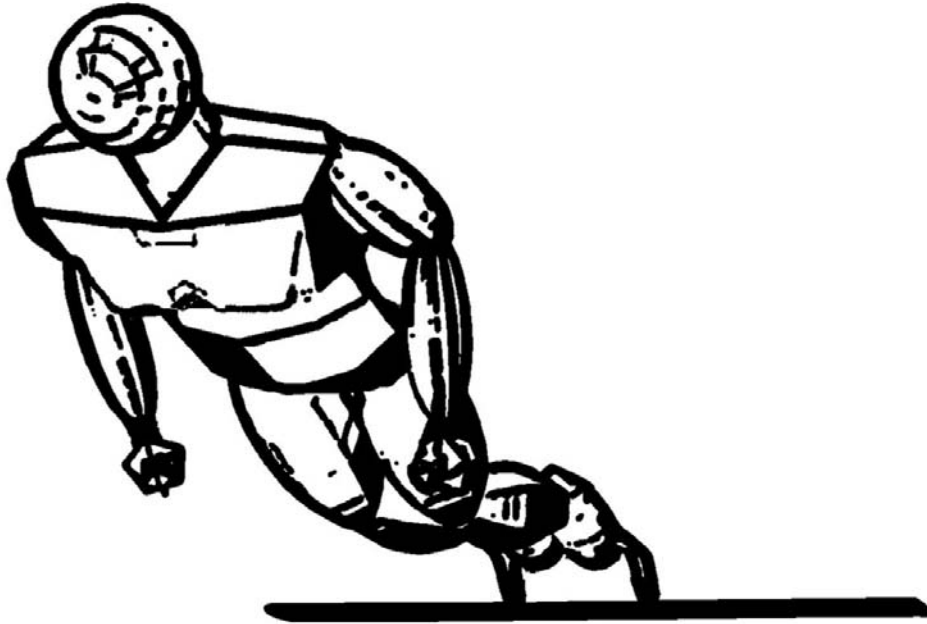




***DOL-Fin***  
*Dynamic Oscillating Lateral Fin*

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## DOL-Fin Classic & HP Owner's Manual (Rev. 2)



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## Safety:

Before using the DOL-Fin, read this owner's manual. The DOL-Fin is a unique piece of swimming equipment. Venturing into the water with unfamiliar equipment can result in injury or death. Understanding and being competent with the operation of the DOL-Fin is crucial for its safe use. Reading this manual can greatly assist a user of the DOL-Fin to become competent. However, it is the sole responsibility of the swimmer to determine whether or not they are competent to use any certain equipment, including a DOL-Fin, in a particular situation and to evaluate safety.

Swimming is hazardous in and of itself which can result in serious injury including drowning. Users of the DOL-Fin should be good swimmers who are comfortable in the water, and not prone to panic. Swimming with fins can be physically demanding. Therefore, users of the DOL-Fin should be physically fit. If a potential user has any doubt about their fitness level, he/she should consult competent medical advice before venturing into open water.

The DOL-Fin is not life saving equipment. It is intended, for swimmers proficient in its use, to swim faster and with less effort than with other fin designs. When learning to use the DOL-Fin, swimmers should train in confined water with lifeguard supervision. For your own safety, only venture into open water after you have mastered use of the DOL-Fin. As with any other form of unsupervised swimming, swimming with the DOL-Fin in open water or in any unsupervised conditions is done entirely at the swimmer's own risk. Before each use, always perform a pre-dive checkout of the DOL-Fin to verify the structural and mechanical integrity of the unit to the swimmer's own safety and risk standards. Even easy dives can become dangerous when equipment unexpectedly fails.

Always dive with a dive buddy qualified to perform a diver rescue in the case of an emergency, and be qualified yourself to perform a rescue for your dive buddy if needed. For your safety and the safety of your dive buddy you should receive dive training from a recognized training organization for the level and complexity of the dives you are planning. Remember, industry safety standards for diving still apply when using a DOL-Fin for swimming propulsion and it is important to have a viable plan for dealing with equipment failures or medical emergencies of any kind at any time during a dive.

As with all diving equipment, always perform a Pre-Dive Checkout (page 10) of your DOL-Fin monofin to inspect it for safety and proper functional operation. Never attempt to stand with both feet engaged into the DOL-Fin as you will be unstable which can cause you to fall over and can lead to injury. Be careful when using your DOL-Fin around others. The fin is hard and can injure others if you hit them with it. Make sure you leave appropriate safety clearances between yourself and others in the water so that it does not contact anyone else while you are swimming. Do not use a fin without the fin tips installed. The fin tips cover the potentially sharp ends of the fin to help to protect other surfaces if they are inadvertently struck with the fin.

Have fun, and be safe.



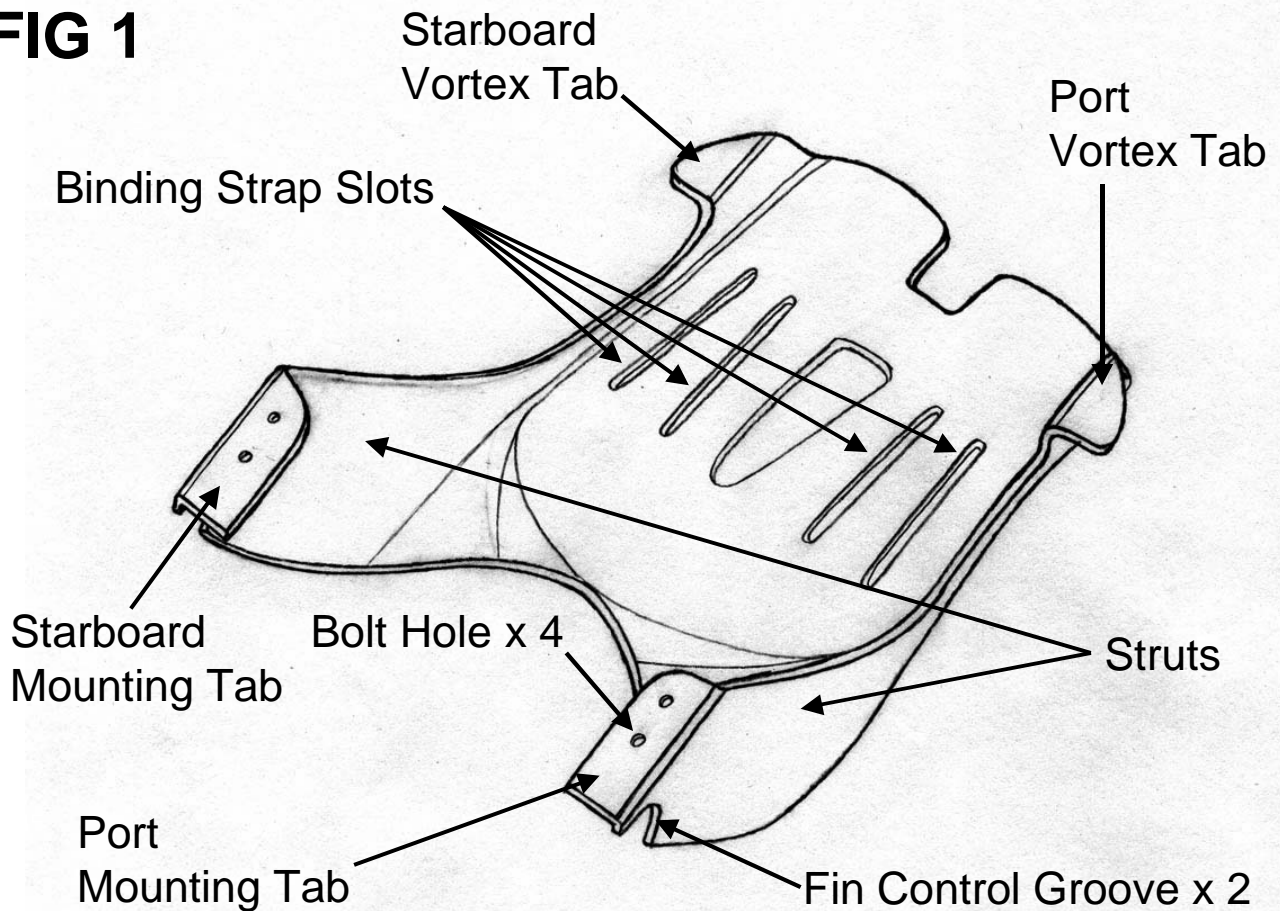
**Parts & Assembly:**

The DOL-Fin consists of the following parts:

- Base Plate (1)
- Binding Straps (2)
- Suspension Straps (2)
- High Aspect Ratio Fin (1)
- Fin Tips (2)
- Hardware (nut, screw and washer sets) (6)

The DOL-Fin Base Plate is the structural support between the high aspect ratio fin and the user's feet. **Figure 1** shows the Base Plate and labels various features.

**FIG 1**





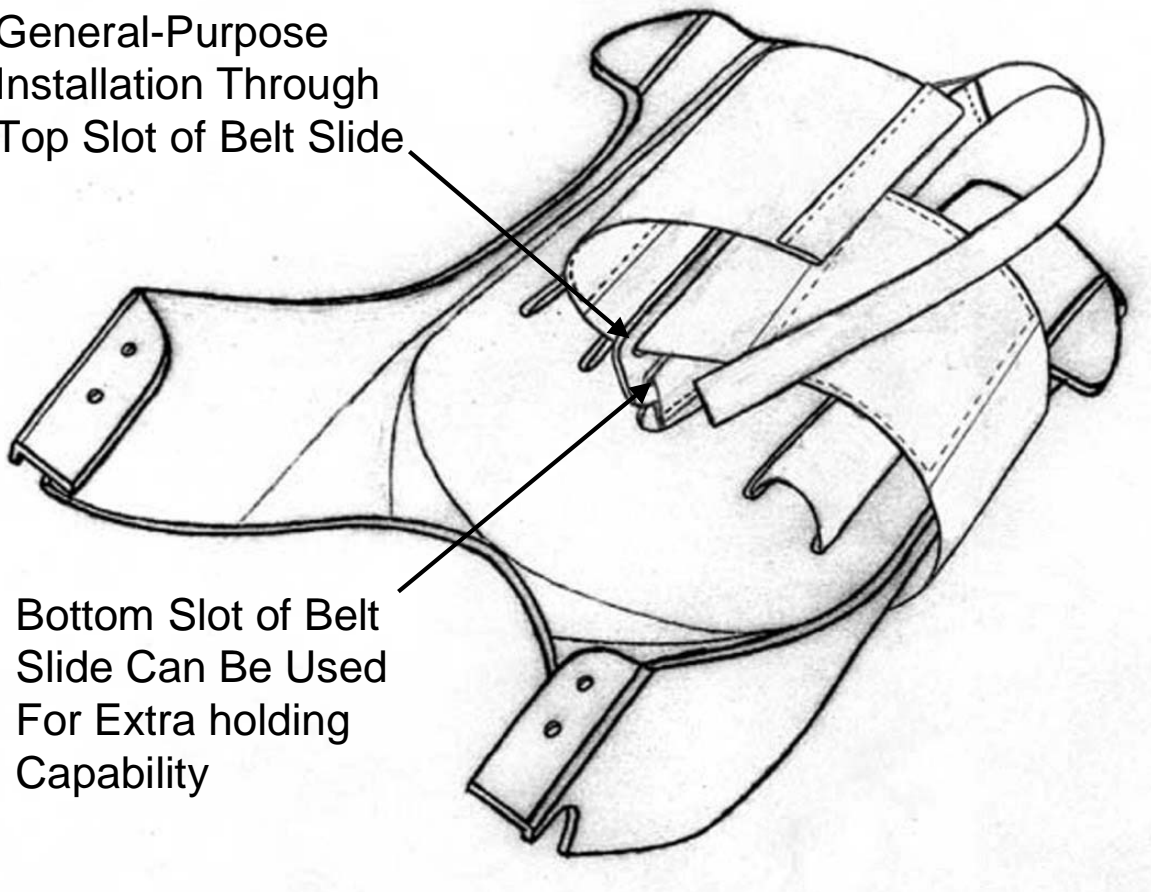
***Installing the Binding Straps:***

The Binding straps are user replaceable and can easily be switched out for straps of different styles and lengths to accommodate different uses and changes in size. With the DOL-Fin, there is no need to own one set of fins for warm water diving and a different set of fins for use with a dry-suit in cold water. Instead, swap out one set of binding straps for another size. **Figure 2** shows the general-purpose installation of the portside Quick-Adjust Binding Strap into the base plate. The starboard binding strap is installed in a mirror image of the portside. The binding straps can be made extra secure by looping the strap through the bottom slot in the belt slide first and then looping it back through the top slot. This provides an extremely secure holding of the straps, but it is also more difficult to tighten. Most users will configure the strap as illustrated.

**FIG 2**

General-Purpose  
Installation Through  
Top Slot of Belt Slide

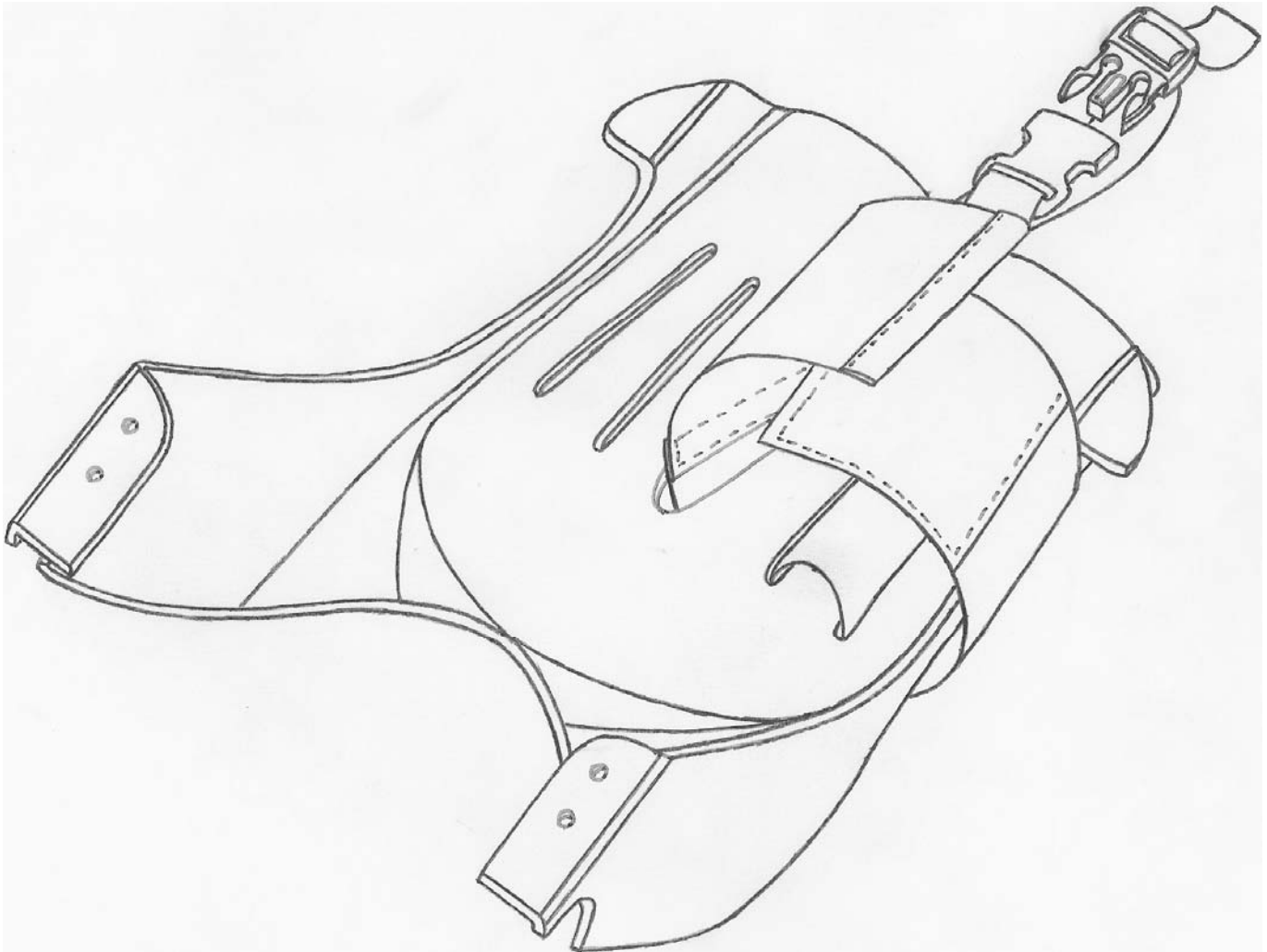
Bottom Slot of Belt  
Slide Can Be Used  
For Extra holding  
Capability





**Figure 3** shows the installation of the portside Quick-Clip Binding Strap into the base plate. The starboard binding strap is installed in a mirror image of the portside. The user should size the straps to their feet before entering the water. To size the straps, place the feet in the desired locations on the base plate, and then tightly close the hook-and-loop fastener of the straps around each foot. The straps should be wet for this. If the DOL-Fin will be put on after the diver enters the water, it is recommended that the user adjust extra length in the heel straps prior to entering the water. The straps may then be easily pulled tight after the feet are in the bindings and the side buckles have been secured.

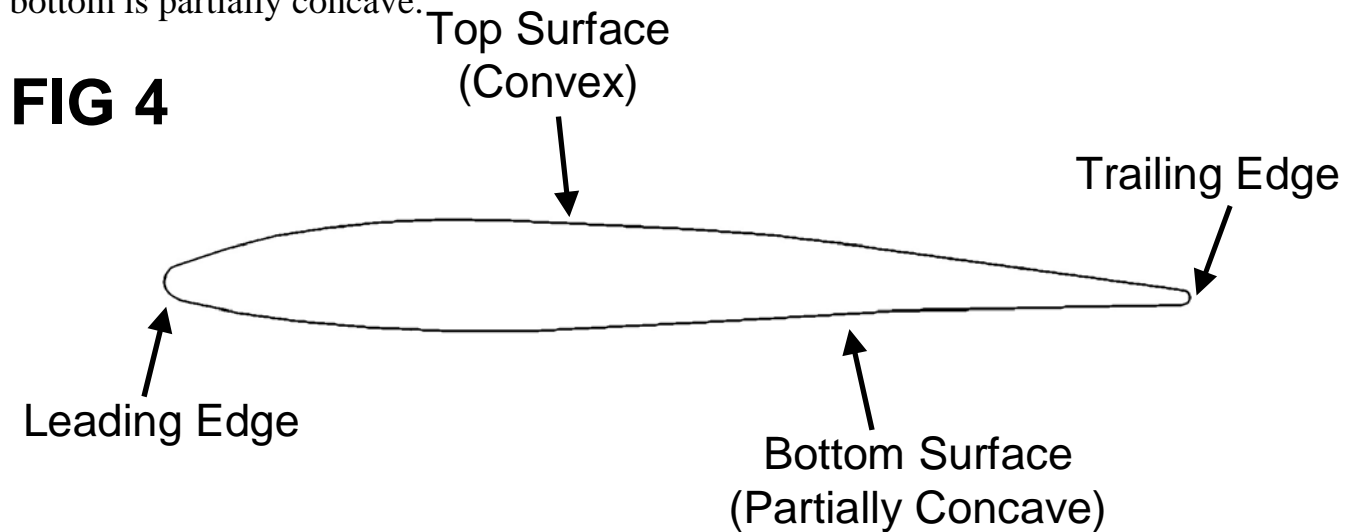
### **FIG 3**



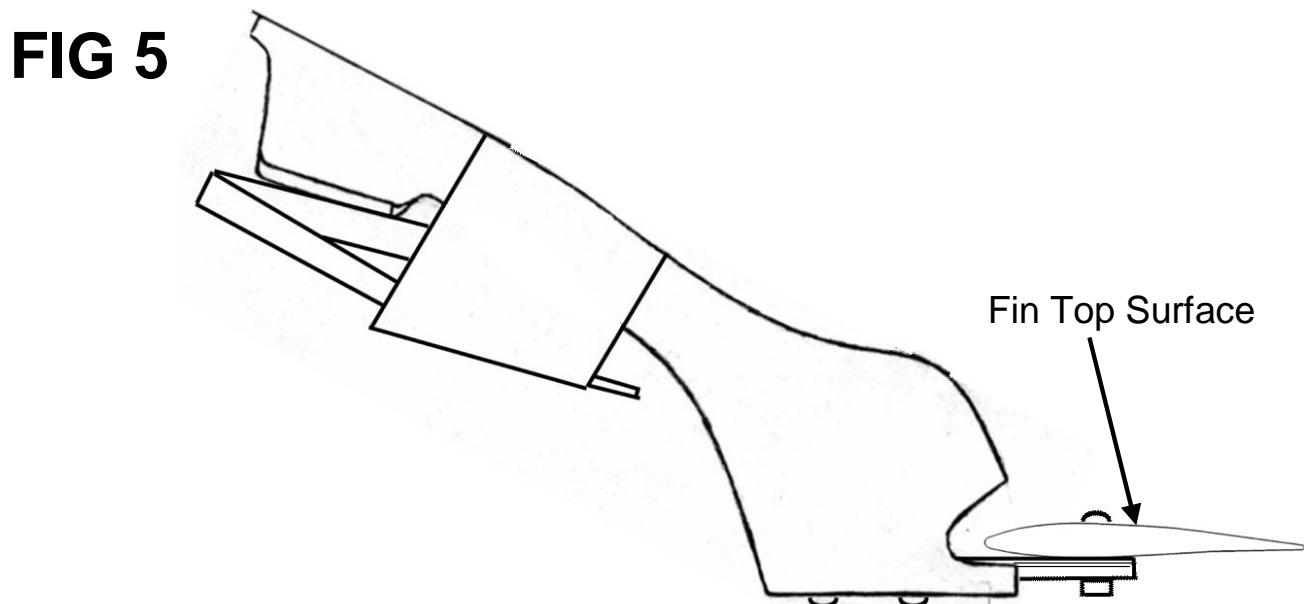


***Fin Mounting:***

The High Aspect Ratio Fin uses a custom non-symmetrical hydrofoil section. This fin has a top and a bottom as defined in **Figure 4** which shows an end profile of the fin's cross section. The top of the fin can be identified by its completely convex shape, while the bottom is partially concave.



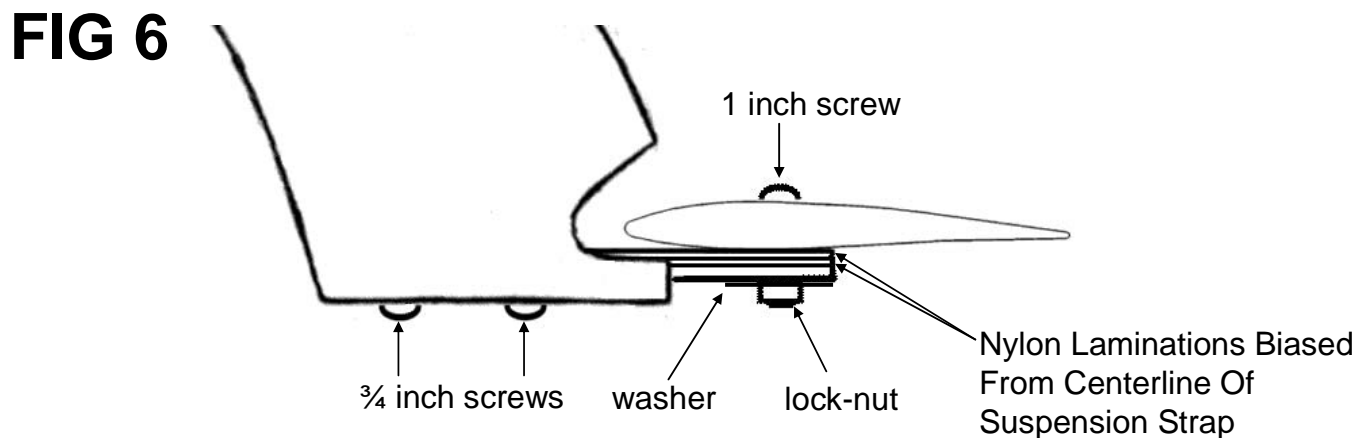
When properly assembled, the fin mounts to the base plate with the fin's leading edge and top facing the fin control grooves and the bottom facing the mounting tabs as shown in **Figure 5**. An improperly mounted fin will severely decrease fin performance.





### ***Suspension Straps:***

The Suspension Straps are made of an elastomer & nylon composite material configured to give the fin suspension a non-linear response. To achieve this characteristic, the nylon laminations are biased from the centerline of the Suspension Strap. This bias is visible by looking at the side edge of a Suspension Strap. To properly mount the Suspension Straps to the Base Plate, the nylon laminations should be biased away from the Mounting Tab and close to the fin as depicted in **Figure 6**. Improperly mounting the Suspension Straps to the Base Plate will affect the fin's angle-of-attack control and thus affect the overall performance of the DOL-Fin.



### ***Hardware:***

There are six sets of nut, washer and screw fasteners used in the DOL-Fin assembly. Each of the six fasteners attaches a Suspension Strap to either the Base-Plate or the Fin. The proper location of the screw heads can be seen in **Figure 6**. The screws always go through in a direction such that the screw end terminates at the Suspension Strap. One inch diameter fender style washers are retained between the Suspension Strap and the nut on each fastener set. Do not over tighten the screws, as the base plate could get cracked from the screw heads placing too much pressure on the mounting tabs. Each on the six nuts should be tensioned to approximately 1 lb\*ft (1.4 N\*m) of torque.



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## Pre-Dive Checkout:

Before each use, the DOL-Fin must be visually inspected for damage or loose hardware. Never use a DOL-Fin that has loose hardware or shows signs of structural damage or cracking. One of the great benefits of your DOL-Fin is its modular design which makes part repairs and replacement very easy to perform. So, if visual inspection shows that something on your fin is broken or compromised, don't dive it as is; **fix it!**

### *Inspection Checklist:*

- (1) Check the hardware. Make sure that all the nuts are appropriately tight and that the nut locking mechanisms are properly engaged such that none of the hardware can come apart during use. Visually inspect the hardware for corrosion. Replace any screws, nuts or washers that show signs of damage.
- (2) Visually inspect the Base Plate for signs of cracking and delamination. Carefully look at the area around the mounting tabs and the fin control grooves for cracks. A cracked base plate should be replaced.
- (3) Visually inspect the suspension straps for cuts, cracks or signs of weakening. The suspension action should be pliable and responsive. Replace Suspension Straps that show damage or seem degraded in any fashion. Degraded straps with the wrong amount of elasticity can diminish the DOL-Fin's performance.
- (4) Check that the Binding Straps are in good shape and that the Velcro has adequate strength for the dive.
- (5) For the DOL-Fin HP, extend the fin tip bungee to visually inspect the fasteners and materials of the bungee assembly for wear and loosening. Insert the fin tips into the foil ends in swimming configuration, and inspect them for desired shape, curvature and twist. If necessary, massage the fin tips with the hands until they hold the desired shape.

## Use and Operation:

Your DOL-Fin is a revolutionary swimmer propulsion device and works differently from traditional swimming fins. It is important that you read this section before using your new DOL-Fin.

The DOL-Fin Classic and DOL-Fin HP can be set up in different configurations for use. These include different types and sizes of foot binding straps and also different trim



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settings for the lateral fin's suspension system. Before entering the water to dive, check that the fin you have has the proper configuration for the dive you are conducting.

### ***Selecting a Trim Setting for the DOL-Fin:***

The DOL-Fin can be configured with different trim settings for the lateral fin's suspension system through inserting trim plates between the mounting tabs of the base plate and the fin's suspension straps. These trim plates modify the position of the fin relative to the fin control grooves as well as modify the elastic pivot point of the foil relative to its center of lift. Changing these settings can have a large impact on the dynamic balance of the hydrofoil and the overall thrust and feel of the fin. Your DOL-Fin can essentially become many different monofins through selection and use of different trim plates. Stock trim plates can be purchased through Smith Aerospace Corporation, but individuals can also experiment with making their own custom trim plates to get their own customized performance.

Ultimately, you will need to get your fin in the water and test it out to know how a particular trim setting will perform. In general, thicker trim plates will provide both more thrust and more resistance on the fin's down stroke, whereas a longer trim plate will provide both more thrust and more resistance on the fin's up stroke. Most individuals will find a particular configuration that they most prefer and will not change it after that. However, there may be times when a diver may want to change settings of their fin, such as when changing from scuba diving over to freediving. Freediving application of the DOL-Fin are likely to be optimized with thicker and longer trim plates as compared to scuba applications which may work best with either thin trim plates or no trim plates at all.

### ***Swimming With the DOL-Fin:***

There are two main forms for swimming with the DOL-Fin; the Starting Form, and the Power-Flow Form. The Starting Form is often used for much more than starting, particularly by SCUBA divers. It is often used by the sight seeing diver who is not trying to go anywhere, but wants to slowly wander around at typical SCUBA diving speeds and change directions frequently between strokes of the fin.

The Starting Form is characterized by a large up-kick with the fin mostly feathered to the flow (calf muscles relaxed), followed by the down-kick and then usually a coast period



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before the cycle repeats. With the application of a large amplitude down-kick, the Starting Form produces a powerful thrust which can rapidly accelerate the diver from stand still to intermediate swimming speeds. Various repetitions of this stroke are adequate for slow swimming. This method is often employed by DOL-Fin divers who want to match speed and follow other SCUBA divers using traditional stereo-fins. Aggressive use of the Starting Form is not recommended for swimming at faster speeds because the diver will quickly become exhausted. High speed swimming requires the diver to transition to the Power-Flow cycle after an intermediate swimming speed has been attained with the Starting Form.

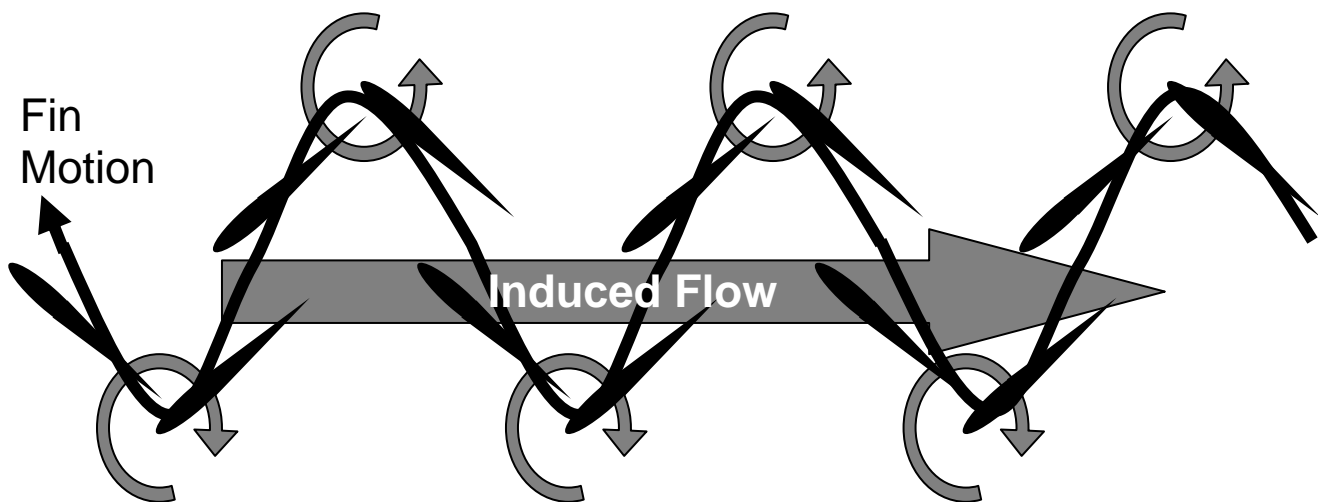
The Power-Flow Form is characterized by lower amplitude strokes of the DOL-Fin with the fin extended to the flow on both up-kicks and down-kicks (toes always pointed back) with no coast period between the strokes. The Power-Flow Form usually takes more practice to master than the Starting Form.

The Power-Flow Form is a continuous high-frequency and low amplitude motion of the DOL-Fin. The low amplitude strokes, which are usually 2 to 4 chord lengths of the fin in total magnitude, keep the swimmer's body substantially inline with his/her motion through the water which is crucial for the drag reduction needed for moving efficiently at high speed. The high frequency motion produces closely spaced alternating patterns of starting vortices of the oscillating fin, which forms a reverse Kármán vortex street to focus a powerful jet of water flowing through the volume affected by the fin as illustrated in **Figure 7**. The fin motion is shown in black. The reverse Kármán vortex street and resulting flow of water is shown in grey. This high speed water flow provides the thrust needed to accelerate to high swimming speeds, which may take several strokes of the Power-Flow Form to achieve. In general, faster DOL-Fin swimming requires a higher frequency cycle rather than a larger amplitude cycle.

Power-Flow Form does not have to result in high speed swimming. The reason Power-Flow Form can be fast is because it is efficient. Efficiency can be of benefit at any speed. Maintaining the stroke amplitude, but slowing down the frequency of the stroke cycle will produce a very efficient method of underwater conveyance which is useful for maximizing the distance that can be covered by both SCUBA divers and freedivers. Since the power required for propulsion rises to the third power of the speed attained, an intermediate swimming speed using the Power-Flow Form is the best way to maximize economy and distance covered. For example, if a swimmer is to double his/her swimming speed, he/she

will have to produce eight times the power needed at the slower speed, which can rapidly exhaust the available air supply. Swimming fast is fun, but it unfortunately comes at a cost.

**FIG 7**



Streamlining becomes increasingly important as a swimmer's speed increases. For freediving, a swimmer can substantially reduce his/her frontal cross section area and therefore drag, by extending his/her arms in front and tucking the shoulders in tight around the ears while swimming. For SCUBA diving, simplifying and streamlining of equipment configurations will have a significant impact on a diver's swimming speed.

***Control:***

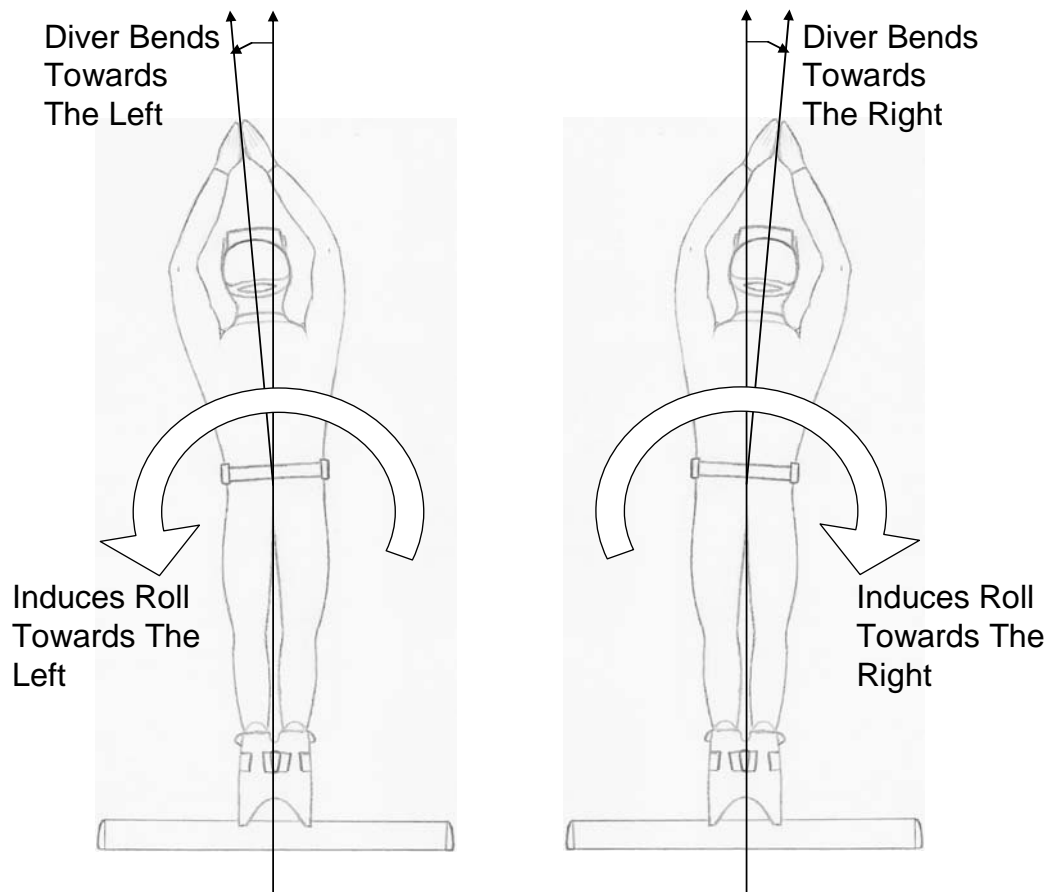
*Diver Steering and Roll Control*

Roll-trim buoyancy is a process by which a swimmer can control their roll orientation in the water. A swimmer, extended horizontally in the water, can control roll orientation by simply bending his/her body from side to side as illustrated in **Figure 8**. A swimmer's heavy legs at one end and the heavy head and arms at the other end will sink in relation the more buoyant chest area. If the swimmer bends his/her body reaching toward the right, the swimmer's body will roll to the right. If the swimmer bends his/her body reaching to the left, the swimmer's body will roll toward the left. In this way, roll trim buoyancy can be used to control ones roll orientation in water. This is also how steering is accomplished



while under propulsion with the DOL-Fin. As a user becomes proficient with the DOL-Fin, they will learn how to use roll-trim buoyancy for control without interrupting the swimming stroke.

## FIG 8



If this process is new to a swimmer, that person should practice using roll-trim buoyancy without a DOL-Fin first to become familiar with the process. One can practice this control by floating face down in the water with arms out in front and legs held tightly together. Bending from side-to-side will roll the swimmer one direction and then the other. Once the swimmer is comfortable with this, he/she can try it with the DOL-Fin. Combining this control technique with the before mentioned fin-kicking forms makes up the primary methods of swimming with the DOL-Fin.



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### *Controlling Fin Twist and Side-Slipping*

A common problem many people have when first using the DOL-Fin is avoiding fin twist and side-slip when stroking the fin. Don't get discouraged. It is a little like learning to ride a bicycle. It takes some practice and instruction, but once you know how to do it, it feels completely natural.

The important thing to remember is that the DOL-Fin is a “Dynamic Oscillating Lateral Fin”, not a “Dynamic Oscillating Skewed Fin”. The fin should always be stroked in a direction that is orthogonal to the span of the hydrofoil fin. If the fin is twisted in roll relative to the diver's upper body, and the diver inappropriately strokes the fin orthogonal to his upper body rather than orthogonal to the fin's span, the fin will side-slip and tend to increase the amount of roll misalignment in the fin with each down-stroke.

To become proficient at swimming with the DOL-Fin, the diver will need to learn to sense the fin's orientation from the base-plate through their feet and stroke the fin in the direction orthogonal to that sensed fin orientation. This may take a little practice to become proficient, but before long, the desired body motions will become automatic and happen without having to consciously think about it.

Adhering to this method will stabilize the fin and prevent it from diverging. Until even kicking is learned, a twisted fin can be corrected by a coast period where roll-trim buoyancy can be used to pull the fin back into position. With continued practice, the coast can be eliminated and smooth even kicking will become completely natural.

### *Entering and Exiting the Water:*

#### *Shore Diving*

If you are facing a long walk just to get to the shore, the DOL-Fin carries comfortably in one hand much like a lightweight briefcase. The fin between the fin's support struts is the handle and the fin extensions on either side of the struts can serve as a rack for your mask & snorkel and even a towel. Everything you need to go freediving can be transported in one hand as a single easy to carry package.



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The DOL-Fin is designed to be used with soft sole dive-boots without incurring any significant drag penalty. By using dive-boots, the diver's feet will have some protection from cuts and scrapes while gaining access to the water. Also, the long hydrofoil fin of the DOL-Fin Classic is so sturdy that it can be used like a walking stick to increase a diver's stability while wading through waves and surge when trying to negotiate a water entry or exit on a rocky shoreline (do not use the DOL-Fin HP's fin as a walking stick as it will damage the fin tips). Always be careful in such conditions as they can be dangerous and even deadly. Be sure to carefully assess the conditions for safety before entering the shore zone between water and land.

When shore diving, the DOL-Fin should be carried into and out of the water. To make it easy to put on, the fin's binding straps should be adjusted prior to entering the water. For safety, the fin should be put on and removed in water shallow enough to stand in. However, the DOL-Fin is put on and removed while in a floating position in the water.

#### *Boat Diving:*

The preferred method of entering the water from a boat is to use the rolling back entry. This works well for SCUBA diving as well as freediving. The DOL-Fin is secured to the swimmer's feet while sitting on the edge of the boat where the rolling back entry will be performed. With all gear set up and ready to go, the diver can then roll back into the water and start swimming. Since all of the diver's gear is ready to dive prior to entering the water this is the safest way to dive with a DOL-Fin. Be sure that you have appropriate clearances around you before starting your rolling back entry. You don't want to injure others with your fin or get it caught on anything in the boat.

On boats where a rolling back entry is not possible, a giant stride entry can be used. To perform a giant stride with a mono-fin, the diver only puts one foot into the fin, leaving the other foot free, so that it is still possible to walk. The DOL-Fin's base plate is designed to flex enough to make it possible to stand on a flat surface with one foot engaged into the DOL-Fin. Do not stand on uneven surfaces, stairs or steps as the irregular loads on the base plate may break it, damage that will not be covered by your warranty. The giant stride should be performed leading with the foot wearing the fin and that foot oriented with the toe pointed up such that the fin is aligned vertically. Once in the water, the free foot may then be secured into the mono-fin. Before attempting this for the first time in open



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water, a diver should be comfortable swimming with only one foot in the DOL-Fin. This should be practiced in a pool or other confined water with lifeguard supervision.

Never attempt to stand on the base plate with both feet engaged into the DOL-Fin as you will be unstable which can cause you to fall over and lead to injury. Never attempt to jump or dive from the end of a platform, dock, diving board or similar structure with both feet engaged in the DOL-Fin. Besides being dangerous, the irregular loads placed on the DOL-Fin can break the base plate, damage that will not be covered by your warranty.

When exiting the water, as with other fins, the DOL-Fin should not be removed until the swimmer has a firm hold of the boat or a safety line. Never leave yourself exposed to water currents without an effective means of propulsion.

### **Care & Maintenance:**

The DOL-Fin should be rinsed with fresh water after use to keep it clean and reduce corrosion. This includes the hollow sections of the High Aspect Ratio Fin. The DOL-Fin should be stored out of sunlight to avoid ultraviolet light degradation of materials.

Always perform a pre-dive checkout of the DOL-Fin before using it. See the “Pre-Dive Checkout” section of this owner’s manual for the inspection checklist.

Replacement parts for your DOL-Fin can be ordered from Smith Aerospace Corp.

### ***Fin Tips:***

The DOL-Fin Classic and DOL-Fin HP have different fin tips.

**DOL-Fin Classic:** The DOL-Fin Classic fin tips are short non-performance altering bumper strips that are glued into the ends of the hydrofoil fin. These fin tips are designed to be an eroding and replaceable part. They are there to help protect other surfaces (boat hulls and swimming pool surfaces) from the fin. If the fin tips become excessively worn and need to be replaced, they can be removed by pulling them out with pliers. Replace them with new fin tips by putting some waterproof plastic glue on the edges of the new fin tip’s tangs and then tapping the new fin tips into the ends of the fin until the tangs are completely inside the foil and only the external bumper part of the fin tip remains exposed.



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Remove the excess glue and any plastic shavings from the fin tips. Many adhesives can work for this job. One acceptable product is Loctite Stik'n Seal Waterproof Adhesive.

Do not use a fin without the fin tips installed, as an inadvertent fin strike will be more likely to injure someone or cause damage to property.

**DOL-Fin HP:** The DOL-Fin HP fin tips are large foldable performance enhancing hydrodynamic devices. A DOL-Fin HP with missing fin tips will suffer a significant performance penalty over the baseline HP design with fin tips installed. Damaged, deformed or misshapen HP fin tips can also effect and degrade the fin's performance and balance. It is important to maintain the HP's fin tips in good operating form for the fin to function properly and as designed.

The shape of the HP's fin tips can be maintained by storing the monofin with tips extended in swimming configuration and the fin lying on a flat surface with the back side of the base plate facing down similar to the view shown in **Figure 1**. The trailing edge of the foil will be resting in-line with the surface which will place an appropriate amount of curvature on the raked fin tips to maintain an optimum shape for performance. If the DOL-Fin HP will not be stored in this manner, or if the fin is packed in a gear bag for transportation, fold the fin tips over and secure them in place with rubber bands. This will help prevent them from becoming deformed. Fin tips that have become misshapen can be worked back into shape by massaging the plastic with the hands until the desired curvature has been achieved.

The fin tips on the DOL-Fin HP are held in place by a bungee system internal to the hydrofoil. If this internal system breaks, the fin tips will be free to come out of the foil which would have a significant degrading effect to the monofin's performance. The loop string ends of the bungee system that attach to the fin tips should be visually inspected prior to diving and compromised parts should be replaced. In critical applications where a suddenly lost fin tip and a 50% performance reduction could become a safety hazard, it is recommended that the user of the DOL-Fin HP elect to install the optional redundant bungee system for the fin tips. This option provides two independent bungee systems internal to the foil, each holding the fin tips in place. If either bungee fails on a dive, the monofin's performance will be unaffected unless and until the other remaining bungee also fails. The redundant bungee can be ordered from Smith Aerospace Corp. and can be installed at the factory on a new fin or installed by the owner to an existing fin.



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When replacing worn bungee systems, make sure to return the fin tips to the same ends of the foil from where they came or the curvature in the fin tips will be opposite from the desired curvature. When installing new replacement fin tips take care to install them with any preset curvature aligned in the desired direction relative to the foil to avoid extra work shaping the tips. When new tips are installed it is recommended to begin storing the fin as described above to get the proper shape set into the plastic. The longer it sets with the proper shape the more permanent the shape will become to the plastic. Divers can play with changing the amount of curvature and twist the fin tips have in order to customize the feel and balance of their individual monofin. This is a subtle method by which divers can optimize their fins performance to their individual swimming style.

To install a new bungee system, begin by fastening one end of the bungee to one of the fin tips with the loop string and plastic zip tie. Thread the loop string through the loop in the end of the bungee and then through the forward hole in the fin tip. With the loop string threaded through these two parts, bring the free ends of the loop string together and then fasten them together with the zip tie tightened to form about a 1 cm loop. Trim the excess tail from the zip tie. Adjust the loop such that the zip tie is biased closer to the bungee than to the fin tip so that it will not interfere with folding the fin tips later on. This can also be adjusted after assembly if you find that things moved around on you. If you are installing a redundant bungee system repeat this step using the aft hole in the fin tip. The next step is to pull the bungee assembly through the aft hollow of the hydrofoil. This can be accomplished using a wire, a string, or a combination thereof to pull the bungee(s) through the foil. Then, with the already fastened fin tip installed into one end of the foil and the free end of the bungee(s) stretched through and exposed on the opposite end of the foil, use the remaining loop string and plastic zip tie to fasten the remaining fin tip the same as the first fin tip was fastened. Use locking pliers to hold the bungee(s) in place, or hook the tail of the bungee loop over the edge of the foil, to keep the bungee from receding back into the foil while the second fin tip is being installed.

### **Warranty:**

A 6 month limited warranty is available to customers only. You are a customer if you own a DOL-Fin Classic or DOL-Fin HP which you purchased from Smith Aerospace for personal use. We warrant that your DOL-Fin Classic or DOL-Fin HP will be free of defects in materials and workmanship under normal use for a period of 12 months from the original date of purchase. If your DOL-Fin should prove to be defective within the



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warranty period, we will repair it (or, if we think it necessary, replace it) without charge to you except for shipping and handling costs. This limited warranty does not cover any damage caused by accident, misuse, shipment or other than ordinary swimming and diving uses as outlined in this DOL-Fin Classic & HP Owner's Manual.

Please contact Smith Aerospace Corp. through our contact information listed on our website at <http://www.smithaerospace.us> or by mail at PO Box 130 Sahuarita AZ. 85629, USA to get a shipping address for returning your DOL-Fin parts under warranty. Be sure to include a return address, description of the product defect, sales identification number and any other information pertinent to the product return.