

# The Even Keel

WHERE TECHNOLOGY MEETS PASSION

## TAKING THE “PLUNGE”: SWS-9401

Keel designed in partnership with Reichel Pugh Yacht Design and Southern Wind Shipyard  
Final construction drawings and methods generated by MarsKeel Design Group

**M**arsKeel Technology has partnered with Reichel Pugh Yacht Design to produce the SWS-9401 keel for the newest SW 94 SL Cruiser Racer by Southern Wind Shipyard. The final engineering was generated for MarsKeel Technology through MarsKeel Design Group and associates.

The SWS-9401 keel is a combination of a fully fabricated and 3-D Computer Numerically Controlled (CNC) machined fin with a custom cast lead MarsKeel Technology “T”-bulb. This fin is a major step forward in both design concept and production technique. It incorporates an additional step of complete CNC machining for all of its parts, not just a CNC finished surface, allowing for a very accurate confirmation of each part’s position in the assembly. The higher degree of precision during the fitting process permits for a more accurate finished part – a demand in the marine industry.

The fin is a fabrication made from SSAB Weldox 700 and 900 steel plates, chosen for their superior physical properties (Weldox 900, yield strength is 900 Mpa and tensile strength is approx. 1,000 Mpa, based on a plate thickness of 50mm.).

Through continuous consultation between all parties involved in the production, all eleven panels that make up the fin assembly were refined to meet, not just the engineering requirements set by the designer, but also to ensure a natural assembly progression. Everyone from the designer, naval architects and engineers (structural and welding), to the fabricator and machinist were involved to vet the design and ensure that it would work as planned.

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This is the dry fitting of SWS-9401 fin into its cast bulb, 32,000 lbs. The fin has just come off the mill, with no finish on it yet. This process is always done to ensure proper bolt alignment and all clearances are adequate for assembly by the customer, prior to shipment.



The SWS-9401 fin fabrication during the second surfacing pass on the horizontal CNC mill.



The completed SWS-9401 is dry fitted into a custom-made steel shipping cradle, prior to being loaded for shipment.

## ...SWS 94

In terms of the general production of the fin, the panels and the weld joints in the fabrication were designed to meet engineering requirements and industry fabrication standards by MarsKeel Design Group, based on the offered drawings from Reichel Pugh Yacht Design. The welding procedures defined by a welding engineer were confirmed through destructive physical testing before production. The actual welding process was carefully managed to evenly distribute the stresses from the welding throughout the fabrication, holding the fin in very tight tolerance. These stresses were removed through thermal stress relieving after fabrication, prior to machining.

A high level of quality control was maintained throughout production. For example, during fabrication, the welds, root pass and fill underwent Non-Destructive Testing (NDT) to ensure

quality. The actual tolerance of the surface on the fin was provided by the horizontal CNC mill at a tolerance of 0.004", using the offered IGES file.

Once completed, the fully machined fin was sent for dry fitting with the cast bulb, ensuring fabrication accuracy to design specifications and industry standards.

Generally, the finishing process includes etching of the fin, multiple application of Interprotect 2000E barrier coat and sanding until smooth, removing evidence of tiny machining scallops.

The bulb is patterned, molded and cast (bulb is a 32,500 lbs casting) in MarsKeel Technology custom designed tooling. The bulb has a recess for the attachment of the fin and integrally cast attachment bolts. The bulb is finished with epoxy based fillers and coated with Interprotect 2000E for a high tolerance finish. The bulb finish is sanded smooth

and inspected a final time prior to loading on the custom shipping cradle.

Finally, the entire keel, fin and bulb are fitted on a custom designed and built steel shipping cradle to ensure proper fit and security. The fin is removed from the cradle, allowing the bulb and cradle to be loaded together and the fin to be loaded and secured separately. The shipping cradle and bulb (as a single unit) are then loaded into a 20' open top sea container and the fin is loaded into place. Once secured and given a final inspection, the container is sealed and released for the trip to Southern Wind Shipyard's production facility in Cape Town, South Africa.

Southern Wind Shipyard, established in 1991, is the builder of quality yachts, supplying to clients worldwide.

For more information, visit [www.southernwindshipyard.com](http://www.southernwindshipyard.com).



The keel is attached and prepared to be submerged in the water for the first time on Southern Wind Shipyard's SW 94 SL Cruiser Racer, "Kiboko," in Cape Town, South Africa, Oct. 31, 2010.

# TECH TALK

By: Bill Souter

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## FABRICATED FINS

Are you looking for higher performance keel options for your yachts other than the standard all lead casting? The next step up in performance could be a fabricated fin, with an attached lead bulb. The fabricated fin offers both the designer and the builder options that are not possible with a lead casting and much more economical than the fully Computer Numerically Controlled (CNC) machined fin from either a billet or forging.

In terms of performance, the fabricated fin option is superior (Note that this is within normal design criteria. Very high performance yachts, i.e. Open 60, may still require solid construction based on foil sizes and working loads.) to the lead keel or solid billet through the overall lightening of the keel and the lowering of the centre of gravity. The fabrication fin keel allows the use of less material, both lead and steel, while achieving better sailing performance.

The new hybrid version of a fabricated fin does not involve formed shells welded to internal stiffeners. By utilizing complete 3-D modeling and machining of all of the parts, and CNC generation of the final surface, the engineering potential of both the design and the material are maximized. The newest example is the SWS-9401 keel (see *Taking the "Plunge": SWS-9401* on page 1.). This production method requires excess material (approx. 0.375") outside of the final surface to allow proper machining during the fabrication of the fin. A standard fabricated fin does not require this excess material because the keel does not require CNC surfacing.

In terms of production, this method lowers the tooling cost for the keel - a pattern and mold has to be made for the cast bulb only, not for the entire keel. This is important for one-off production, as the tooling price can be a significant portion of the cost of a keel. The timing for production is virtually as fast as an all lead casting. This can be accomplished by the simultaneous construction of the fabricated keel, fin and bulb. Independent production systems are run down until either attached or dry fitted.

The range of metals available for a fabrication include everything from mild steel, A36, to armour plate, CHT 100, to high strength Stainless Steel, 2205 Duplex and Weldox 900-700. It is the engineering and design requirements of the keel that will tend to define the material to be used. Generally speaking, the higher performance keels will lean toward higher strength materials (i.e. Weldox, 2205 Duplex SS), while cruising yachts will be able to use less exotic materials (i.e. A36, 44W).

In terms of price, a fabricated option is slightly above a single metal lead casting for a one-off keel. However, the cost of fabrication can be lowered by multiple orders and mass production methods (i.e. current production of J111). Repeatable production standards for fabricated fins can be met through careful design and material choices, as well as high levels of quality control and technical skill during assembly.

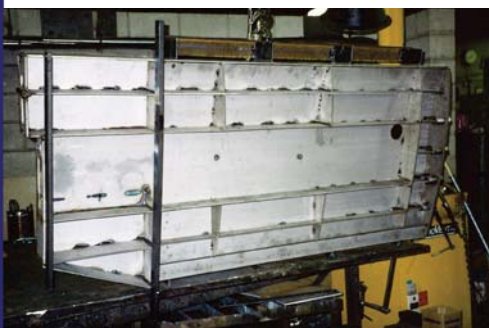
Another benefit of utilizing the fabricated fin is the designer's ability to use the internal volume of the fin

for other purposes. Depending on the type of keel, this volume can be used for tankage, as a current 68' is doing, or as a location for operating systems (i.e. hydraulic cylinders, as in the 62' Daysailer keel). Utilizing this offered volume in the fin allows the relocation or location of weight lower in the yacht, which in turn lowers, or at least maintains, the centre of gravity of the yacht.

The completed fins can be faired to a racing finish right from the fabrication shop, or if required, they can be CNC machined to achieve very high surface tolerance. The different levels of surface tolerance are approx. +/- 1-2mm on a hand faired fabricated fin (i.e. SWS 100), and approx. 0.004", plus applied paint roughness, for a CNC machined surface (i.e. SWS-9401).

To summarize the attributes of the fabricated fin and cast lead bulb/keel design option, the designer, engineer and builder are given material and surface tolerance flexibility, as well as additional usable volume and owner-improved sailing performance. Couple this with competitive production timing and pricing over the all lead casting, and in most applications a solid fin design and a fabricated option is something to consider.

If you would like to see some of the projects completed by MarsKeel Technology, please visit our web site, [www.marskeel.com](http://www.marskeel.com). For inquiries on materials or options, please call 1-800-381-5335 or email [bsouter@marsmetal.com](mailto:bsouter@marsmetal.com).



316 Stainless Steel fin showing internal structure and first side skin applied.



The internal structure of a 2205 Duplex lifting fin.



SWS 100 "L" fabricated fin dry fitted to cast bulb prior to disassemble and shipping.



Global Leader in Keel Technology  
*Where Technology Meets Passion*

Our clients  
don't compromise.

Neither do we.

SW 100 DS PH Peter Schreiber/courtesy of Southern Wind Shipyard

Builders and designers that demand the absolute best in keels demand MarsKeel Technology™.

That's why our customer list from around the globe includes the most respected and renowned names in the industry today. From the ultimate in design and manufacturing to worldwide shipping, we have the experience, advanced technology and passion to deliver the best without compromise.



SY Mrs Seven,  
SW 100 RS, PH Francesca van Rooyen/courtesy  
of Southern Wind Shipyard.  
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