Protective Suits – All you need to know…….

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Introduction

Some form of protective suit is required for all diving, whether it be just a pair of swimming shorts or a full-blown Drysuit (although there are a few weirdo's out there who advocate diving 'in the buff'!). Water conducts heat 25 times faster than in air which is why divers, in all but the warmest of water, require some form of protective suit. If body heat production cannot match the speed at which the water absorbs it, the diver eventually becomes chilled. This chilling affects the ability to think clearly and impairs control of body functions like dexterity. The type of protective suit chosen will be dictated primarily by the state of the water and its temperature. Other factors such as the type of dive, air temperature and prevailing weather conditions will also impact on the type of suit chosen.

There are various types of protective clothing and the materials and construction of the suit may differ greatly. Let's take it suit by suit starting with warm water / pool wear.

Swimwear

Swimwear may be worn in water above 28^{o}C and is fine to wear in the pool, and for occasional dives 'in the tropics'. A T-shirt should be worn to protect the torso from chafing by the Buoyancy Compensator, and shorts are preferable to trunks for the same reason. The advantage of swimwear is that it takes no time to change into, it is comfortable and creates a 'sense of freedom'. The main disadvantage is that swimwear offers little in the way of protection from the marine life – don't be surprised to find fish 'having a nibble' particularly cleaner Wrasse in tropical locations. You can also easily pick up cuts and grazes from coral, and rashes if you come into contact with any 'fire coral'. Once out of the water, it is usually necessary to change immediately as the wet swimwear will cause rapid cooling of the body especially if the wearer is in a shaded and/or breezy position. Swimwear has a negligible effect on buoyancy.

Dive Skins

Dive Skins are akin to wetsuits, but don't really have any thermal properties. Dive Skins are usually made of close fitting stretch Lycra of varying thickness or 0.5mm Neoprene. Most Dive Skins have a lightweight nylon zip running down the front of the suit. Due to their body-hugging nature, they can be revealing and will show every bump and ripple of your body, so should only be worn by a well honed male Adonis or a curvaceous young lady! Dive Skins provide slightly more protection than swimwear as they are generally a full suit (i.e. they have long sleeves and legs), and will protect the wearer from the marine life and from most cuts and grazes caused by contact with coral. Dive Skins are also useful as they can be worn in conjunction with a thicker wetsuit to provide additional warmth by using the layering principle.

Some divers may wear a Lycra Dive Skin to avoid the rash associated with the rubbing of the nylon facing of a neoprene wetsuit against the skin, especially under the arm and around the neck. Rash Vests are specifically made for this purpose and are a thin Lycra shirt which protects the upper body from coming into contact with a Neoprene suit. Again Rash Vests may also be worn as an additional thermal layer. Dive skins have little effect on buoyancy, although a light weightbelt may be needed to compensate if wearing a 0.5mm Neoprene skin.

Again, once out of the water a dive skin provides little protection from cooling breezes, so it is wise to have a change of dry clothing, or wind protection readily available. Expect to pay £50 - £150 for a quality Dive Skin – try Oceanic or ScubaPro for good quality skins. Rash vests are available from most watersports centres and cost £15 - £50 again depending on quality and logo!

Wetsuits

Wetsuits are perhaps the most common thermal protection worn by divers. In water temperatures as cold as 12 degrees and within commonly accepted recreational depth and time limits, they perform well. Minor punctures or tears are easily fixed and are not usually severe enough to stop a day's diving. Wetsuits cost less to buy and maintain than drysuit systems. They are also usually lighter to take travelling. However, they perform less well than drysuits as water temperature decreases and depth increases, and as dive times are extended or repetitive dives are made.

Wetsuits, as with all dive suits, cannot replace lost body heat. Wetsuits act only to slow down heat loss and this is achieved in two ways. Firstly, the suit creates a physical barrier that body heat must cross in order to reach the cooler water outside. The thicker the suit, the longer this takes and the longer chilling is delayed. Secondly, they allow a small layer of water to become trapped between the wearer's skin and the inner of the suit. This layer of water is quickly warmed by the body and as long as the warm water is not allowed to escape, it will assist in keeping the wearer warm. The more often water enters and exits the suit (water movement through the suit is called 'flushing'), the greater the amount of heat that is used from the diver's body to warm it. This is why a wetsuit *must* be close fitting. Wetsuit designers try to ensure a close fit that sculpts around the diver's body, and special features like seals and waterproof seams and zips may be used to decrease water flow. A suit bought for comfort will not efficiently trap the warm layer of water and will allow more cold water to flush through, thereby cooling the wearer.

Construction

Wetsuits are made from expanded foam neoprene rubber. Expanded foam neoprene contains bubbles of Nitrogen. The Nitrogen bubbles are created in the rubber by either a chemical reaction, to give chemically blown neoprene, or by injection to give gas blown neoprene. Gas blown neoprene is considered to be more consistent in its production qualities and is usually more supple. Neoprene wetsuits come in various thicknesses to accommodate a range in water temperature, cuts and designs.

Expanded foam neoprene itself is normally uncompressed and comes in thicknesses ranging from 1mm to 7mm. The neoprene is normally laminated with thin sheets of Nylon which protects the neoprene, makes the suit more hard wearing and allows colour to be added to the end product. The inner Nylon laminate may have a plush 'loopstitch' finish – this type of finish enables ease of entry to the suit and also retains additional warmth. The neoprene itself may also be impregnated with metal such as Titanium in an attempt to increase its thermal properties.

Obviously, wetsuits are made from several pieces of neoprene stitched together. The actual method of stitching is important as it not only affects the durability and comfort of a suit, but also the cost! The different types of seam construction in wetsuits are;

(1) Overlock Stitch
(2) Flatstitch or Flatlock
(3) GBS – Glued & Blindstitched
(4) GBS with seam tape (Mauser)

1) Overlock Stitch - recommended for warm water suits (i.e. 2/3mm), it is the cheapest of all stitches and the most bulky and least comfortable. The seams are stitched on the inside. From the outside you will not see any stitching. On the inside you may recognize this construction from clothing as it is commonly used for sweat shirt and T-shirt seams. Some water may seep in through these seams.

2) Flatstitch or Flatlock – also recommended for warm water suits (3/5mm) Probably the most common stitch used in wetsuit construction. The edges of the neoprene are butted together, and then stitched in a flat weave. You can recognize this seam from the outside as the stitch looks like railroad tracks. The interior and exterior seams look about the same. The interior seam construction is flat and is more comfortable against the body then the overlock stitch. Some water may seep in through these seams too.


Flatstitch or Flatlock Stitch

3) Blindstitch is recommended for cold water suits (5/7mm) and is considered as the most durable and most expensive. This construction is best for cold water because the seams are glued, then bonded with a pneumatic compressor before being stitched, typically on both sides, although some seams are only stitched on one side. The thread and needle holes penetrate only the top area of the surface. This seam construction looks similar to the Flatstitch although it is narrower in the width. Very little water, if any, will seep through these seams.

4) Blindstitched with seam taping (Fluid Seal) otherwise known as Mauser stitching is recommended for extremely cold water usually 10 ^{o}C and below. The seam construction is the same as Blindstitch except the inner seams are reinforced or covered with tape. Very little water if any will seep through these seams.

Blindstitch

Choosing a Wetsuit

Three factors should determine your choice of wetsuit: planned maximum depth, anticipated water temperature (it is usually cooler, the deeper you dive) and work rate. For example, instructors who spend long periods stationary while teaching entry-level courses and are acclimatised to the water temperature will often need a thicker wetsuit than a holiday diver. Once you have decided on how thick you want the neoprene material to be, you will then need to decide on the design of wetsuit that you require.

The most basic is a Shortie. This is a basic suit usually made of 1-3mm neoprene with short arms and legs, thereby only providing protection to the torso. The suit is normally closed by a full length, medium duty, nylon zip running down the spine. The neck may have additional fastenings to minimise water ingress. This suit can be ideal for diving in the tropics with water temperatures of 27 ^{o}C or above. However, not having any arm or leg covering will lead to marine life and coral hazards. The suit may also be used as part of a layering system with a full length suit on top, or a dive skin underneath.

A shortie wetsuit

The next type of suit is called a Steamer – these normally have long legs and sleeves, although some sleeves are detachable. Steamers are the mainstream suits for a lot of watersports and there is an extremely wide choice of manufacturer, price and construction. Some suits use different thicknesses of neoprene to make the suit more articulated. Most steamers are manufactured out of 3mm or 5mm neoprene, although 7mm steamers are also available. Most general watersport suits will not have the additional features found on suits made specifically for diving. Diving suits generally have some sort of additional protection on areas of high wear such as the knees and the shoulders. Good quality diving suits will also feature a Spine Pad, which is a thicker area of neoprene which runs down the spine to aid diver comfort when wearing a cylinder. Zips on steamers are usually medium weight nylon zips either running along the spine or down the front. Suits with cross-shoulder zips can be found, but these zips tend to be inflexible and therefore restrictive and they also make the suit difficult to self-don. The neck will usually be closed by an adjustable Velcro strip and the ankles and sleeve cuffs may have small zips fitted to allow ease of dressing. Most steamers have a smooth-skin seal at the neck, ankle and wrists to help reduce water flushing.

Steamers

Whilst steamers come in a variety of thicknesses, even the thickest may not be enough to cope with cold conditions. It is therefore possible to get two piece wetsuits usually consisting of a 'Long John/Farmer Jane' long-legged sleeveless garment, normally fastened at the shoulder. This is then augmented by a long sleeved jacket, normally with an attached hood with a full length front zip. This type of suit will give up to 14mm of Neoprene over the main torso area, for warmth whilst retaining only 7mm of neoprene over the arms and legs to maintain flexibility. Two piece suits can come in a variety of weights, but the normal is for either 5mm or 7mm.

A 3mm wetsuit will typically retail at about £50 - £120 depending on make and whether it is a standard watersports suit or one made specifically for diving. A 5mm wetsuit will retail at between £100 to £150, whilst a 7mm suit will retail between £130 and £200. A two piece suit may add about £30-£50 to the price.

All wetsuits, immaterial of thickness, are prone to cool the wearer once out of the water. It is therefore imperative that a wetsuited diver either changes into warm dry clothes or puts on a windproof jacket and hat immediately after a dive in order that they keep warm. Even a slight breeze in what would normally be a hot tropical sun, can be surprisingly chilling!

Finally, it is important to have a correctly fitting wetsuit. If it is too loose the suit will be ineffective at minimising water flushing. However, too tight and it will reduce your body's blood flow. Both outcomes will result in rapid heat loss. A well-shaped wetsuit is essential to reducing flushing. It must closely follow the contours of the human body. A badly-shaped suit will have pockets of water in it. A combination of stretchier neoprenes, contoured shaping and a range of sizes means that many – but not all – people can be accommodated with off-the-peg suits. For those of a non-standard size, 'made- to-measure' suits are available from some companies. It may take six or more weeks to deliver a made-to-measure suit, and the suit may need small final adjustments. It may be worth visiting the manufacturer for a fitting.

Semi-Dry Suits

For very cold conditions, it will be necessary to wear a Semi-Dry suit. These suits are similar to a wetsuit in that warmth is maintained by the neoprene and a small amount of water trapped within the suit. Suit construction is also similar, but these suits will almost exclusively be Blind (or Mauser) stitched.

The difference between a Semi-Dry suit and a standard wetsuit are that the ankle and wrist seals are cut tight, and have a smooth-skin seal, to minimise water flushing. The neck seal will also be cut to minimise the entry of water. The effect of minimising water entry is to enable the diver to maintain the warm water next to the skin. These suits are generally two piece with attached hoods, and again are usually made of either 5mm or 7mm neoprene. It is possible to buy single layer Semi-Dry suits but obviously these are not that effective in cooler water. It is imperative that these suits fit well and that the wrist and ankle seals are tight to prevent water seepage (but not so tight that blood circulation is slowed!).

A good quality Semi-Dry suit will retail at between £150 and £250 depending on manufacturer, thickness and features.

The same après-dive chilling effects apply to a Semi-Dry suit as for a wetsuit and precautions must be taken. Please read the above section on wetsuits for more information on neoprene suits.

Drysuits

Membrane Drysuit

Urethane Drysuit

Neoprene Drysuit

In the U.K., and other cold water areas, the Drysuit has become the suit of choice for the experienced diver. In fact, most divers undertaking diver training in the U.K. now start using a Drysuit right from the start. Drysuits are much warmer than wetsuits or Semi-Dry's as they use air for insulation and they are regularly used in water temperatures of 20 ^{o}C down to freezing point.

Drysuits are one-piece suits with watertight seals at the neck and wrists – these seals should exclude water entirely, but most seals will let some water in during use – and a watertight zip. Using watertight seals and a watertight zip, enables the diver to wear warm dry clothes underneath the suit to insulate themselves from the outside water. The amount of clothing warn beneath a Drysuit depends on the material used in the manufacture of the drysuit. Specialised thermal undersuits specifically designed to be worn with a drysuit are normally worn by divers, and these are described in more detail later. 'Normal' clothes may also be worn for insulation, but these are not normally as warm or as practical as an undersuit. Most suits have integral boots, but some come with attached waterproof socks over which a separate pair of boots may be worn, or for use with slipper fins.

Drysuits may be bought 'off-the-peg' and it is worthwhile going to a specialist retailer to get the best fit. It is therefore not recommended that drysuits are bought via the Internet. Made-to-Measure suits are also available at a price!

Caution : The use of diving drysuits requires specialised training prior to their use in open-water.

Drysuit Construction

The construction of a Drysuit will vary depending on the material used for the suit. Quality seams are essential to the longevity and watertightness of any drysuit In the main, Strobel and cup stitches which are waterproof are used on the majority of drysuits. In this type of stitching the thread does not fully penetrate the suit. Cup and Strobel sewing machines are expensive to buy and as the suit usually requires stitching twice they are more labour intensive to produce – these factors are obviously reflected in the final price. However, price is normally dictated by the quality of the materials used in the manufacture of the suit. Neoprene suits are usually glued edge to edge and then sewn. Membrane suits are usually stitched and sealed along the seam with either waterproof tape or sealant.

Seams can leak due to ageing or damage. If the sealant breaks down or is dissolved by chemicals, water can wick along the stitch and then spread through the suit lining. Vulcanised suits use a heat-pressure seal and are effectively seamless.

Types of Drysuit

There are no real 'types' in Drysuits. However, the buyer is presented with a series of choices. These may include:

- The materials used its construction (Neoprene or Membrane)
- The type of seals used at the cuffs and neck
- The type of valves used
- The type and position of zip
- Whether the Drysuit has attached boots or socks with separate boots
- Colour
- Accessories
    - Ancilliary pockets
    - Pee zips and valves
    - Internal Braces
    - Attached hoods
    - Glove systems

Drysuit Materials

Foam neoprene

Manufacturers – Northern Diver, Otter, ScubaPro, Robin Hood, Aqua Lung

This is the same material that is made into wetsuits, and is widely available. The spongy, gas-filled rubber is a poor conductor of heat, which, combined with the insulating air inside the suit, makes it ideal for cold-water diving. A nylon lining on both sides of the neoprene increases its strength and makes it easier to put on.

Advantages

- Durable
- Moderately low cost - £350 - £600
- Excellent thermal protection both in and out of the water.
- Thermal undersuit not always required.

- Very resistant to puncturing
- Easy to effect minor repairs
- Close fitting
- Low drag in water.

Disadvantages

- Buoyancy changes. At the surface, for example, a 5 mm neoprene suit is warm but very buoyant, so a diver must carry lots of weight. During descent, the air bubbles inside the material compress, the suit loses warmth and buoyancy, and the diver must add lots of air to stay neutrally buoyant, making it least effective at depth.
- Bulky
- Heavy
- Extremely slow to dry.

Crushed neoprene

Manufacturers - DUI

Originally patented by the US manufacturer DUI and consists of foam neoprene that's been hydrostatically compressed to eliminate the bubbles

Advantages

- Thin, supple and rugged material
- Crushed neoprene suits are fairly close-fitting and do stretch.
- Little inherent buoyancy.
- Medium drying time.
- Durable and very resistant to puncturing.
- Easy to effect minor repairs.
- Reduced drag in water
- Excellent mobility.

Disadvantages

- Little insulation, so an undersuit must be worn.
- Very heavy, especially when wet
- Expensive - £850 - £1200

Compressed neoprene

Manufacturers – Northern Diver, Otter, O'Three, Poseidon

Offers many of the advantages of both foam neoprene and membrane drysuits. The material starts off as foam neoprene, but it's only partially compressed usually to 4-5mm. Hyper-compressed neoprene of 2.5mm is available but is more expensive.

Advantages

- Offers some insulation, although an undersuit will generally be worn
- Lighter than normal foam neoprene
- Less buoyancy change as it compresses only a small amount at depth
- Medium drying time.
- Durable and very resistant to puncturing
- Easy to effect minor repairs
- Excellent mobility
- Reduced drag in water

Disadvantages

- Medium-Upper cost range - £500 to £900

Urethane

Manufacturers – Abyss (USA); No U.K. manufacturers (to my knowledge)

A relatively cheap material to manufacture. An outer layer of abrasion resistant nylon is coated on the inside by one or more layers of waterproof (Poly)urethane.

Advantages

- Usually the least expensive membrane suits
- Little buoyancy change
- Excellent mobility out of water.
- Quick drying time

Disadvantages

- The material offers little stretch, so must be loose-fitting which creates drag in the water.
- Minimal thermal protection - Full thermal undersuit must be worn.
- Moderately bulky
- Slightly less resistant to puncturing and more difficult to effect minor repairs than neoprene types.
- Not very durable – depends on the outer nylon layer.

Trilaminate

Manufacturers : Northern Diver, Otter, ScubaPro, Oceanic, Robin Hood

Trilaminate material usually consists of a thin, waterproof layer of rubber sandwiched between two linings, which tend to be nylon. The inner lining makes it easy to slip the suit on and off; the outer one protects the rubber from abrasion. The outer nylon comes in a variety of weights – the better suits now use Cordura, a highly abrasion resistant nylon fabric.

Advantages

- No inherent buoyancy.
- Short drying time
- Less bulky than neoprene suits
- Excellent mobility out of water.
- Moderately inexpensive - £300 to £700

Disadvantages

- Minimal thermal protection - Full thermal undersuit must be worn.
- Slightly less resistant to puncturing and more difficult to effect minor repairs than neoprene types.
- Some drag in water due as trilaminate does not stretch and suits are not close-fitting.
- Diver may require ankle weights as suit legs may be cut large and therefore contain more trapped air.

Vulcanised rubber

Manufacturers – Viking (Gates)

Advantages

- Dry almost instantly
- Quick to repair using glue and a patch.
- The seams are usually vulcanised as well, so are very tough and shouldn't leak.
- Long-lasting if heavy-weight suit is chosen.

Disadvantages

- Thin suits are vulnerable to punctures
- Moderately expensive

New materials and designs are always being tested and introduced by manufacturers. They can't all be covered here, particularly as many are patented and their exact composition can't be published. Keep your eyes peeled: there are some good innovations around.

Drysuit Seals

Good fitting seals are essential in a Drysuit. Seals can either be made of Latex or Neoprene.

Latex seals come in a variety of sizes, and most will fit a range of wrists and necks. Latex seals are relatively inexpensive and DIY kits are available to replace seals that are torn/worn. It is important to get the correct size of seal, as seals which are too tight may restrict breathing and circulation to the hands. Latex seals are also quite cold to wear, as they have no thickness and as the seals are positioned at the wrist, they may lead to a diver having cold hands. Some suits are now being made with neoprene covers over the latex seals to help retain warmth. Latex seals are extremely easy to damage, particularly whilst donning a suit – use plenty of talcum powder on the seals to ease your way in.

Neoprene seals are more expensive and they require personalisation to ensure a good fit. However, a neoprene seal is very hard-wearing and warm to use. They are also very comfortable and may be worn all day which causing much discomfort, unlike the Latex seal. Neoprene seals have a smooth-skin finish on one-side – this needs to be next to the skin so it is usual for a Neoprene neck seal to be rolled inward to form a collar. When air is injected into the suit, this collar will expand and form a closer seal. It is possible for Neoprene seals to 'pop' if the air pressure in the suit cannot be contained. In these events a diver will become damp! In any event, Neoprene seals have a tendency to be a little damp, but most divers are willing to accept this for a superior level of comfort.

Drysuit Zips

It is important for a Drysuit to be fitted with a quality waterproof zip. Zips come in a variety of weights which is measured in terms of pitch. Most standard suits come supplied with a medium-weight zip with 8 pitch teeth. However it is worth the additional cost of a 6 pitch heavy-weight zip as it will last much longer and be more robust in service. Heavy-weight zips are not as flexible however and are therefore not suitable for use in a front-entry suit. Drysuit zips normally have an inner zip guard to ease zip closure and also to provide a thermal barrier. Some suits also have an external cover (sometimes zipped) which further protects the zip from detritus. Zips can be replaced in suits, but it is an expensive repair – a standard replacement medium-weight zip across the shoulder will cost around £100-£140 with a heavy-weight replacement costing about £20 more. A replacement medium-weight front-entry zip will cost in the region of £130-£180. It therefore pays to look after the zips on your suit – see the section below on suit maintenance.

Drysuit Valves

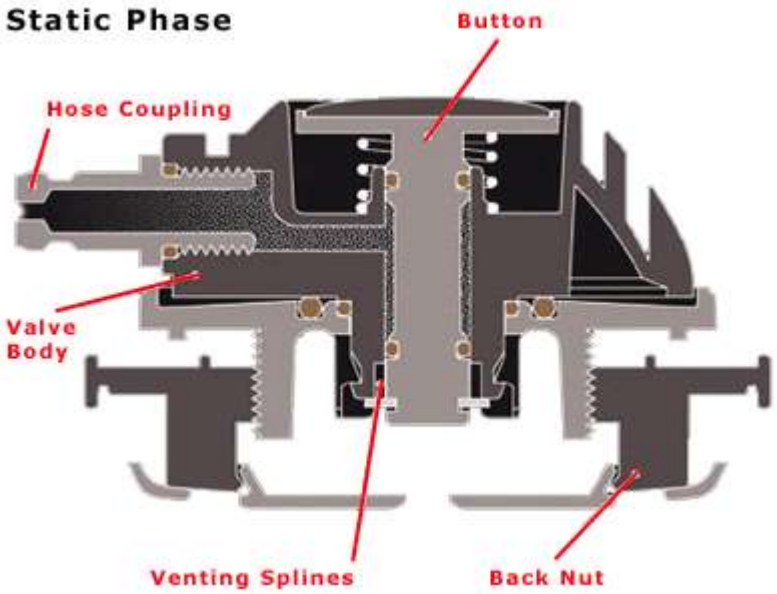
99.9% of drysuits have two valves – an inlet valve and a dump valve. In the U.K. there are two main manufacturers of drysuit valves, these are Apeks Diving Equipment and S.I. Tech. Both are similar in operation. If you are hiring a suit or a regulator, make sure that the drysuit feed supplied is compatible with the valve.

Inlet Valves

Diagram courtesy of Apeks Diving Equipment

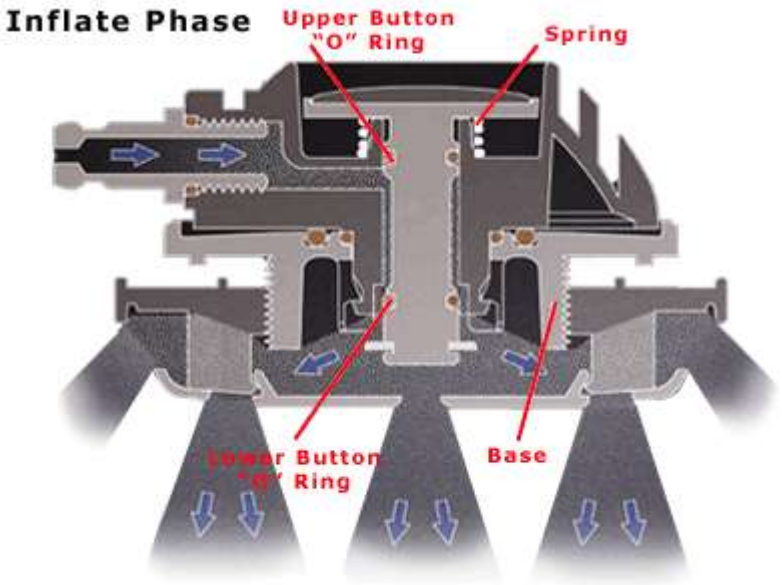
Inlet valves allow air, usually from the divers main air supply, to be fed into the suit for buoyancy, warmth and to prevent suit squeeze. The air is normally supplied by a hose from the diving regulator first stage at inter-stage pressure. Some technical divers use a separate cylinder filled with Argon gas to inflate their suits – Argon is an inert gas with higher thermal retention properties than air. The hose is attached to the inlet valve by a quick release connector. With some valve types it is possible for this quick release connector to specified as an air-gun. During it's static phase, medium pressure air enters the swivel suit inflator via the quick connect

hose coupling. Air is then prevented from leaking to atmosphere by the upper 'O' ring and is prevented from entering the suit by the lower button 'O' ring. This also eliminates the ingress of water to the suit, if the medium pressure is not connected.



.Diagram courtesy of Apeks Diving Equipment

When the central button is pressed, the spring compresses and the lower button 'O' ring moves over the venting splines inside the valve body, allowing controllable flowing air into the suit. When the button is released, the spring moves the button back to its static position, moving the lower botton 'O' ring back into the sealing position in the valve body and preventing medium pressure air entering the suit. When operating the inlet valve, care must be taken to ensure that only small quantities of air are injected into the suit at any one time. This will help prevent an uncontrolled ascent



.Diagram courtesy of Apeks Diving Equipment

Dump Valves

Dump valves allow air in the suit to be vented in a controlled manner to allow for a controlled ascent. There are two types of dump valve – automatic shoulder dumps (auto-dumps) and cuff dumps.

Whichever valve is chosen, ensure that you become well practised in its operation before you do any deep dives.

- **Cuff Dumps**

  Cuff dumps are a very basic valve and are usually positioned towards the bottom of a drysuit sleeve. Air is dumped by the diver lifting up his arm above the level of the air in the suit. Being a simple valve, it is difficult to finely control venting, but after some use, the operation of the valve becomes natural.

- **Auto-Dumps**

Diagrams courtesy of Apeks Diving Equipment

The Auto-dump valve is designed to control the volume of air in the diver's dry-suit and can be adjusted by the diver to attain the correct buoyancy and allow a safe ascent. Auto-dumps are now becoming commonplace on drysuits, and are usually positioned on the drysuit sleeve near to the divers shoulder. The valve may be rotated to provide a fine adjustment to its venting operation.

During a static phase, the volume of air in the dry suit is controlled by means of a rotating cap. Turning the cap clockwise increases the spring load acting on the valve seat and allows a larger volume of air to be maintained in the dry suit. Anti-clockwise rotation of the cap reduces the spring load, allowing air to escape and so hold a smaller volume of air. The rotating cap also features a ratchet mechanism, to prevent accidental adjustment of the dump valve. It is possible to completely close the valve, but in any underwater situation this is highly dangerous. The manufacturers recommend setting the valve at fully open less one quarter of a turn.

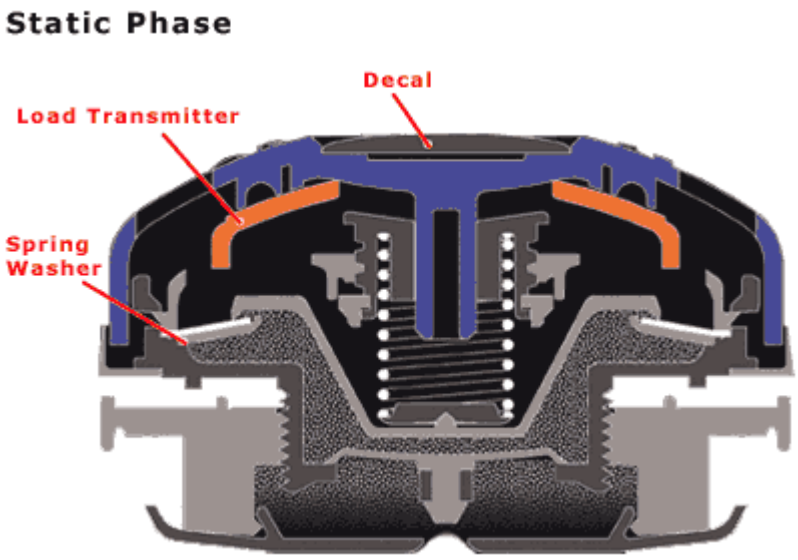


Diagram courtesy of Apeks Diving Equipment

As the diver ascends, the air in the dry-suit expands, increasing the diver's buoyancy. The auto-dump valve senses the increased pressure in the dry-suit, which lifts the valve seat against the spring, allowing air to vent. This venting action maintains the volume of air in the dry-suit and allows a controlled ascent by the diver. If, at any time during the dive, it is felt that there is too much air in the dry-suit, the cap can be pressed manually to over-ride the valves settings and vent excess air.

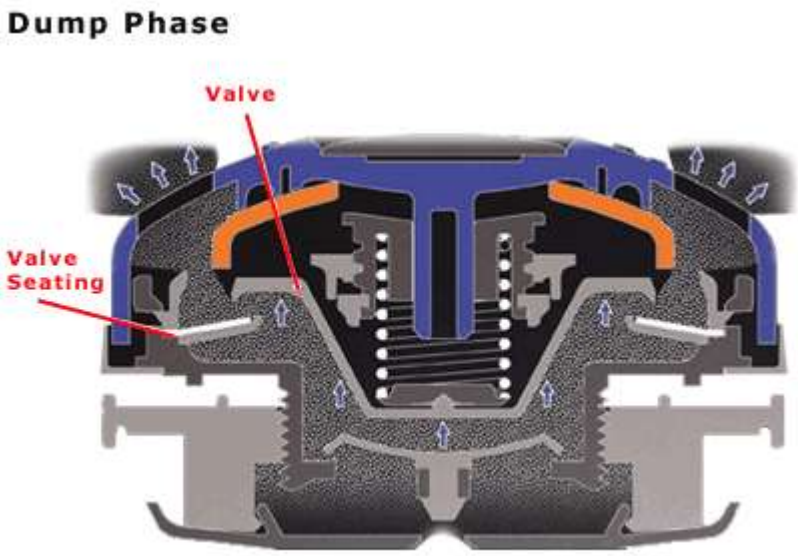


Diagram courtesy of Apeks Diving Equipment

If the cap is pressed with insufficient dry-suit pressure a secondary non return valve is fitted to prevent the ingress of water into the dry-suit. Selection of under clothing is important to allow escaping gas to vent through the valve, however the back nut is designed to prevent under clothing from blocking the escaping gas.

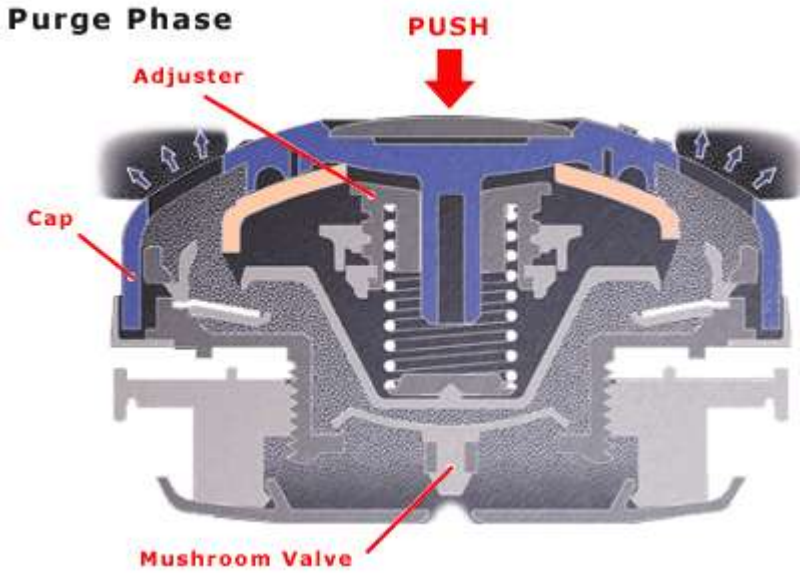


Diagram courtesy of Apeks Diving Equipment

The valve can be assembled and removed from a dry-suit without the use of any tools, this is achieved by pressing the cap and turning simultaneously to lock while the back nut is removed or tightened.

Socks or Boots?

The majority of Drysuits come with attached boots. Styles of boots vary from suit to suit and manufacturer to manufacturer. It may be possible to specify the style of boot that you require when you buy the suit. Always ensure that the boots are a good fit, but allow some room so that you can wear a pair of thick socks or thinsulate booties to keep your feet warm and cosy. Boots that are too large will make it more difficult to fin efficiently and will therefore be more tiring. Over-large boots will also fill with air which can place a diver at a strange attitude when finning horizontally and it is also uncomfortable when you are horizontally stationery looking at a point of interest. Over-large boots could ultimately lead to a highly dangerous uncontrolled feet-first ascent. Ankle weights may alleviate some of the problems encountered with slightly large boots, but it is always better to get it right when you buy a suit.

Some suits come with the option of attached waterproof neoprene socks. These will be close fitting, but again don't forget to allow for the wearing of thermal socks. If neoprene socks are supplied, then it is usual that some form of separate boot is worn to protect the sock. Neoprene socks and boots do allow for a closer fitting and therefore more comfortable boot, however this option may be costly.

If you buy a second-hand suit it is possible to have new boots fitted to most suits. However the cost of new boots will be in the region of £60 - £100 so it could make the purchase of a new suit more cost effective.

Drysuit Accessories

Pockets

Most drysuits have at least one basic thigh pocket. If having a drysuit made to measure you are normally able to specify the type and number of pockets and their positioning. Drysuits pockets come in all shapes and sizes – some are specifically tailored for certain knives while others may be voluminous cargo pockets for stowing away reels and Thermos flasks! If you have the choice, you are probably better going for a low profile knife pocket and one medium size cargo pocket which can take a reel. If you are unable to specify pockets – do not despair as separate pockets which are fastened by straps are available. Some drysuit manufacturers also offer alteration services which include the addition of pockets to drysuits.

Pee-Zips

Useful for gentlemen only! It is usually a divers nightmare as to when to zip up their Drysuit, because as soon as the zip is closed then you will need to pee! Hence pee-zips. They save you from having to virtually take off your Drysuit while answering your call of nature. They are however an additional point of failure in the suit and the zip must be maintained with as much care as the main zip. Also if you are wearing an undersuit you must ensure that your two way zip is working correctly and it helps if you are one of the 'big boys' – enough said! They will cost an additional £50 - £100 to have put into an existing suit depending on the type of suit material and the quality of the zip.

Pee-Valves

As with pee-zips – Pee-Valves are for gentlemen only – sorry ladies, there's nothing available for your relief yet! To describe this device fully – here's an extract from the 'O-Three' website:

"The O'Three P-Valve enables male divers to urinate whilst submerged. All components, from the nickel-plated non-ferrous metal to the main nylon body are machined and finished to the highest standard. A short length of surgical latex hose connects to a quality penile sheath via a positive snap connector.

The self-adhesive sheaths can be applied several hours before use. The applicator is thrown away after the sheath is in-place. Just before you zip up, connect your sheath and you're ``ready to go.''

The P-Valve is a straight flow through design. Extensive deep-water trials have proven that there is no need for an internal non-return valve. The users bladder is experiencing ambient pressure.

Step by step instructions make it easy to fit to all types of drysuit. Alternatively, it can be fitted by O'Three by prior arrangement."

So there you have it – cost around £65.

Internal Braces

Internal braces are normally required on membrane drysuits and the thinner compressed and crushed Neoprene drysuits. The braces basically ensure that any excess material in the suit legs is safely gathered in – they are also useful when the top half of the drysuit is not being worn pre, or between, dives. Be aware that the plastic hooks on some internal brace systems can, if installed incorrectly, cause the drysuit material to thin (especially on neoprene suits) and cause leaks.

Attached Hood

It is possible to have a hood attached permanently to a suit. Attached hoods can be slightly warmer as they tend to be a better fit and also reduce the amount of water flushing. However suits with attached hoods are slightly more difficult to put on (especially the neck seal), and if the hood is not being worn, then it becomes an annoyance. See further information below.

Dry-Glove system

Dry-Glove systems are available which allow a diver to keep their hands dry, and therefore warm. Dry-Gloves are sealed at the wrist and the glove itself usually has some form of warm fur-like lining and a tough outer shell. Dry suits with neoprene seals will require dry gloves with latex seals that will seal under the neoprene cuff seal. There are a number of dry glove systems that mate to a detachable cufflink system which is easily attached to drysuit latex seals. The advantages to this system are that if the glove leaks there is a second latex seal to the suit and there is no installation cost. If a glove is punctured, any of the four cufflinks damaged or a glove lost for any reason the suit can still be used. However, they are quite large and cumbersome and they make it difficult to carry out intricate manual tasks. Dry-Glove systems are also quite expensive so unless you are doing a lot of cold water diving then you may be better off with a ‘Semi-Dry’ system consisting of a glove with a double cuff which can interleave with the double cuffs (i.e. latex seal and neoprene cover) of a drysuit.

Undersuits

Undersuits are required for thermal protection when wearing membrane drysuits and compressed or crushed neoprene suits. In colder waters an undersuit is also desirable under a full weight neoprene drysuit. Standard undersuits and normally a one-piece 'romper' suit with a full length front zip. They are usually made of an outer hydrophilic fabric such as Pertex™ (see below), and an inner, permeable woven fabric. Sandwiched in between is an insulating layer – Thinsulate™ (see below) is popular, although various manufacturers use their own proprietary insulation (i.e. Softie™, Flectalon™ - see below for more information). Insulation works in two ways: first, by trapping air - the more air trapped, the more efficient the insulation – and second, by reflecting back the body's radiant heat.

Undersuits come in a variety of weights, to cater for temperature variations. Membrane drysuits will require the diver to wear the thickest of undersuits during winter, whereas a neoprene drysuit diver would require a much lighter suit as the neoprene of the suit offers some thermal protection. Also, neoprene drysuits are cut closer to the divers body and therefore a thicker undersuit cannot be worn. Alternative insulating systems particularly aimed at neoprene drysuit divers are becoming increasingly available (Fourth Element, O-Three to name two manufacturers), which use single layer fabrics such as Polartec™ to create close fitting thermal garments.

Whilst most undersuits work best when wearing a minimal amount of clothing underneath (this is to ensure that the 'wicking' capabilities of the undersuit materials are not impeded which, therefore keeps the divers skin drier and warmer), it is possible to supplement a lighter weight undersuit with modern high-wicking thermal underwear during the cooler months. This 'base-layer' underwear is also available at most climbing and outdoor shops which may keep the cost down!

For the ultimate in warmth and comfort insulated socks are also available from most undersuit manufacturers.

Pertex™

Pertex™ makes up the outer layer of most undersuits. The fundamental strategy of Pertex™ technology involves a unique combination of micro-fine yarns with ultra-precise thread spacing. The result is the creation of millions of microscopic spaces, the equivalent of pores in the human skin, and with similar properties - these allow perspiration out but preventing water coming in. The fabric's pores are the perfect size and shape for rapid transmission of water vapour. Added to which, the natural capillaries of the weave draw moisture from the inside and spread it over a large surface area, from which it can quickly evaporate.

Thinsulate™

The unique micro-fibres of Thinsulate™ Insulation are about ten times smaller than the fibres of most other synthetic insulations, which means they're much more efficient at trapping air. . . and more effective at keeping you warm. It also means we can pack more fibres into the same space, where they can reflect back more of the body's radiant heat. Neither repeated machine washings nor dry-cleanings markedly affect the performance of Thinsulate™ insulation. When you compare equal thicknesses, the original "warmth without bulk" Thinsulate™ insulation offers almost one-and-one-half times the warmth of down, and twice the warmth of other high-loft insulation materials.

Softie™

Manufactured by the Swiss under the Hardi brand (Established in 1915 by Jacob Hardi), Softie™ is used by Weezle in their undersuits. The Softie™ insulation or 'superfine high thermal' is a combination of fibres with different crimp systems and surface finishes. Some are crimped, some are curled and others are simply left straight. The random nature of the process results in a product that closely resembles the structure of natural down and the way it performs. The yarns used are staple yarns as in natural insulations (as opposed to continuously extruded as in most synthetic fills), giving it excellent re-loft abilities when unpacked. Softie™ is easy to care for, machine washable and still retains a lot of its thermal property when wet. The fibres have now been updated with special binders and treatments for an excellent combination of softness and durability.

Flectalon™

Flectalon™ is used in the Northern Diver range of undersuits. Developed by The Ascent Group, Flectalon™ is an ultra-lightweight, high-performance insulating material designed to reduce air movement. It is made from shredded metallised film, conceived as a result of research, carried out by NASA, into the ability of aluminised surfaces to reflect up to 95% of radiant heat. Flectalon™ is 100% breathable and retains its insulating qualities when wet or compressed. The quilt construction retains thermal integrity throughout the life of the garment. Flectalon™ is also quick-drying and bacteria & fungus resistant. Flectalon™ garments are fleece lined for comfort.

Other Protective Equipment

Wearing exposure accessories such as gloves, boots and a hood helps to keep extremities warm and slow down overall cooling. Remember, around 75 per cent of total body heat can be lost through the top of your head.

Hoods

In cooler conditions, any diving suit may be augmented by a diving hood. Just wearing a hood can increase the effectiveness of any diving suit. However, hoods must fit properly as hoods that seal tightly can cause aural barotrauma. This happens when external pressure is not properly transmitted to the diver's outer ear and is similar to wearing ear plugs. Care should be taken to flood the hood at the beginning of the dive. Hoods can be either be permanently attached to the dive suit or, more commonplace, separate. If the hood is an extension of a wetsuit jacket, the zip that will run up to the cheek can restrict head movement. Separate hoods sometimes have bibs which are meant to divert water over the top of the suit. If it is tucked into the jacket, cold water will be channelled into the jacket. Some hoods also have vents in the top of the hood which allow trapped air to escape on the initial descent.

Gloves

3-fingered diving gloves

'Standard' diving gloves

As with hoods, a pair of gloves will enhance the comfort of a diver when diving in temperate or cold water. Gloves come in a variety of designs and materials. Dry-Glove systems have already been mentioned, so here we will concentrate on the more standard, and cheaper, neoprene glove. Neoprene gloves, as with wetsuits, work on the principle of warming a layer of water next to the skin. Gloves should therefore be a good fit, and to minimise flushing, most gloves will have some form of elasticated wrist closure. Gloves also come in a variety of thicknesses, ranging from 1mm general watersport gloves to 5mm diving gloves. It is normal to buy standard 5-fingered gloves, however some gloves have been designed to keep three fingers together in one 'glove-finger', with a separate covering for index finger and thumb. These gloves are reputably warmer, although there is some loss of dexterity.

The thickness of gloves is not only dependant on the water temperature, but also the amount of dexterity required – underwater photographers will probably find that a 5mm glove is too thick to handle delicate camera controls, therefore when buying gloves make sure that they provide the dexterity that you will require to operate your various items of equipment (e.g. BC inflators, reels etc.). Finally, some gloves have a covering of Kevlar (or similar), which is a highly abrasion resistant, but flexible, material – gloves with a Kevlar covering are extremely suitable for wreck diving where sharp metal edges may be encountered. Costs of gloves varies between £10 to £50 depending on type, thickness and construction.

Wetsuit Boots

Wetsuit boots are required when diving (or snorkelling) using open-heel fins and wearing either a wetsuit, semi-dry suit or swimming attire. Wetsuit boots are made out of neoprene and are available in various thickness depending on the water temperature being dived in. Wetsuit boots should have a reasonably thick and sturdy sole to protect the wearers foot when walking to and from shore-dives. Wetsuit boots also protect divers feet from the hot dive decks often found on tropical dive-boats. Short zips at the ankle assist in putting the boots on, but these zips are highly susceptible to damage. Wetsuit boots costs vary depending on the thickness of the neoprene and their construction, but expect to pay £15 to £30 for a pair.

Sting-Guards

Facial sting-guards are available to cover the cheeks, lips and chin of a diver to prevent stings from Jellyfish. Worn over your hood, neoprene sting-guards have a hole for the regulator mouthpiece to pass through and it also protects against that sudden icy feeling you get when submerging in cold water. They cost around £10.

Care and Maintenance

Want your suit to last for years, smell like roses and look almost as good as the day you bought it? If you do, then follow these tips religiously:

Dive Skins, Wetsuits & Semi-Dry's

- **Hot Surfaces** – avoid placing your wetsuit on, or near, hot surfaces
- **Suiting Up** – try to suit up in a sand-free environment and take care in smooth-skin areas so that finger-nails don't cut into the seals.
- **Zippers** - are designed to be pulled closed or open in a straight line. Try to avoid pulling on the zipper pulls at an excessive angle to their intended path of travel. It is best to ask your dive buddy for zipper assistance in either opening or closing the back-zipper of a one piece back-zipped wetsuit
- **After a dive** – try to keep the suit as clean as possible and free of sand. Undo all zips and take care not to cut any smooth-skin seals with finger-nails remove the suit. It is best to roll the suits up to protect the zip. Put it in its storage bag until you get home.
- **Soak the wetsuit** - Salt water and especially chlorine can "dry out" the neoprene material. When neoprene material "dries out" it looses it's flexibility. To ensure the wetsuit material retains it's flexibility for a extended period of time, it is important to thoroughly soak the wetsuit in a tub of warm fresh water (not over 120°F) for at least 15-20 minutes, then..
- **Rinse in fresh cold water** - Rinsing your suit, inside and out, after each use helps to wash away salt, bacteria, body oils and all the other generic gunge that conspires to make your suit a smelly mess.
- **Hang dry** - Find a wide-bodied plastic hangar and hang your suit in a well-ventilated area. Avoid the bright sun as it will fade the colours and may affect the material. Open all the zippers to ensure maximum air circulation and complete drying.
- **Don't warm from within** - A lot of people do it (sometimes involuntarily!), but "relieving" yourself in your suit is nasty. It smells, plus it can break down the materials used in the suit's construction.
- **Bathe** - Not you, your suit! Find some wetsuit shampoo at a surf or dive shop and scrub-a-dub-dub. Conditioners in the shampoos will also keep your suit flexible and prevent any premature drying or cracking of the neoprene.
- **Clean and lubricate the zips** – use a proprietary zip-lube from your local dive shop to clean and lubricate the zip, particularly if the suit is to be stored for a long time.
- **Examine the suit for tears and damage** – repairs to wetsuits can be simply made to prevent further degradation.
- **Store properly**— Putting your suit away for the season?
    - Take it down off the hangar to avoid stretching and lay it flat (don't fold!). Wetsuit material can develop a permanent crease if left folded for a extended period of time. It is best to store your wetsuit laying flat.
    - If that is not possible, you can store your suit on a hanger. Use as thick a hanger as possible to better support the weight of the suit. The thicker the suit, the heavier, and therefore the thicker your hanger should be. There are several after-market hangers available designed specifically for this purpose.
    - Store in a cool, dry and protected place out of direct sunlight.
    - Do not store your wetsuit in garage if the garage is used to park a vehicle. The exhaust emissions from the vehicle can over time deteriorate the neoprene.

- **Chemicals/Solvents:**
    - Avoid any contact with oil, gasoline, aerosols, or chemical solvents.
    - Do not expose any part to aerosol spray, as some aerosol propellants attack or degrade rubber and plastic materials.
    - Do not use any type of alcohol, solvent or petroleum based substances to clean or lubricate any part.
    - Do not store your equipment near any oil, gasoline, chemicals, or solvents.

Drysuits

- **Prior to diving** –
    - Ensure the drysuit zip opens and closes easily – lubricate the zip (soap can be used in an emergency) with wax or zip lube.
    - Check the zip teeth for damage
    - Lubricate the neck and wrist seals with talcum powder – baby lotion or any non-oil based lubricant can be used on neoprene seals ***only***
    - Remove jewellery and watches prior to putting the suit on
    - Check that the suit inflator and exhaust valve work correctly
    - Ensure that wrist and neck seals are not damaged by long fingernails
    - Check that all seals are smooth with no trapped hair or clothing.
    - Unless the suit has a front-entry zip, ask your buddy to carefully close the drysuit zip with a steady action, ensuring that no hair or clothing is trapped
- **After a dive** – try to keep the suit as clean as possible and free of sand. It is best to roll the suit up from the boots so that the zip is rolled up last. This allows the zip to retain a more natural curved shape. Put it in its storage bag until you get home.
- **Rinse in fresh cold water** - Close zip and wash the outside of suit after every diving day – pay particular attention to the zip(s) and the valves. Do it religiously and you'll dramatically extend the life of your suit. Stubborn stains can be removed with soapy water, but rinse thoroughly afterwards.
- **Hang Dry** – Find a wide-bodied plastic hangar and hang your suit in a well-ventilated area. Avoid the bright sun as it will fade the colours and may affect the material. Before putting the suit away, check that the inside of the suit is totally dry, in particular the legs and boots as these are notoriously difficult to dry. It is possible to buy a special boot drying device – Dampire – for around £20. You can also stuff the boots with lightly screwed up newspaper to assist in soaking up the damp – this is a cheap option!
- **Clean, lubricate and check the zip** – clean the teeth with a small brush prior to lubricating with a proprietary zip-lube or a stick of beeswax from your local dive store. **DO NOT** use a Silicone spray. Ensure that you lubricate the inner teeth. Inspect the zip carefully for signs of wear. If you find any wear have the zip repaired/replaced before you dive again – a failed zip underwater could lead to a very uncomfortable dive and heightens the possibility of a more serious incident occurring.
- **Check all seams and seals** – check regularly for deterioration and repair/replace in good time. Latex seals will perish quickly if any kind of moisturising cream, boady oils r oil is applied to them. After dives clean the seals with mild soapy water to remove dirt and body oils.
- **Dust neck and wrist seals** – dust neck and wrist seals (particularly latex ones) with a non-scented talc after rinsing and drying
- **Check the valves** - Check inflation/dump valves for correct operation. If they are found to stick, then have the valve serviced at your local dive shop.
- **Avoid contact with hydrocarbons** – these can cause perishing of seals

- **Store properly** – If putting the suit into storage ensure that it is completely dry, inside and out. Avoid folding it, especially the zip. Hang the suit either on a wide-bodied, plastic hangar (be careful of the neck seal) or by the boots. Leave all the zips lubricated and closed, and all seals and boots powdered. Store in a cool dry place away from heaters.