting clothing, standing side-on to the apparent wind.

The drag proportion break-down is worthy of mention. The PBO outboard ends (OBE) and turnbuckles (TB) are a significant source of drag. The EC6 turnbuckles are buried in the mast tube, reducing the drag of this connection noticeably. The table below shows the drag breakdown in Newtons (N) and also as a percentage of the total aerodynamic drag.

Style	Rods	Spreaders	OBE & TB	Total Drag(N)
EC6+	172.3 (88%)	23.7 (12%)	0.8 (<1%)	196.8
PBO	161.5 (74%)	24.6 (11%)	33.1 (15%)	219.2

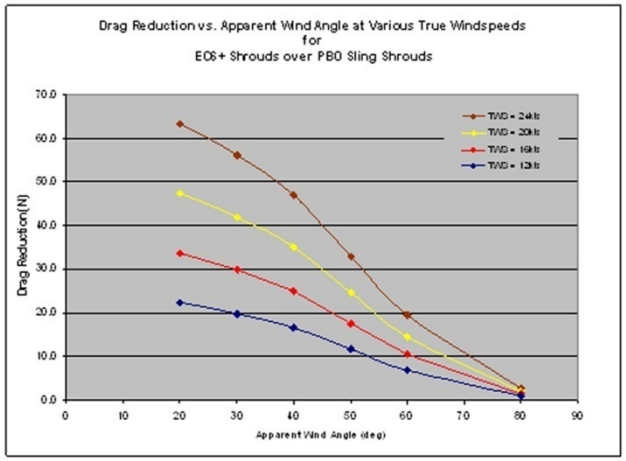
Even though the smaller PBO rods gave a drag reduction over the EC6 rods, this was outweighed by the bulky junctions of the PBO outboard ends and their exposed turnbuckles. These drag differences are amplified as the windspeed increases, but are also reduced as the yacht heading increases to broader angles to the true wind direction. This is shown in Fig.1.

For upwind sailing, the EC6 rig offers a performance advantage over the PBO rig.

Richard Karn B.E (Mech), M.E (Aero)
Research Engineer

16 July 2007

FLUID DYNAMIC RESEARCH & DESIGN



PASSION | TECHNOLOGY | DESIGN | PERFORMANCE

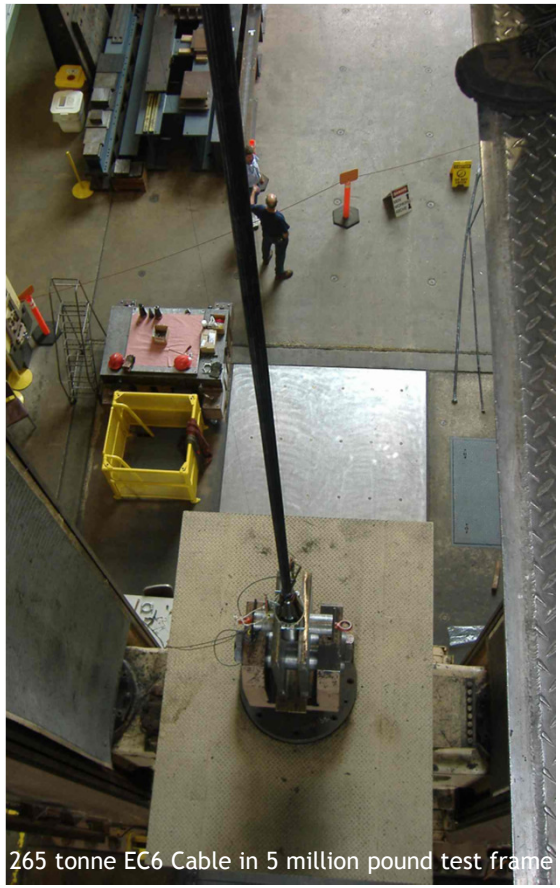
COMPOSITE RIGGING | SouthernSpars

RESEARCH & DESIGN:


80tonne EC6 Cable in 5million pound test frame


Instrumented for Elongation measurements


Bare Rod Chafe test set-up


265 tonne EC6 Cable in 5 million pound test frame

SERVICE RECOMMENDATIONS: Maintenance Schedule

Regular Intervals - Inspection
Particularly after racing or long passages

Visual inspection of all cables and fittings for wear, chafe and corrosion.

Yearly - Intermediate Service

Visual inspection of all cables and fittings for wear, chafe and corrosion.
Check pretension loads.
While off-jack inspect and lubricate all seats.
Re-tension and tune if necessary.

Five Years - Full Service

Visual inspection of all cables and fittings for wear, chafe and corrosion.
Check pretension loads.
Disassemble rigging components for full clean, inspection and re-lubrication.
Proof test comparison against initial test figures of select rigging pieces.
Non-destructive testing (dye penetrant or x-ray) of hangers, ball-head screws and turnbuckles.
If necessary, replacement of hangers, ball-head screws, turnbuckles and other components as recommended.

For a trained EC6 service technician: contact your nearest Rig Pro Service Centre

Rig Pro is a global service provider with centres in Spain, Denmark, USA, New Zealand, Australia and South Africa, and are able to make the trip to you **wherever you are in the world.**

COMMERCIAL CONSIDERATIONS:

LIMITED WARRANTY:

Composite Rigging Limited and Co. warrants the products, in normal usage, to be free of defects in materials and workmanship for a period of two years from the date of the successful completion of the sailing trials.

The warranty is subject to conditions and limitations that are typical of the industry. These conditions and limitations will be found in the Terms and Conditions section of the Sales Agreement.

PROJECTS:

GEORGIA, Farr 53' (EC6 Full Set - March 2003)
MR. A, Farr 67' Rotating Wing Mast (EC6 Full Set - January 2004)
SHOCKWAVE, RP 90 (EC6 Full Set – April 2004)
GENUINE RISK, Dubois 90 (EC6 Full Set – April 2004)
FANTASTICA (ex-Kora II), Swan 100' (EC6 Full Set – October 2004)
CREAM, Gunboat 48' Catamaran (EC6 Full Set – April 2005)
Y3K, Wally 94' (EC6 Full Set – April 2005)
JANICE OF WYOMING, Dubois 130' (EC6 Outer Headstay – April 2005)
IACC Headstays, Backstays and Jumpers (4 teams – Ongoing)
NUMBERS, Farr 60 (EC6 Continuous – June 2005)
WANDA, Viper 830 (EC6 Continuous – July 2005)
HISSAR, Farr 60 (Headstay & EC6 Continuous – August 2005)
BELLA MENTE, JV66 (EC6 Continuous – December 2005)
MONEYPENNY, Swan 601 (EC6 Headstay – June 2005)
FALCON, Swan 56 (EC6 Runners & Backstay – August 2005)
BLUE YANKEE, RP66 (EC6 Continuous – May 2006)
TITAN, RP75 (EC6 Headstay, Backstay & Runners – June 2006)
HUGO BOSS, IMOCA Open 60 (EC6 Continuous – July 2006)
MORNING GLORY, RP MaxZ86 (EC6 Headstay – July 2006)
BOUNDER, Juan K. IRC 55 (EC6 Continuous – January 2007)
VIRBAC, IMOCA Open 60 (EC6 Continuous – January 2007)
GINGER, Swan 601 (EC6 Continuous – February 2007)
PUMA, Volvo Open 70 (EC6 Runners and Headstay – May 2007, August 2008)
ROSEBUD, Farr STP 65 (EC6 Continuous – April 2007)
RIMA 2, RP IRC 55 (EC6 Continuous – May 2007)
METEOR, 52m Huisman Schooner (EC6 Full Set – May 2007)
PYEWACKET, RP/Juan K. 92 Canting Keel (EC6 Continuous – June 2007)
NUMBERS, IRC 68 (EC6 Continuous – August 2007)
RANGER, J-Class Sloop (EC6 Runners and Checkstays – September 2007)
ERICSSON, Volvo Open 70 (EC6 Continuous – October 2007, June 2008)
TELEFONICA, Volvo Open 70 (EC6 Continuous – October 2007)
MAXIMUS, Elliott 30m (EC6 Continuous – November 2007)
WILD OATS XI, RP105 (EC6 Continuous – November 2007)
BRISTOLIAN, Briand 120' Sloop (EC6 Full Set – December 2007)
PUMA, Volvo Open 70 (EC6 Continuous – February 2008)
MONEYPENNY, RP STP 65 (EC6 Continuous – February 2008)
SPEEDBOAT, Juan K. 100 (EC6 Continuous – April 2008
BELLA MENTE, RP IRC 69 (EC6 Continuous – April 2008)
GREEN TEAM, Volvo Open 70 (EC6 Continuous – June 2008)
RAMBLER, RP 90 (EC6 Continuous – August 2008)
ETHEREAL, Holland 55m (EC6 Headstays – August 2008)
VELSHEDA, J-Class Sloop (EC6 Continuous – August 2008)
HANUMAN, J-Class Sloop (EC6 Full Set – October 2008)
YENDYS, RP 55 (EC6 Continuous – November 2008)
SHOCKWAVE 69, RP IRC 69 (EC6 Continuous – August 2008)
LIMIT, RP IRC 62 (EC6 Continuous – December 2008)
LOKI , RP IRC 62 (EC6 Continuous – December 2008)
PENDRAGON, Davidson 69 (EC6 Continuous – April 2009)
LUNA ROSA, JV STP 65 (EC6 Continuous – December 2008)
SWAN 90, Frers 90 (EC6+ Continuous w/Discontinuous V1 – May 2009)
RANGER, J-Class Sloop (EC6 Continuous – January 2009)
GHOST, Luca Brenta 125 (EC6 Continuous Retrofit – January 2009)
LADY BARBARETTA, 110' Cruising Catamaran (EC6 – June 2009)
RAN, JV IRC 72 (EC6 Continuous – January 2009)
STEVENS 90, 90' Cruising Yawl (EC6 Continuous Mizzen – June 2009)
BEAU GESTE, Farr 80 (EC6 Continuous – July 2009)
HIGHLAND FLING, Wally 80 (EC6 Cpntinuous – August 2009)
BRIAND 86, 86' Performance Cruiser (EC6 Continuous – May 2009)
ALFA ROMEO, RP 100' Maxi (EC6 Continuous – June 2009)
MAXI DOLPHIN 65', (EC6 Continuous – May 2009)
Martin 49', (EC6 Continuous – May 2009)
Carbon Arrow, Martin 72' (EC6 Continuous – May 2009)
SINGULARITY, Lutra 80', (EC6 Continuous – June 2009)
KOKOMO III, Dubois 55m Sloop (EC6 Headstays and Backstay – December 2009)
IMAGINE, Dubois 44m Sloop (EC6 Hybrid – February 2010)
ZEFRIA, Dubois 50m Sloop (EC6 Hybrid – March 2010)
SWAN 601, (EC6 Continuous Retrofit – March 2010)
VIRBAC III, Open 60, (EC6 Continuous – April 2010)
FRENCH SPIRIT (ex Bols), (EC6 Continuous Retrofit – April 2010)
ICON, Perry 65 (EC6 Continuous Retrofit – May 2010)
TWIZZLE, Dubois 57m Ketch (EC6 Continuous – May 2010)
PUMA, VO70 (EC6 Continuous – July 2010)
WHISPER, Ted Fonatine 116' (EC6 Continuous Retrofit) – September 2010)
LAHANA (ex Zana), BW100 (EC6 Continuous Retrofit) – September 2010
HUMPHREYS 54, (EC6 Continuous – September 2010)
HOLLAND 150, (EC6 Hybrid – October 2010)
ROGERS 82', (EC6 Continuous – October 2010)
AY41, Briand 66m (EC6 Hybrid – November 2010)