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RB70 Automatic Diluent Valve Maintenance Manual

Version 2.2
March 2017
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1. Introduction

The Automatic Diluent Valve (ADV) is an optional feature, specifically designed for the AP Diving line of Inspiration and Evolution closed-circuit rebreathers. Use with any other type of rebreather is not recommended.

It replaces the inhale T-piece on the left shoulder counterlung and is usually fitted with the diaphragm facing the diver's head. The ADV is activated by a pressure differential across the diaphragm and it supplies gas to the loop (breathing circuit) whenever a substantial negative pressure is experienced within the inhale counterlung.

The gas supply hose connects with a 3/8" UNF thread to the low pressure port on a first stage or into the diluent port of the Inspiration's manifold and connects to the ADV's 300° swivel. The swivel allows for the hose to be fed from the rear e.g. from the manifold, from the front or from a side mounted diluent cylinder. If the side mounted cylinder needs to be removed in water the optional in-water quick release connector is available.

The ADV is an upstream valve and can be used with 1st stages delivering 7 to 11 bar (nominal 9.5 bar) above ambient and requires no adjustment. The elastomeric diaphragm cover allows manual operation.

During descents it is normal for the ADV to add gas on nearly every inhalation. However, this is unusual during all other phases of the dive. Normally the ADV adds gas to make the counterlung volume breathable and then stops.



WARNING: If the ADV operates on every inhalation this is an indication of either poor rebreather diving practice like exhaling through the nose or is a sign of some other leak from the loop. Any extra diluent addition usually has the effect of reducing the ppO₂ within the breathing circuit and would be countered by the oxygen controller adding oxygen to regain the setpoint. The danger of inadvertently using excess gas from both diluent and oxygen cylinders is higher when using an ADV and extra monitoring of cylinder contents gauges should take place.

Located on the left shoulder, rolling left side down may force the ADV to add gas to the loop as will rotating head down, when the gas in the counterlungs migrates upwards away from the ADV and causes a negative pressure on the inside of the diaphragm. Whenever these manoeuvres are undertaken you may need to run the counterlungs with a higher gas volume than normal.



The numbers between brackets after the part names in the disassembly and assembly chapters correspond to the sequence numbers in the first column of the diagrams on the next page2.

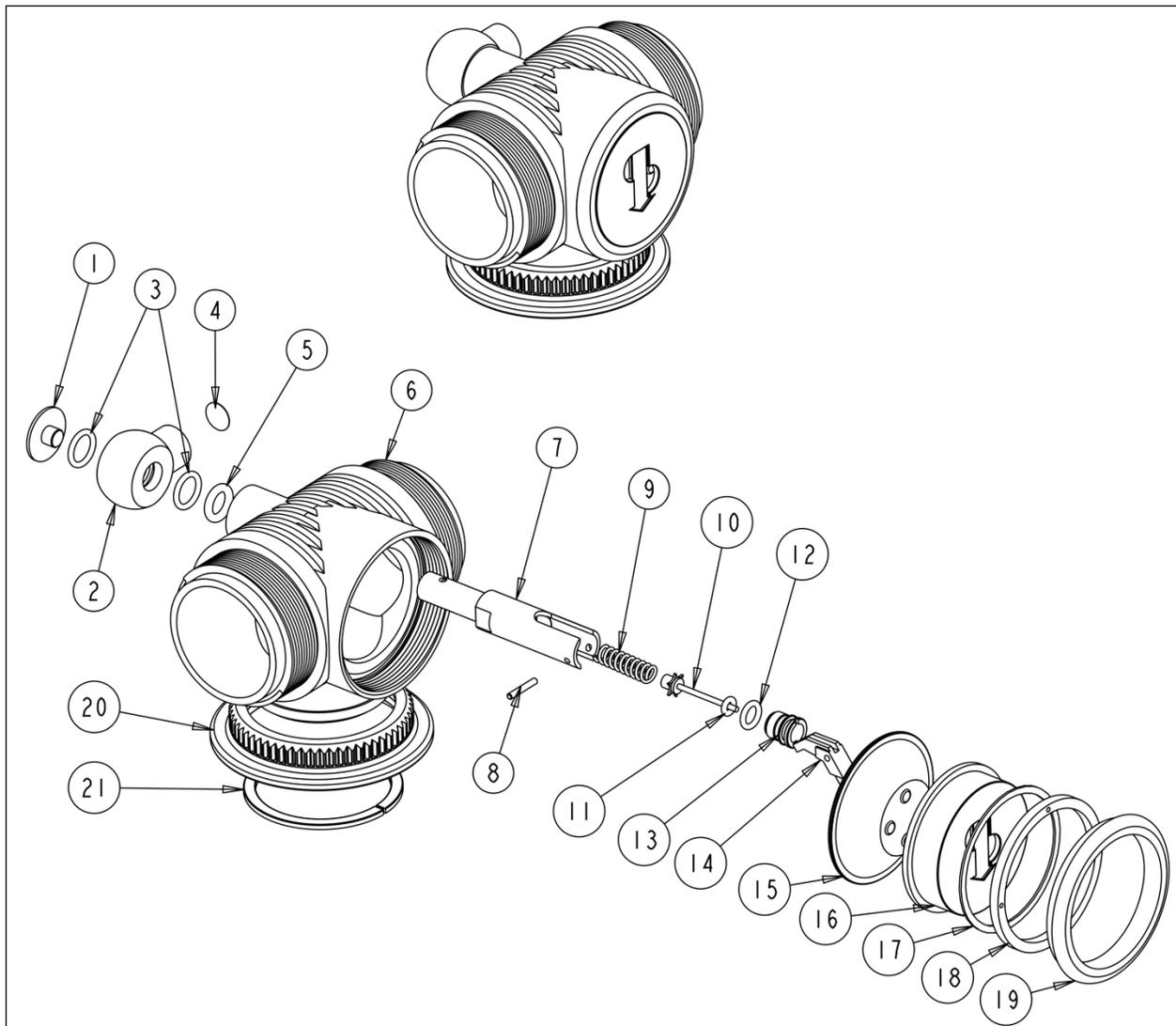
Copyright and Applicable Law

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All products are sold on the strict understanding that only English Law applies in cases of warranty claims and product liability, regardless of where the equipment is purchased or used. Should a claim be made then the venue for this would be in Truro, England.

2. ADV diagram and parts list

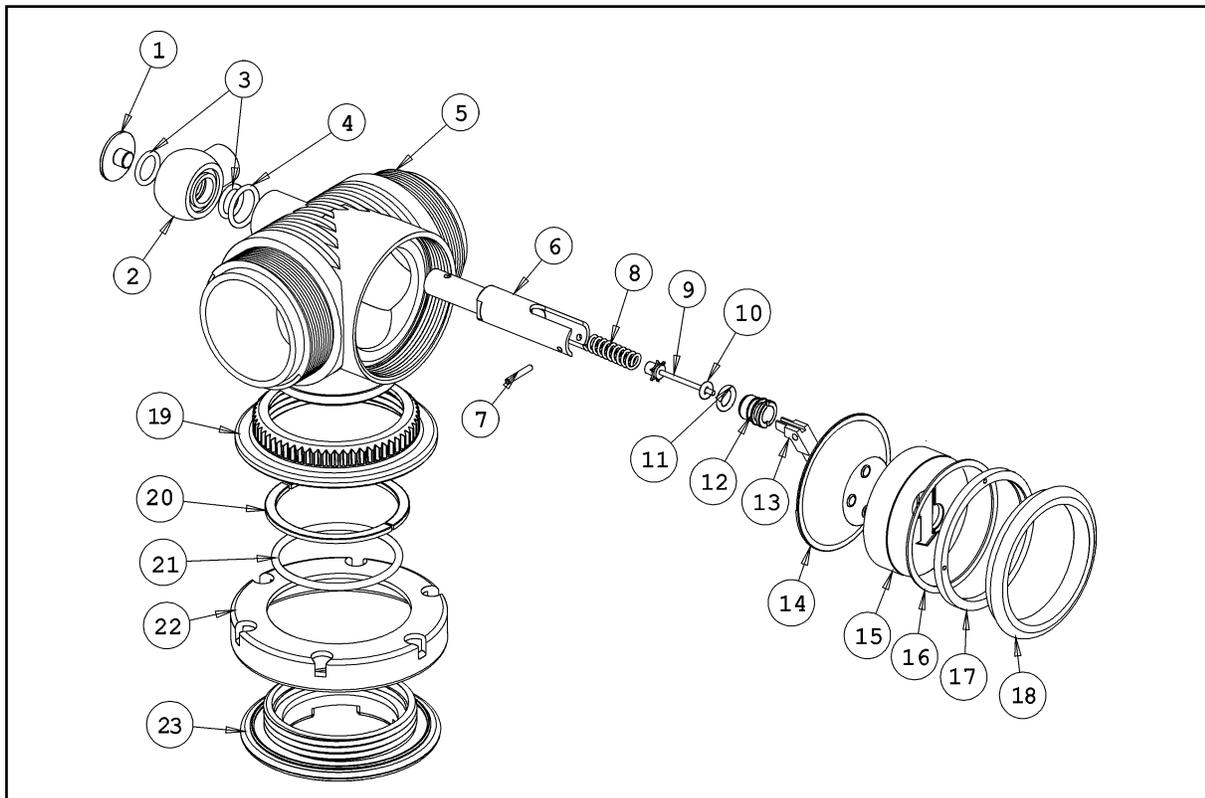
2.1 ADV diagram and parts list – Current version (Post June 2006)



<u>NO.</u>	<u>PART NAME</u>	<u>PART NO.</u>	<u>QTY</u>
1	RETAINING SCREW	RB70/07	1
2	BANJO	RB70/05	1
3	BS012 O-RINGS	BS012 N70	2
4	10mm MESH FILTER	AP100/41	1
5	BS109 O-RING	BS109 N70	1
6	T-PIECE BODY	RB70/01	1
7	ADV BODY	RB70/04	1
8	LEVER PIN	RB70/08	1
9	SPRING	RB70/11	1
10	TILT AXLE	RB70/13	1
11	BS006 O-RING	BS006 N90	1
12	BS010 O-RING	BS010 N70	1

13	TILT BOSS	RB70/12	1
14	LEVER	RB70/09	1
15	DIAPHRAGM	RB70/06	1
16	DIAPHRAGM COVER	RB70/10	1
17	SKID DISC	RB70/14	1
18	LOCKING RING	RB70/03	1
19	RETAINING RING	RB70/02	1
20	TOP	RB03/02	1
21	SPLIT RING	RB03/05	1
---	BS130 O-RING	BS130 N70	1 (not shown; see paragraph 2.2, no. 21)
---	BASE PROTECTOR	RB03/04	1 (not shown; see paragraph 2.2, no. 22)
---	RETAINER BASE	RB03/03	1 (not shown; see paragraph 2.2, no. 23)

2.2 ADV diagram and parts list – Previous version (Pre June 2006)



<u>NO.</u>	<u>PART NAME</u>	<u>PART NO.</u>	<u>QTY</u>
1	RETAINING SCREW	RB70/07	1
2	BANJO	RB70/05	1
3	BS012 O-RINGS	BS012 N70	2
4	BS014 O-RING	BS014 N70	1
5	T-PIECE BODY	RB70/01	1
6	ADV BODY	RB70/04	1
7	LEVER PIN	RB70/08	1
8	SPRING	RB70/11	1
9	TILT AXLE	RB70/13	1

10	BS006 O-RING	BS006 N90	1
11	BS010 O-RING	BS010 N70	1
12	TILT BOSS	RB70/12	1
13	LEVER	RB70/09	1
14	DIAPHRAGM	RB70/06	1
15	DIAPHRAGM COVER	RB70/10	1
16	SKID DISC	RB70/14	1
17	LOCKING RING	RB70/03	1
18	RETAINING RING	RB70/02	1
19	TOP	RB03/02	1
20	SPLIT RING	RB03/05	1
21	BS130 O-RING	BS130 N70	1
22	BASE PROTECTOR	RB03/04	1
23	RETAINER BASE	RB03/03	1
---	10mm MESH FILTER	AP100/41	1 (not shown; see paragraph 2.1, no. 4. It fits inside the MP hose that connects to the banjo.)

3. Service kit contents and special tools

3.1 Service kit contents



WARNING: When replacing O-rings, next to the size of the O-rings, the material and hardness of the O-rings are ESSENTIAL for proper operation. (The material designation is shown with a letter, and the hardness is expressed in degrees Shore), For example: N denotes the material “Nitrile”. The BS006 N90 O-ring which acts as valve seat in the ADV is deliberately chosen to be harder (N90) than the other O-rings (N70) to ensure proper sealing and resistance against wear. The material and hardness of the O-rings are deliberately selected by AP Diving. If you choose to select your O-rings to come from another source than AP Diving, make sure you select the right type in size, material AND hardness.

When servicing the ADV, the following parts need to be replaced:

<u>PART NAME</u>	<u>PART NO.</u>	<u>QTY</u>
BS012 O-RING	BS012 N70	2
BS014 O-RING	BS014 N70	1

These three O-rings go in the rotating banjo.

BS006 O-RING	BS006 N90	1
BS010 O-RING	BS010 N70	1

These two O-rings go in the tilt boss.

BS109 O-RING	BS109 N70	1
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Fitted to ADV's manufactured after June 2006.

It goes onto the shaft of the ADV body, protruding through T-piece body.

MESH FILTER	AP100/41	1
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This goes between the regulator hose and the banjo

Optionally, the diaphragm and skid disc needs to be replaced if it is damaged or shows signs of wear and tear.

<u>PART NAME</u>	<u>PART NO.</u>	<u>QTY</u>
DIAPHRAGM	RB70/06	1
SKID DISC	RB70/14	1

Assuming the ADV is left in place on the left counterlung while servicing, no other parts need to be replaced. If it is removed from the counterlung, the following parts also need to be replaced:

<u>PART NAME</u>	<u>PART NO.</u>	<u>QTY</u>
BS130 O-RING	BS130 N70	1
BASE PROTECTOR	RB03/04	1

This O-ring sits between the retainer base (23; inside the counterlung) and the T-piece body (5).

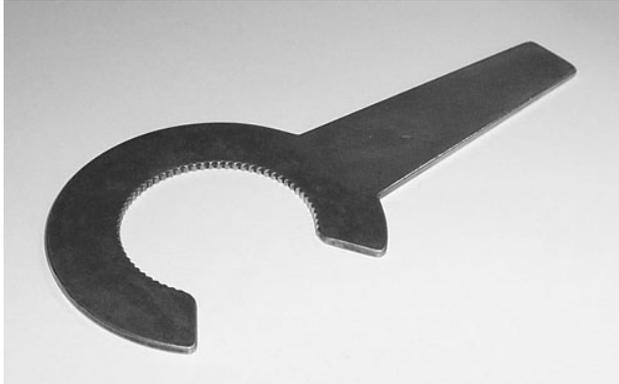
Although it is not mandatory to replace the base protector at every service interval, it is highly recommended to replace it as it plays a key role in making sure the T-piece assembly seals well against the inside of the counterlung.

See Annex A for replacement instructions of these particular parts.

3.2 Special tools

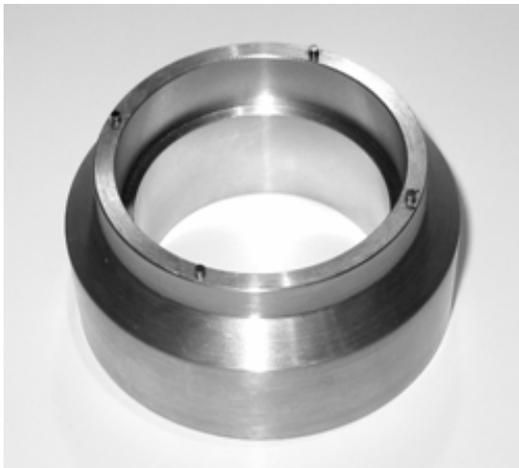
Three special tools are needed for proper servicing of the ADV:

- **RBTOOL 6: T-Piece C-Spanner**



This tool is used to remove and fit the ADV from the Lung.

- **RB TOOL 8: 4-pin locking ring tool.**



This tool is used for removing and re-fitting the locking ring on the T-piece body.

Using this tool avoids damaging the locking ring, which is not easy to remove using standard pliers due to the small size of the slots and the size of the locking ring.

- **RB TOOL 9: Demand valve slotted tool.**



This tool is used for removing the tilt boss from the ADV body during disassembly, and screwing it back into the ADV body during assembly. Using this tool avoids damaging the delicate tilt boss and the inside of the ADV body.

4. Disassembly instructions

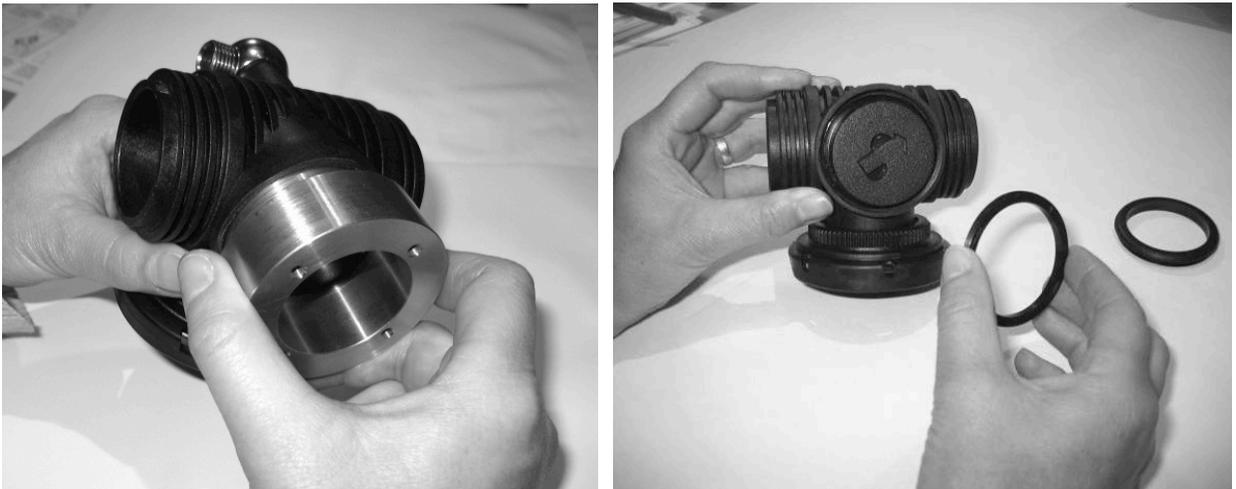
4.1 Remove retaining ring from T-piece body



Unscrew counter-clockwise.

 **TIP:** use a piece of super-fine sandpaper as a cloth if you cannot get a good grip on the ring to remove it.

4.2 Unscrew locking ring from T-piece body



Unscrew counter-clockwise, using special tool RB TOOL 8 or a correct fitting pair of pliers with thin tips.

Make sure that the 4 pins from the special tool are properly locked into the 4 small holes in the locking ring to avoid damaging the ring.

4.3 Remove skid disc, diaphragm cover and diaphragm



Treat the diaphragm with care. Inspect it carefully for wear and tear. Consider that damage to the diaphragm can lead to a flooded loop of your rebreather! When in doubt, replace.

4.4 Unscrew retaining screw from protruding part of ADV body



Unscrew counter-clockwise. Use a 5 mm Allen key.

4.5 Remove banjo from protruding part of ADV body



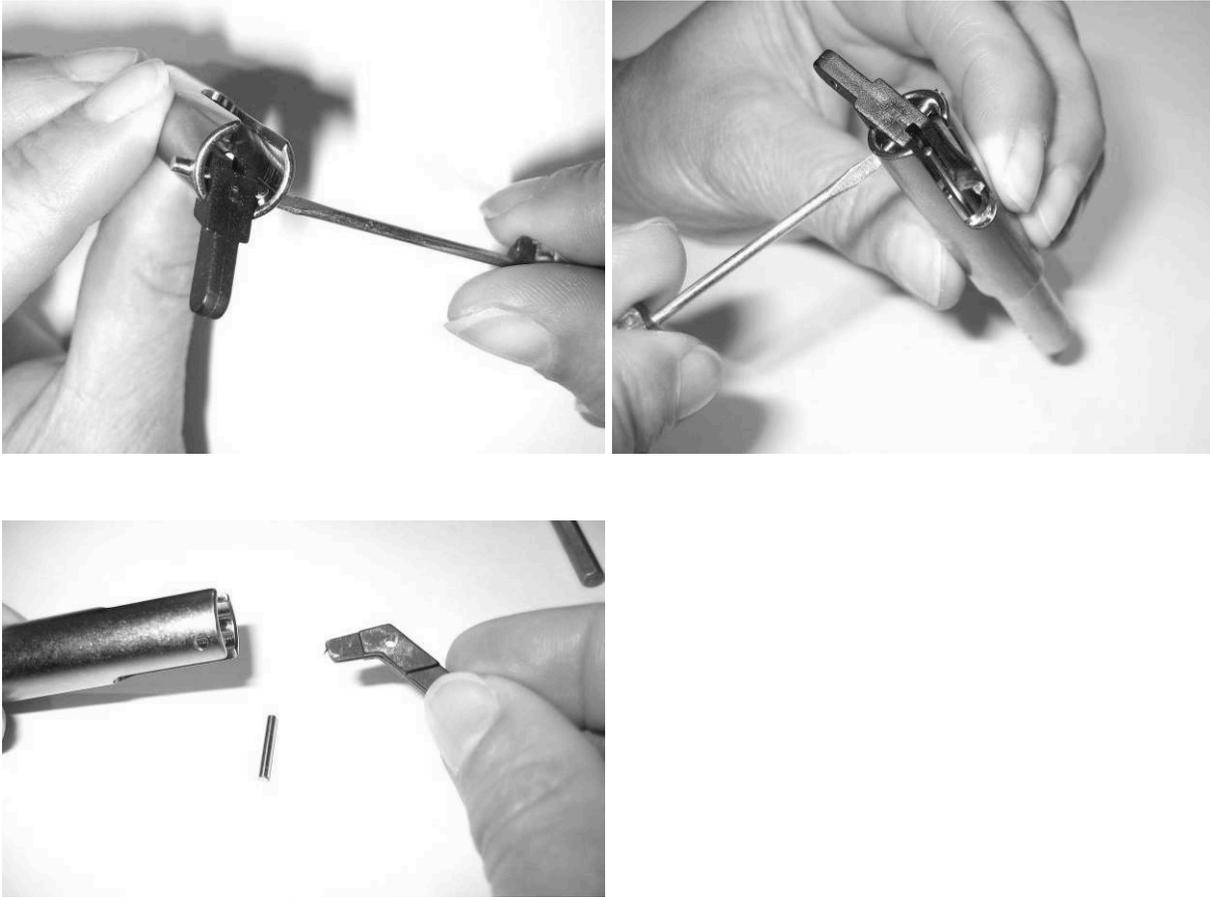
4.6 Push the ADV body out of the T-piece body



The BS014 O-ring on the outside of the banjo seals on the outer face of the ADV. Make sure you extract the ADV body carefully, without levering.

⚠ WARNING: Do NOT rotate the ADV body while extracting, as it is aligned to the T-piece body with small plastic notches to keep it in the correct vertical position. Rotating it might damage the plastic notches on the inside of the T-piece body.

4.7 Push lever pin from lever and ADV body



The pin holds its position in the lever solely by friction; no locking rings etc. are used. Make sure you do not damage the plastic lever if you use a small tool to push out the lever pin. Use a pair of pliers to pull the pin out once you can get hold of it.

4.8 Screw tilt boss out of ADV body



Insert the demand valve slotted tool (RB TOOL 9) into the ADV body. Make sure it connects properly into the groove on top of the tilt boss. Unscrew counter-clockwise, and take the tilt boss out of the ADV body. Make sure you do not lose the tilt axle and spring as they will now come out also.

⚠ WARNING: make sure that the centre stem of the tilt axle slides into the centre hole of the demand valve slotted tool when inserting it into the ADV body. The 90° angle of the tilt axle is VITAL to the correct operation of the ADV. Bending it will lead to either free-flow or the opposite, non-delivery of diluent gas by the ADV.

4.9 Remove spring, tilt axle and tilt boss from ADV body



After removal check again if the tilt axle hasn't got bent by the removal process.

5. Replace service parts

5.1 Servicing action groups

The servicing of the ADV inflator contains 4 “action groups”:

1. Removing and binning all parts that should be replaced. This includes all O-rings.
2. Depending on the gas content the ADV inflator is exposed to, keep it in oxygen service.
The CGA (Compressed Gas Association), US Navy, UK’s HSE and the EIGA (European Industrial Gas Association) all recommend that breathing gasses with an oxygen content of 23.5% or higher should be treated as 100% oxygen. However, some technical training agencies still use 40% as the maximum percentage that is allowed for equipment that is not in oxygen service.
AP Diving advises to err on the side of safety, and to use the value of 23.5% as the cutoff percentage beyond which the equipment must be in oxygen service.
If in doubt: keep it in oxygen service, as that only takes a little bit more effort.
3. Ultrasonic-cleaning of all disassembled metal parts. This is mandatory if the ADV inflator is to be kept in oxygen service, but recommended in all other servicing situations.
4. Lightly grease new parts, fit them, and re-assemble the ADV inflator with the correct tools. And the correct torques (7 Nm). Use oxygen-compatible grease, and avoid contaminating the metal parts after cleaning. Use the smallest amount of grease possible.

The use of rubber gloves while re-assembling the ADV is highly recommended to avoid rendering the ADV unclean due to human touch.

5.2 Make sure you have the right combination of banjo and T-piece body



WARNING: AP Diving has produced **TWO** versions of both the banjo and the T-piece body, as can already be seen in the two diagrams in chapter 2.

There is a banjo/body combination that was used until 2006, and a banjo/body combination that is used since 2006, which is the current version.

Make sure you always use the right combination, as they **CANNOT** be mixed.

The differences are easy to identify, as shown in the table and pictures below.

ADV Version	Banjo characteristics	T-piece body characteristics
Pre-2006 (old) version	Has 3 O-rings: <ul style="list-style-type: none"> - 2 inside (BS012N70). - 1 outside, facing T-piece body (BS014N70) 	<ul style="list-style-type: none"> - Has NO O-ring around the protruding ADV body shaft. - The T-piece body is “<u>flat</u>” around the hole though which ADV body shaft protrudes.
Post-2006 (current) version	Has only 2 O-rings: <ul style="list-style-type: none"> - 2 inside (BS012N70). 	<ul style="list-style-type: none"> - Has an O-ring around the protruding ADV body shaft (BS109N70). - The T-piece body has an O-ring groove around the hole though which the ADV body shaft protrudes.



Pre-2006 (old) banjo: 2 O-rings inside + 1 O-ring outside



Pre-2006 (old) T-piece body: flat area around protruding shaft, no O-ring



Post-2006 (current) banjo: 2 O-rings inside

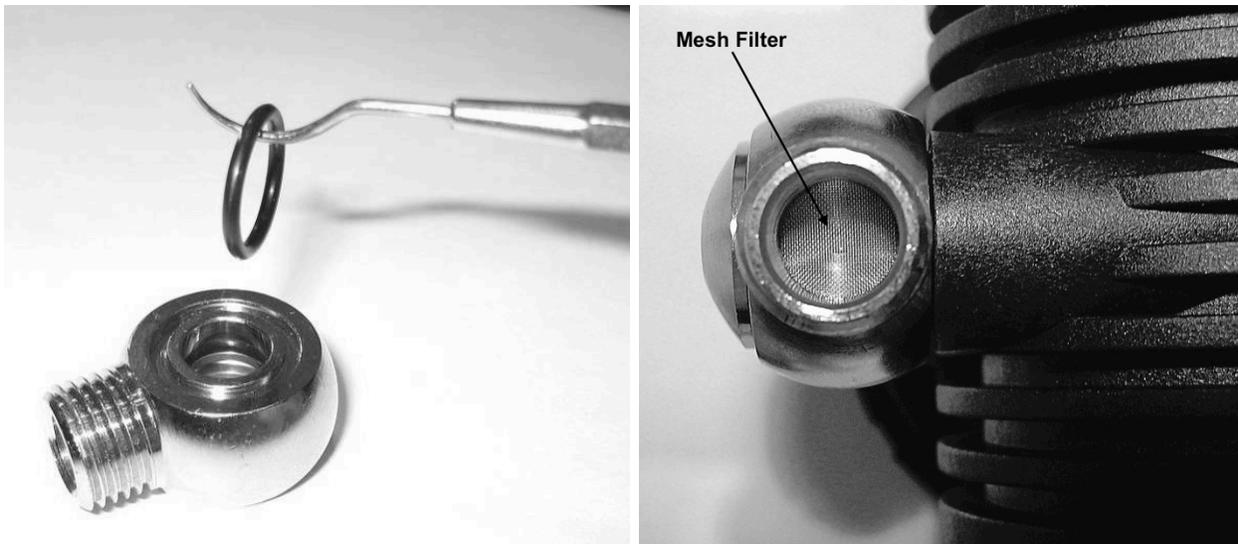


Post-2006 (current) T-piece body: O-ring groove and O-ring

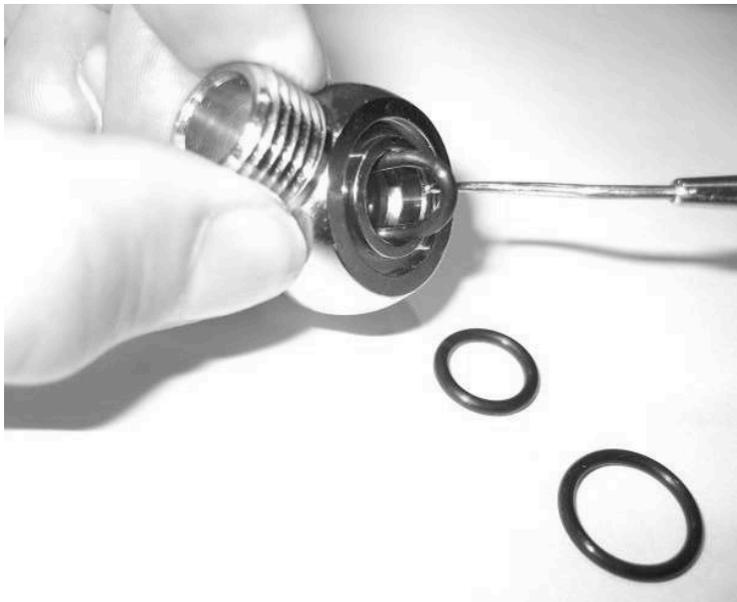
5.3 Remove BS014 N70 O-ring and Mesh Filter AP100/41 from banjo.

ATTENTION: the BS014N70 O-ring removal ONLY applies to the pre-2006 version of the banjo.

Replacing the mesh filter applies to all versions. The mesh filter is inside the banjo.



5.4 Remove the two BS012 N70 O-rings from the inside of the banjo



⚠ WARNING: It is almost impossible to remove these O-rings without damaging them – especially the smaller ones on the inside. Therefore NEVER re-use the old rings; always use new ones! DO NOT use the Banjo body to lever the O-rings out, this may damage the sealing face.



Post-2006 banjo
(2 O-rings – inside only)



Pre-2006 banjo
(3 O-rings – 2 inside, 1 outside)

5.5 Remove BS010 N70 O-ring from tilt boss



When this O-ring is damaged, diluent gas will leak into the loop. Also, removing it has a high risk of damaging it in the process. Therefore ALWAYS replace this O-ring when servicing the ADV.

5.6 Remove BS006 N90 O-ring from tilt boss



This small O-ring has a very special role. It acts as the valve seat for the tilt-axle which acts as an up-stream valve. Together with the tilt-axle they act as the core valve assembly of the ADV. Damage to this O-ring will lead to a leaking ADV. Therefore ALWAYS replace it when servicing the ADV.

⚠ WARNING: do NOT grease this O-ring. Greasing it might result in it collecting dirt from the diluent gas flowing past it and might lead to leaking.

5.7 Ultrasonically clean deposits from all metal parts

Clean deposits from all metal parts, like chalk and salt.

⚠ WARNING: Do NOT use aggressive chemicals. They might damage the metal plating. Use an ultrasonic cleaning bath with a suitable cleaning fluid instead. A good cleaning fluid is Biox "O2" immersion fluid. See WWW.BIOXINT.COM for further information and distributors.

5.8 Replace all O-rings and Mesh Filter with new ones from the service kit

- Replace the two BS012 N70 O-rings inside the banjo.
- Replace the BS014 N70 O-ring on the outside of the banjo.
→ applies **only** to the **pre-2006** version of the ADV.
- Replace the Mesh Filter AP100/41 from the Banjo hose connection.
- Replace the BS010 N70 O-ring on the outside of the tilt boss.
- Replace the BS006 N90 O-ring on the inlet topside of the tilt boss.
- Replace the BS109N70 O-ring around the protruding shaft of the ADV body through the T-piece body
→ applies **only** to the **post-2006** version of the ADV.
- Optionally replace the diaphragm if it shows signs of wear and tear.

⚠ WARNING: do NOT grease the BS006 O-ring. It acts as a valve seat and might collect dirt from the diluent flowing past it when greased. This could lead to leaking due to improper sealing of the tilt axle which acts as the up-stream valve.

5.9 How to lightly grease O-rings

When greasing O-rings, make sure NOT to use too much grease.

Especially O2 compatible grease has the potential to become stiffer over time, which may cause a hardened clot of grease to become a source for leaking.

The best way to grease O-rings is using a simple “grease bag”.

A grease bag is a clean and clear plastic bag, into which you put a small amount of grease.

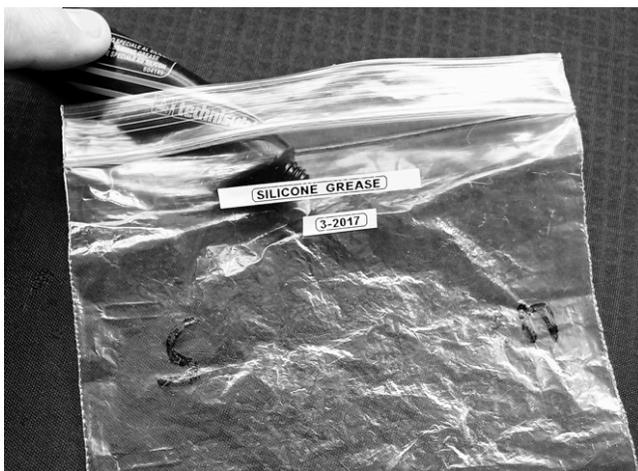
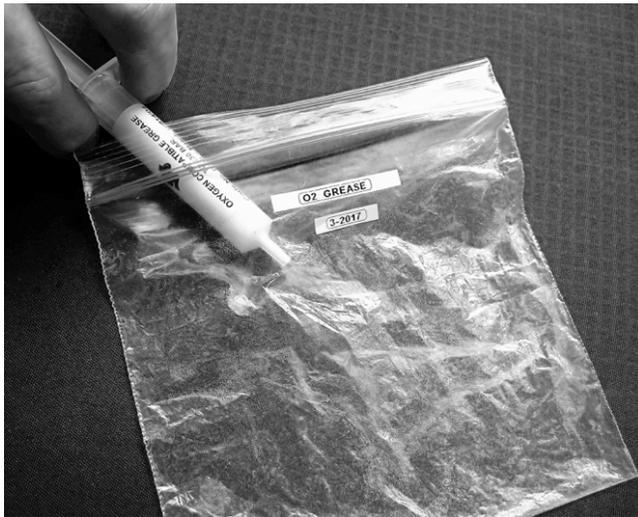
Optionally you can make two bags: one with O2 compatible grease, and one with normal silicone grease. Make sure you label them properly to avoid mixing them up! Also put a date on it, so you know how old your grease bag is. Don't use them longer than a year.

A nice advantage of using a grease bag is that you use only a tiny amount of grease for greasing many O-rings, so there is little waste.

We recommend that you use resealable bags, e.g. the ones with a plastic zipper, typically used for airtight food storage. This allows you to zip up the bag after use, keeping the contents clean for repeated use.

The simple steps are as follows:

- Take a plastic bag and deposit a SMALL amount of grease in it.



- Massage this grease all around the bag until it is evenly distributed over the inside surface area.

- Take the O-rings to be greased out of their storage container, either using gloves or using an O2-cleaned instrument like a dentist hook.



- Drop them in the grease bag, and from the outside of the bag move them around with your fingers, making sure they get in full contact with the grease.



- Open the bag, and using a clean instrument like a dentist hook, take the now properly greased O-rings out.
- Inspect them to make absolutely sure that the grease is evenly and lightly distributed on the O-rings and that there are no areas of excess grease - no globs or strands.
- Fit them where they belong on your diving equipment, still making sure not to touch them with your bare hands.

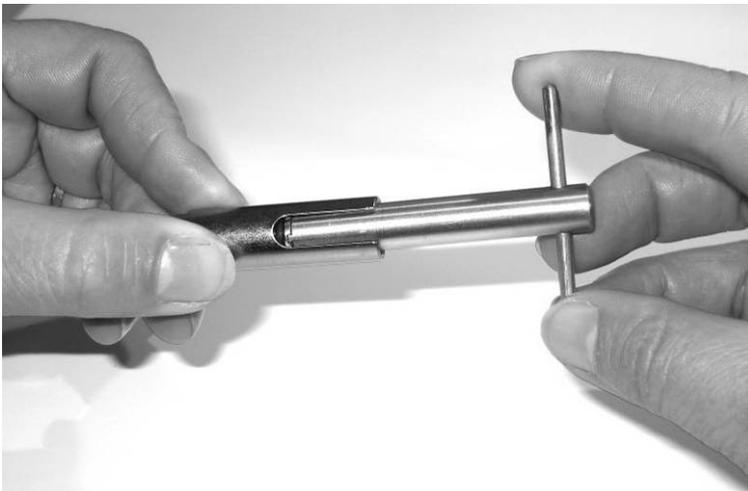
6. Assembly instructions

⚠ WARNING: When assembling the RB70 ADV, use rubber gloves to avoid polluting it while assembling and rendering it not oxygen-clean. Note: For clarity, gloves are not shown below.

6.1 Put spring, tilt axle and tilt boss in ADV body



6.2 Screw tilt boss back in ADV body



Use the demand valve slotted tool (RB TOOL 9) to screw the tilt boss back into the ADV body. Screw clockwise.

Make sure the centre stem of the tilt boss fits into the centre hole of the demand slotted tool. Also make sure it connects properly into the groove on top of the tilt boss.

⚠ WARNING: do not use force. Make sure you do NOT BEND the tilt axle! The 90° angle of the tilt axle is VITAL to the correct operation of the ADV. Bending it will lead to either free-flow or the opposite, non-delivery of diluent gas by the ADV.

Screw the tilt boss all the way in, then back off half a turn to ensure that the tilt axle is centred.

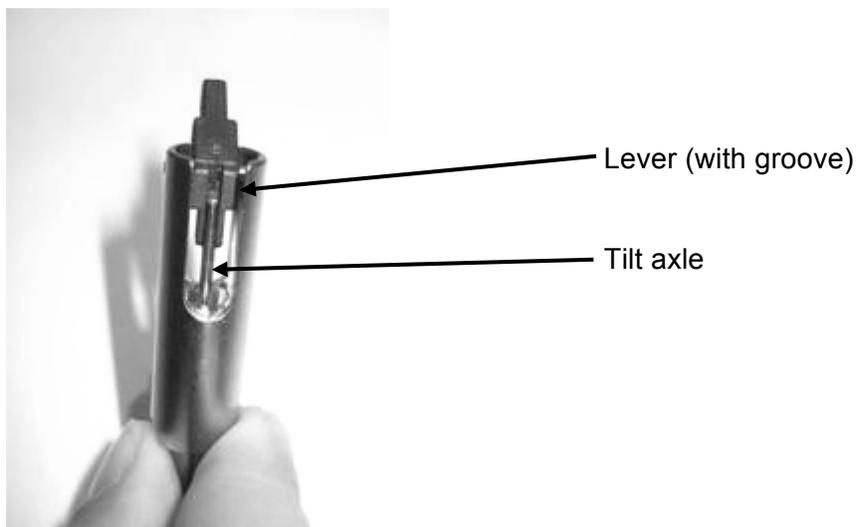
⚠ WARNING: *Backing off half a turn is the ONLY adjustment needed for the ADV. Do NOT use other settings other than backing off half a turn, as it might lead to free-flow or otherwise incorrect operation or injection timing.*

6.3 Push lever pin back through lever and ADV body



The pin holds its position in the lever solely by friction; no locking rings etc. are used. Try to push the pin in without using tools to avoid damaging it. If you need to use a small tool, make sure you do not damage the plastic lever or the holes in the ADV body.

⚠ WARNING: the holes in the ADV body are not in the centre, as you can see in the picture above right. The lever needs to be positioned in the lower position, pointing down. The lever also has a groove on one of its sides. The part with the groove needs to go in the inside of the ADV body, supporting the tilt axle. When positioned correctly, the tilt axle is exactly in the centre of the ADV body, and the tilt axle axis rests aligned in the groove in the top of the lever.



Check proper alignment and free movement of the tilt axle when operating the lever.

6.4 Push ADV body back into the T-piece body



The BS014 O-ring on the outside of the banjo seals on the outer face of the ADV. Make sure you push it through carefully, without levering.

! **WARNING:** Do NOT rotate the ADV body while pushing it through, as it is aligned to the T-piece body with small notches to force it in the correct vertical position. Rotating it might damage the plastic notches on the inside of the T-piece body.

If the ADV body is fitted and aligned correctly, it looks like this:

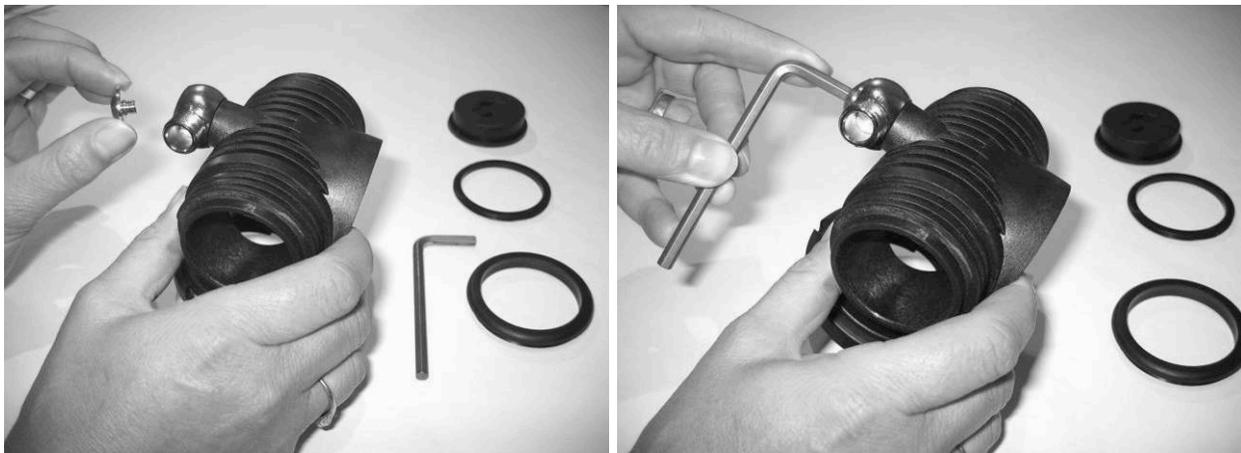


6.5 Push banjo back (2) on protruding part of ADV body (6)



- If servicing a pre-2006 version of the ADV, make sure the new BS014 O-ring on the outside of the banjo is facing the T-piece body.
- If servicing a post-2006 version of the ADV, make sure a new BS109N70 O-ring is fitted around the protruding shaft of the ADV body.

6.6 Screw retaining screw back in protruding part of ADV body

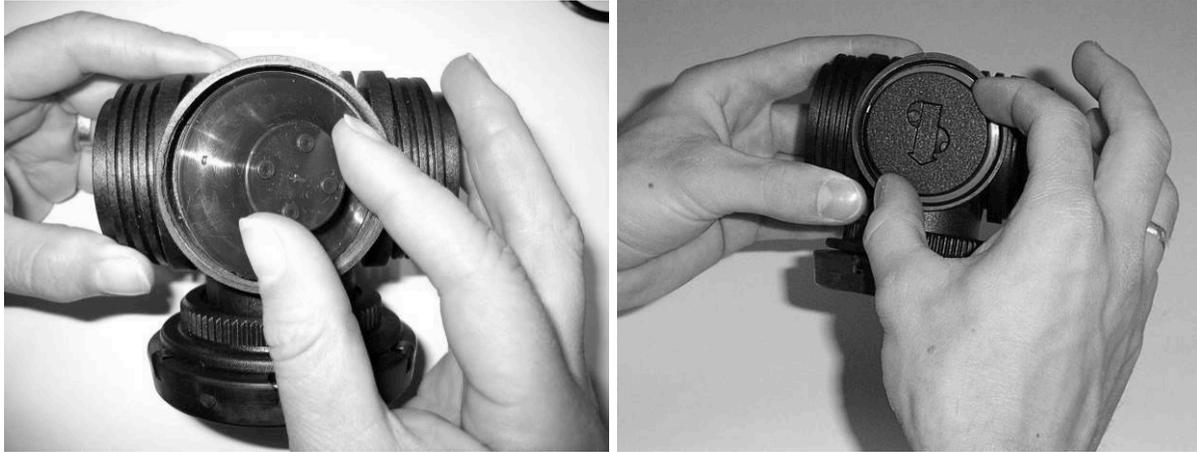


Screw clockwise. Use 5 mm Allen key to tighten until locked against ADV body.

⚠ WARNING: Do NOT over-tighten, as this might cause the ADV body to rotate and damage the notches on the inside of the T-piece body (see paragraph 6.4).

Check that the banjo can swivel freely.

6.7 Replace diaphragm, diaphragm cover and skid disc



Make sure that the rim on the rear side of the diaphragm falls into the groove of the T-piece body.

The skid disc can be fitted to models that previously did not have one.

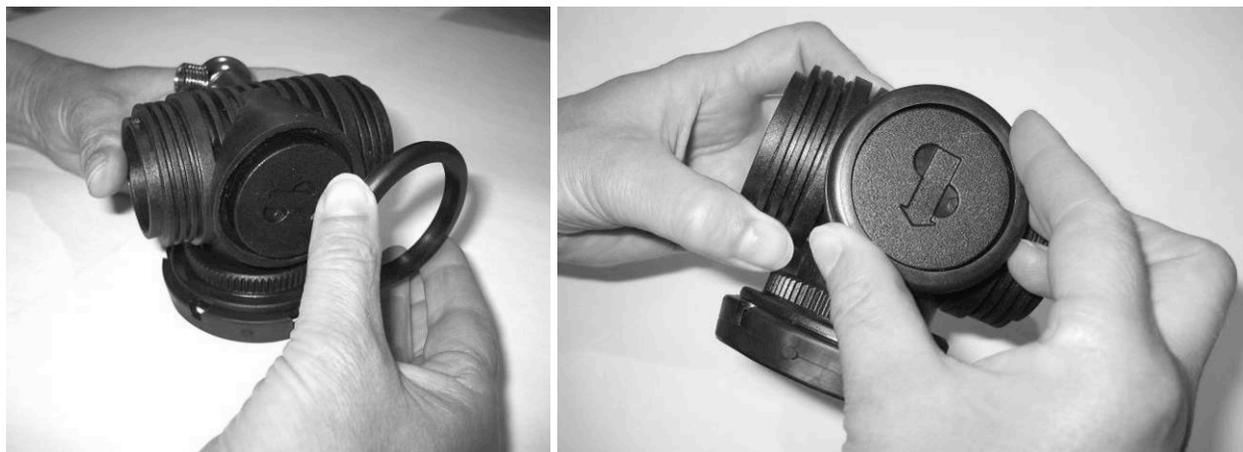
6.8 Screw locking ring back into T-piece body



Screw clockwise, using special tool RB TOOL 8 or a pair of pliers with thin tips that fit correctly. Make sure that the 4 pins from the special tool are properly locked into the 4 small holes in the locking ring to avoid damaging the ring.

After tightening check that the diaphragm is not creased or has not come out of the groove it sits in. This can be done visually and by feel through the inside of the T-piece

6.9 Screw retaining ring back in T-piece body



Screw clockwise. Do not tighten too much, as it might make removal in the future difficult.

7. Testing instructions

7.1 Do negative counterlung leak test (with diluent cylinder valve closed)

Do your negative leak test as you would normally do when testing your rebreather, by sucking the breathing loop vacuum. You can see the diaphragm move inwards through the holes of the diaphragm cover.

During the negative leak test the diaphragm should stay in the inward position (i.e. away from the diaphragm cover). If there is a leak in the system, the diaphragm will not hold this position and return to its resting position (i.e. against the diaphragm cover).

7.2 Do positive counterlung leak test

Do your positive leak test as you would normally do when testing your rebreather, by filling the breathing loop to its maximum while keeping the overpressure valve on the right exhale counterlung in its “heavy” position (i.e. screwed in all the way towards the counterlung). If there are leaks, the counterlungs will loose their firmness.

7.3 Test ADV operation by breathing from empty loop

Open the diluent valve. Suck the breathing loop empty. The ADV should now operate and inject diluent into the loop. Injection should stop after a few seconds when the loop has filled with diluent equal to the environmental pressure.

Judge breathing resistance by breathing softly (ADV should still open) and very hard (ADV should keep up, but must not free-flow).

7.4 Check for bubbles from T-piece body or banjo during shallow test dive

Have your buddy check the ADV for any bubbles or leaks during a shallow test dive. Rotate the banjo slightly to see if leaks also stay away under rotation.

The ADV should operate when descending as described in the Introduction chapter.

Annex A Replacing the Retainer Base, Base Protector and O-ring

A.1 Remove the ADV from the counterlung



Use RBTOOL 6 to hold the Top, while your other hand grips the Retainer Base through the counterlung outer bag.

Unscrew the Top, using RBTOOL 6.



To gain access to the parts inside the inner bag, the rear zip on the outer bag must be opened.



The parts can then be taken out through the ADV hole in the inner bag.

⚠ WARNING: Do NOT try and pull the parts through the outer bag hole.

Replace the base protector and O-ring BS130 N70 with new parts.

A.2 Re-fit the ADV to the counterlung



Fit the retainer base, base protector and O-ring BS130 N70 into the inner bag by placing the parts through the rear zip and into the ADV hole.



Once the base parts are inside the inner bag, push the screw threads of the retainer base through the inner and outer bag materials until the materials lay flat.

⚠ WARNING: Ensure that the outer bag materials do NOT obstruct the screw threads by running the flat end of the RBTOOL 6 around the edge of the retainer base.



Screw the ADV on to the retainer base and tighten it up using RBTOOL 6.
Close the rear zip on the outer bag and carry out the tests as described in chapter 7.