Second-Stage

REPAIR & MAINTENANCE MANUAL

Use this manual for these second-stages:

- SEA4
- SE3
- Conshelf 22
- Conshelf 22 Octopus
- Aquarius
- Pioneer

U.S. DIVERS®
AQUA-LUNG®

P/N 7802-30 Rev. 1/95

Contents

I. Introduction

This manual provides maintenance instructions for the Conshelf SEA4, SE3, 22, 22 Octopus, Aquarius, and Pioneer second-stage regulators. Maintenance and overhaul procedures outlined within this manual are to be performed by personnel who completed the U.S. Divers® Aqua-Lung® maintenance instruction program and achieved certification as a qualified repair technician.

II. Safety Precautions

If a procedure has a special warning, caution or note associated with it, you will be alerted with the italicized words, "*Before proceeding, read the following warning (caution or note) that pertains to step x.*" Next to all warnings will be the word "STOP" in white letters on a black octagon (figure 1). Next to all cautions will be a white exclamation point overlaid on a black triangle (figure 2). Next to all notes will be a white capital N overlaid on a gray circle (figure 3).

Figure 1

Figure 2

Figure 3

Warnings, Cautions and Notes Defined

A ***WARNING*** is used before a procedure that will result in serious injury or death if the procedure is not followed carefully.

A ***CAUTION*** is used prior to any maintenance technique that will result in damage to parts if that technique is not followed carefully.

A ***NOTE*** is used before any maintenance technique that is important enough to emphasize.

WARNING: U.S. Divers' SCUBA equipment (regulators, octopus, buoyancy compensators, cylinders, valves and gauges) is designed and intended for use only with clean, compressed atmospheric air (21% oxygen and 79% nitrogen). DO NOT use any other gas or enriched oxygen mixture above 21% oxygen. Failure to adhere to this warning may result in serious injury or death due to fire and explosion, or the serious deterioration or failure of the equipment.

III. General (Preventative) User Maintenance

Providing the best possible preventative routine maintenance before and after dives will help to ensure the maximum life of a regulator, and more importantly, proper function between servicing. To consistently achieve this goal, there are a number of simple, but important, routine maintenance procedures that should be followed by the customer after every use of the equipment. It is therefore important to advise the customer of the following recommended procedures:

NOTE: Refer customer to the U.S. Divers® Aqua-Lung® Regulator Owners Manual, PN 1019-99.

1. After each day of diving, the regulator must be cleaned, inspected and prepared for the next use or storage. As soon as the regulator is removed from the SCUBA cylinder(s), install

User Maintenance (Continued)

the dust cap over the regulator first-stage inlet port. This cap is normally attached to the regulator yoke and, therefore, has been underwater. Blow all the water out of the cap first. Failure to do this results in water entering the first-stage, causing corrosion. Also, make sure the O-ring is inside the dust cap. In most cases, it also serves as a spare O-ring in case of damage to the O-ring on the cylinder valve. This important soft seal should be inspected regularly and replaced if it shows signs of wear or aging.

If the regulator is equipped with the first-stage regulator DIN adapter, then, after removing the DIN adapter regulator from the SCUBA cylinder, install the dust cap over the adapter. Be sure to blow the dust cap completely dry. Failure to do this will result in water entering the first-stage regulator, causing corrosion.

2. There are two methods of routinely cleaning regulators after each dive:

■ **The "Pressurized" Method**

The first (and preferred) method is the "pressurized" procedure.

a. Remove the dust cap. Attach the regulator to a charged SCUBA cylinder.

b. Open the cylinder valve slowly to pressurize the regulator.

Before proceeding, read the following note that pertains to step C.

NOTE: Soaking regulator parts in warm water will remove salt and mineral deposits more effectively than conventional rinsing.

c. Soak the regulator with fresh, warm (not over 120°F) tap water to remove salt and mineral deposits. Allow the water to enter the second-stage mouthpiece. Depress the purge button for a few seconds while water is in the second-stage. To remove excess water after soaking is complete, purge the second-stage a few more times.

d. Disconnect the first-stage from the SCUBA cylinder.

e. Dry the dust cap before putting it over the inlet port of the first-stage regulator.

f. To air dry, lay the regulator on a clean towel, away from direct sunlight.

■ **The "Non-Pressurized" Method**

A non-pressurized procedure can be performed if no charged cylinder is available.

a. Soak the entire first-stage with warm, fresh tap water with the dust cap in place.

b. Soak the second-stage regulator. DO NOT DEPRESS THE PURGE BUTTON while soaking the second-stage. Doing so will allow water to enter the hose and first-stage. Blow out excess water from the second stage after soaking.

c. To air dry, lay the regulator on a clean towel, away from direct sunlight.

3. After air drying, store the regulator as follows:

a. Store in a clean equipment box or, as an alternative, seal inside a plastic bag.

b. It is a good practice to wipe the rubber parts with a light application of silicone grease using an impregnated cloth if the regulator is to be stored for a long period of time.

General Cautions and Warnings - Whenever possible, be sure to advise the customer to take the following precautions while using or caring for their equipment:

CAUTION: First-stage regulators equipped with a DIN regulator adapter must be cleaned with the pressurized method only. Failure to pressurize the DIN regulator will cause water to enter the first-stage regulator, causing corrosion.

CAUTION: Never store the regulator while still connected to a SCUBA cylinder.

CAUTION: DO NOT use any type of solvent to clean any part of the regulator.

CAUTION: DO NOT carry the SCUBA cylinder by the regulator or hoses; such abuse will eventually damage the regulator or the cylinder valve.

WARNING: DO NOT loosen or remove the secondary diaphragm retaining ring or the secondary diaphragm from a Supreme first-stage; this will result in loss of silicone fluid, rendering the regulator unsafe for use.

IV Scheduled Dealer Service

1. Do not assume that a regulator is in good working order because of storage or infrequent use. Remember, either prolonged or improper storage can still result in internal corrosion or deterioration of O-ring seals.
2. A regulator must be cleaned and adjusted frequently. As an authorized U.S. Divers Aqua-Lung repair technician, it is your responsibility to inform your staff and customer that the regulator requires a complete servicing with scheduled parts replacement at least once a year. **Failure to obtain service annually will void the limited 2-year warranty for the regulator**. Frequent use in clean, fresh water environments might require cleaning and an overhaul every six months. Use as rental equipment and/or in salt, chlorinated (swimming pool), or polluted water might require cleaning every three to six months. Remember that chlorinated water is an especially bad environment for regulators because the chlorine deteriorates the neoprene rubber components.
3. Advise your customers to regularly inspect the sintered filter which is visible through the high pressure inlet port of the first-stage regulator. If it is discolored or corroded, replacement by trained personnel is required, along with a complete servicing of the first and second stages, which includes replacement of all soft seals and non-reusable components. Rust (red powder) or aluminum oxide (gray powder) deposits on the sintered filter are usually an indication that salt water has entered the SCUBA cylinder and caused internal corrosion. The customer must be notified that their SCUBA cylinder(s) should be visually inspected and cleaned, or hydrostatically tested as required.
4. When counseling your customers on preventative maintenance, inform them that no other adjustment or maintenance of their regulator is recommended by U.S. Divers. For adjustments such as the intermediate pressure setting or proper lubrication, the regulator must be taken to an Authorized U.S. Divers Dealer, or returned to the factory.

V. Authorized Regulator Disassembly

A. General Considerations

1. This section presents step-by-step disassembly procedures for the Conshelf SEA4, SE3, 22, 22 Octopus, Aquarius, and Pioneer Regulators. It is important that the sequence be followed exactly in the order given. Read over the entire manual prior to overhaul to become familiar with maintenance procedures. Take special note of all tables, especially the Replacement Parts Listing in Section VIII, Table 5 - Lubricants and Cleaners, and Table 4 - Tool List.
2. Disassembly of the second-stage regulator should be carried out in a work area specifically set up and equipped for the task. Adequate lighting, cleanliness and easy access to all required tools are essential for an efficient repair facility. As each regulator is disassembled, the components to be reused should be segregated and not allowed to intermix with components from other regulators. Special tools (see Table 4 - Tool List) are required for disassembly and subsequent assembly.
3. Before disassembling the second-stage regulator, perform a pretest. By following the test described in Section X or Table 2 Testing Procedures and making reference to the Troubleshooting Table, pages 14 through 15, you will be able to determine the need for parts replacement.

NOTE: This manual provides disassembly and reassembly procedures for second-stage regulators only. For proper maintenance of the Conshelf SE3 and 22 first-stage regulator, see the SE2 Service Manual (PN 7802-08). For maintenance of the SEA4 first-stage regulator, see the SEA Service Manual (PN 7802-12).

B. Authorized Second-Stage Regulator Disassembly

1. Slide the hose protector (item 29) along the hose to expose the inlet fitting (item 10) and the swivel nut of the hose (item 26). Next, while holding the inlet fitting (item 10) with a $^{3}/_{4}$-inch open-end wrench, use an $^{11}/_{16}$-inch open-end wrench to unscrew counterclockwise and remove the swivel end of the intermediate pressure hose (item 26).
2. Remove and discard the O-rings (items 27 & 28) from the intermediate pressure hose.
3. With a 4mm Allen wrench, unscrew counterclockwise and remove the port plug (item 25). Next, remove the alignment key (item 23). Remove and discard the port plug O-ring (item 24).

Before proceeding, read the following note that pertains to step 4.

NOTE: To properly remove the box top (item 22), use the PN 1003-06 or 1019-40 boxtop wrench for the Conshelf SE3, 22 and 22 Octopus, the PN 1003-06 box top wrench for the SEA4, or the PN 1004-89 box top wrench for the Aquarius.

4. Using the proper box top wrench, unscrew counterclockwise and remove the box top (item 22). Next, lift out the thrust washer (item 18) followed by the diaphragm (item 17). If working on an SEA4, DO NOT remove the metal "C"-insert from the box top.

NOTE: If disassembly of the box top (item 22) is required to change the color ring, or to change/inspect the purge spring or purge button (items 19 & 20), see page 5, step 13.

Before proceeding, read the following Caution that pertains to step 5.

CAUTION: Keep the demand lever (item 8) depressed while removing the inlet fitting (item 10). Failure to keep the lever depressed may cause damage to the inlet fitting sealing surface.

5. With the lever depressed, use a $^{3}/_{4}$-inch wrench to unscrew counterclockwise and remove the inlet fitting (item 10). Remove and discard the inlet fitting external O-ring (item 9).
6. Place your finger into the inlet hole on the left side of the box bottom (item 12). Next, grasp the lever (item 8) with your other hand. Push in on the insert while pulling on the lever and remove the insert assembly (item 4). See figure 4.

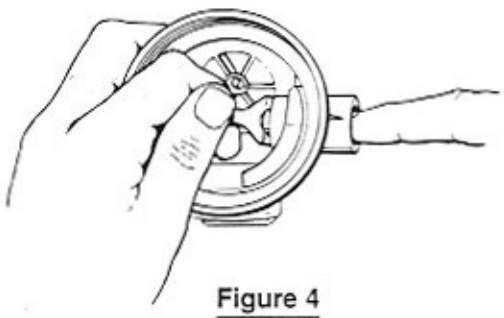


Figure 4

NOTE: Do not remove the venturi baffle (item 30) during servicing. Only remove the baffle if it is broken and needs replacement.

Before proceeding, read the following caution that pertains to step 7.

CAUTION: The disc and retainer assembly (items 1 & 2) is under spring tension. Be careful when removing these parts. This will help prevent damage and/or loss of parts.

7. To disassemble the insert assembly, fit the disc and retainer wrench (U.S.D. PN 1100-05) over the disc end of the retainer (item 2). Insert the 1/4-inch nut driver portion of the lever height adjustment tool (U.S.D. PN 1016-84) over the locknut (item 7). While holding the locknut with the nut driver, turn the nut driver counterclockwise and remove the locknut (item 7). See Figure 5. Discard the used locknut.

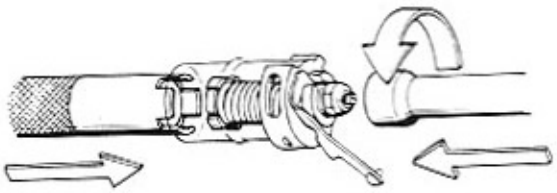


Figure 5

8. Remove the spacer (item 6), lever (item 8) and washer (item 5) from the insert assembly. Next, remove the disc and retainer (items 1 & 2) followed by the spring (item 3). Remove and discard the used disc (item 1) located in the large end of the retainer (item 2).
9. Remove and discard the external O-ring (item 11) located on the insert assembly.
10. To remove the mouthpiece (item 15), snip the plastic mouthpiece clamp (item 16) with pliers, or, with care, wire cutters. Next, pull one side of the mouthpiece and peel it off the box bottom (item 12).
11. Pull off the exhaust tee (item 14) from the box bottom.
12. Cut off the "stem" of the exhalation valve (item 13) from inside the box bottom. Remove and discard the used valve.
13. If removal of the purge button is required, proceed as follows:
    a. Squeeze the four (4) arms of the purge button (item 19) towards the center of the box top (item 22) to release the purge button and spring. Separate the spring and purge button.
    b. **SE3 ONLY**: Lift out the color ring (item 21) from the center of the box top (item 22)

NOTE: If purge button has been removed due to damage, and will require replacement, the purge adjustment screw (item 31) will need to be removed. To remove the screw use a small flat blade screwdriver and unscrew counterclockwise to remove the purge screw.

This concludes the disassembly of the second-stage regulator.

NOTE: This manual provides disassembly and reassembly procedures for the Conshelf SEA4, SE3, 22, 22 Octopus, and Aquarius second-stage regulators only. For proper maintenance of the Conshelf SE3 or 22 first-stage regulator, see the SE2 Service Manual (PN 7802-08). For maintenance of the SEA4 first-stage regulator, see the SEA Service Manual (PN 7802-12).

VI. Regulator Parts Cleaning

In conjunction with this section, the service technician should refer to the list of Lubricants and Cleaners in Table 5.

CAUTION: NEVER expose plastic or rubber parts to solvents or caustic cleaning agents of any type. Never use aerosol silicone sprays to lubricate or clean plastic or rubber parts, as the propellant gas or carrier solvent may attack or weaken them.

A. All original soft seals and expendable parts need not be cleaned as they are routinely replaced during normal maintenance and overhaul (see Section VIII). The other rubber and plastic parts - diaphragm, box top, thrust washer, color ring, hose protector, mouthpiece,

exhaust tee, box bottom, baffle, port plug, and alignment key - which are not usually replaced (unless damaged) during a standard overhaul, should be cleaned with a mild, warm water (not over 120°F) detergent solution. Then, they should be thoroughly rinsed in clean, fresh water and blown dry with filtered, low-pressure air (30 psig). A soft nylon bristle brush may also be used, taking care not to scratch or abrade the rubber or plastic parts.

NOTE: Clean the retainer (item 2) and inlet fitting (item 10) with extra care, especially the seating surfaces. Next, thoroughly rinse all metal parts to completely eliminate loosened material. Immerse components in the ultrasonic cleaning solution and comply with specific instructions for the detergent. If Oakite #31 is used in the ultrasonic cleaning tank, follow instructions carefully. If an acetic acid (household white vinegar) solution is used, a cleaning time of 10 to 15 minutes will suffice, using a recommended concentration of one part acetic acid to one part water.

B. After disassembly, give all metallic parts a preliminary cleaning in a warm detergent/water solution. Use a soft nylon bristle brush if mineral encrustation or corrosion is present. DO NOT USE A WIRE BRUSH! The preferred and recommended cleaning procedure for metallic parts utilizes an ultrasonic cleaning tank with a suitable detergent.

CAUTION: Excessive cleaning times beyond those recommended may damage plated parts. After completion of ultrasonic cleaning, remove all metal parts and thoroughly rinse with clean, fresh water and blow dry with low-pressure (30 psig) air. Only brass, plated brass and stainless steel parts should be immersed in acid cleaning solution, such as Oakite #31 or vinegar.

C. If no ultrasonic cleaning tank is readily available, then use the following, less preferred, chemical procedure: First, using a soft bristle brush, remove any loose adherent or flaking material. Place metal parts in a recommended acid bath solution (e.g. Oakite #31, see Table 5) and gently agitate for three to four minutes. Afterwards, remove and rinse with clean, fresh water and blow dry with filtered low pressure (30 psig) air.

VII. Regulator Parts Inspection

General Procedures

1. All soft seals and non-reusable components in the second-stage regulator are routinely replaced during general overhaul. Refer to the Routine Parts Replacement Schedule following this section.
2. It is still important, however, to visually inspect all soft seals, especially O-rings, for any defects, including any molding flaws, before installation.
3. All reusable metal components must be thoroughly visually inspected for any cracks, burrs, scoring, and corrosion using a high intensity light and magnifier.
4. Examine all plated surfaces for blisters, peeling, or inconsistent plating. Replace if found.
5. Inspect all threaded components for deformation, galling, cross-threading, or stripping. Replace if found.
6. Check all sliding, reciprocating or rotating parts for nicks, burrs, scratches, or scoring. Replace if found.
7. All plastic parts must be closely inspected for distortion, cracking, deformation, or solvent attack. Replace if found.
8. All O-ring surfaces must be completely smooth and free of nicks, burrs, scoring, corrosion, or pitting. Replace if found.

Specific procedures

9. Inspect the retainer (item 2) for nicks, pitting, scratches, defective plating or excessive wear of the screwdriver slot on the threaded end. Make sure the through-hole located on the seating surface is clear and free of debris. Replace if necessary.
10. Examine the retainer orifice crown on the inlet fitting (item 10) for nicks, pitting, scratches, and defective plating. Replace if necessary.
11. Check the demand lever (item 8) for bending, distortion, or excessive wear of the nylon button. Replace the lever if necessary.
12. Examine the box bottom (item 12) for cracks or cross-threading. Replace if necessary.
13. Inspect the second-stage diaphragm (item 17) for cuts, nicks, pinholes or any other damage. Check the rubber for cracking, crazing or hardening. Make sure that the plastic plate is firmly seated in the diaphragm. Replace the diaphragm if necessary.
14. Inspect the second-stage hose (item 26) for cracking, crazing, shrinking or hardening. Make sure that the outer jacket under the crimped portion of the end fittings is not cut through showing the braided reinforcement underneath. There should be no evidence that the hose is "pulling out" of the end fittings. Inspect the male end of the inlet fitting for stripped and damaged threads. Maximum service time for rental hoses is one year. Replace the second-stage hose if necessary.
15. Refer to the Troubleshooting Table for additional problem areas, their causes and recommendations for cleaning and replacement.

This concludes the inspection procedures for the second-stage regulator.

VIII. Routine Parts Replacement Schedule

NOTE: U.S. Divers recommends that parts listed under "Routine Parts Replacement Schedule" be replaced every year for regulators used exclusively for recreational diving. The second-stage diaphragm need only be replaced if damage, signs of age, or chemically-induced deterioration are seen.

Part Number	Description	Item Number	Quantity Needed
1085-10	Disc	1	1
1025-10	Locknut	7	1
8200-14	O-ring	9	1
8200-15	O-ring	11	1
1005-12	Exhalation Valve	13	1
1049-13	Clamp	16	1
9570-25 or 8200-11	O-ring	24	1
9570-25 or 8200-11	O-ring	27	1
9573-10 or 8200-10	O-ring	28	1

IX. Authorized Second-Stage Regulator Reassembly

1. Insert the new disc (item 1) into the bore provided for it on the retainer (item 2).
2. Position the spring (item 3) over the stem of the retainer (item 2).
3. Fit the disc and retainer with its spring onto the disc and retainer wrench (U.S.D. PN 1100-05) and carefully place the assembly into the insert (item 4). See figure 6.

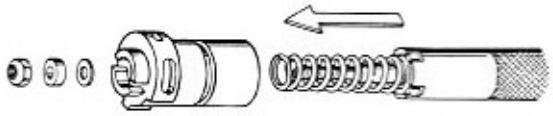


Figure 6

4. Push inward on the wrench so that the threaded end of the retainer (item 2) protrudes beyond the end of the insert (item 4).
5. Immediately place the washer (item 5), radiused end up, spacer (item 6) and a new lock nut (item 7) onto the retainer (item 2). Turn the locknut clockwise until the first threads are engaged.

NOTE: The insert assembly (item 4) has a keying tab on the bottom which fits in the channel of the box bottom (item 12). Properly orient the tab such that, when you install the lever, it will apppear as shown in figure 8.

6. Still pushing inward on the disc and retainer wrench, insert the lever (item 8) between the spacer and the washer (figure 7). Remove the disc and retainer wrench. Depress the lever and then release it. If the lever is properly aligned in its groove on the insert assembly, the lever will spring freely back to the up position after being released.
7. Re-install the disc and retainer wrench over the disc and retainer (items 1 and 2). Do not compress the retainer with the wrench. Next, place the 1/4-inch nut driver portion of the Lever Height Adjustment Tool (LHAT), PN 1016-84, over the locknut (item 7). Turn the nut driver clockwise until about three threads of the retainer are visible beyond the head of the locknut. Remove the disc and retainer wrench and nut driver.

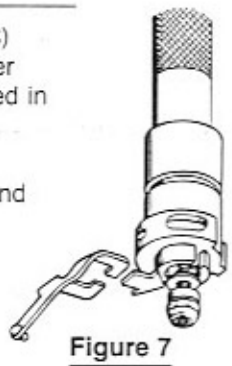


Figure 7

8. Lightly lubricate the O-ring (item 9) and place it on the inlet fitting (item 10). Lightly lubricate the O-ring (item 9) and install it in the groove of the insert assembly.
9. If, during disassembly, the baffle (item 30) was removed, install the baffle at this time.
10. Align the keying tab on the insert asssembly (item 4) with the channel located just above the exhaust port of the box bottom (item 12). See Figure 8. Slide the insert assembly along the channel until the female threaded end is flush with the inlet boss of the box bottom.
11. Lightly lubricate the first two male threads of the inlet fitting. While depressing the lever (item 8), thread the inlet fitting (item 10) clockwise into the box bottom until finger tight. Then, using a 3/4-inch crows foot attached to a torque wrench, tighten the inlet to 50 inch-pounds. Release the lever and remove the wrench.

Figure 8

12. If there is excessive "free play" or "slack" in the lever, insert the 1/4-inch nut driver of the lever height adjustment tool (LHAT) through the port plug opening on the box bottom and over the locknut (item 7). Next, insert the screwdriver portion of the LHAT down through the hollow bore in the nut driver until it engages with the slot in the end of the retainer (item 2). See figure 9. **While holding the screwdriver steady**, turn the nut driver clockwise. Adjust only far enough to eliminate excessive "free play" or "slack."

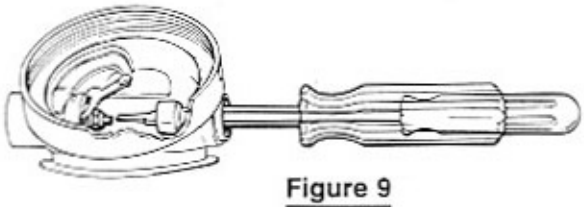


Figure 9

13. Insert the exhalation valve (item 13) into the box bottom (item 12) and pull the stem of the valve until its barb passes through the box bottom. Using wire cutters, trim the stem end of the valve 1/8" to 1/4" above the barb. Be sure the exhaltion valve is properly seated.
14. Reinstall the exhaust tee (item 14) by stretching it over the flange of the box bottom.
15. Refit the mouthpiece (item 15) to the box bottom such that the bridge is facing upward. Next, fasten the mouthpiece in place with a new mouthpiece clamp (item 16). Align the tab on the mouthpiece with the air inlet boss of the box bottom. Tighten the clamp with pliers and snip the extra length with wire cutters.
16. Position the diaphragm (item 17) over the lever with the plastic plate facing down. Next, place the thrust washer (item 18) over the diaphragm.
17. If the purge button (item 19), purge spring (item 2), or color ring (item 21) were removed in disassembly, reassemble as follows:
    A. Place the spring (item 20) on the four arms of the purge button (item 19) such that the smallest end of the spring is against the purge button.
    B. Place the color ring (item 21) into the center front of the box top (item 22).
    C. With the front of the box top facing you, and the alignment key hole of the box top on your right, place the purge button spring assembly (items 19 and 20) with the Aqua-Lung logo facing up into place in the box top.
18. Thread the box top (item 22) clockwise onto the box bottom (item 12) until the locking holes in the box bottom and box top are aligned so that the alignment key (item 23) can later fit into the slot.

NOTE: Do not install the alignment key or port plug assembly (item 25) until final adjustments of the second-stage assembly is complete.

X. Authorized Regulator Adjustment and Testing Procedures (With Test Bench)

CAUTION: Before adjusting and testing the second-stage regulator, you should first become familiar with the proper first-stage regulator adjusting and testing. The SE2 Service Manual (PN 7802-08) or SEA Service Manual (PN 7802-12) is required to perform these adjustments. Refer to these service manuals before proceeding in this manual.

After following the first-stage reassembly and testing procedures, proceed as follows:

NOTE: Before placing the second-stage regulator back in service, the following sequence of adjustments is necessary. A properly calibrated flow bench is the preferred device to ensure the quality of your adjustments. This will enable the service technician to check critical performance requirements of the regulator more precisely. If a test bench is not available, use of a SCUBA cylinder (the less preferred testing procedure) will follow this section.

A. Attachment of the First-Stage to Second-Stage

1. Install two lubricated O-rings (items 27 & 28) on the intermediate-pressure hose (item 26).
2. Attach the hose (item 26) to the appropriate low-pressure port on the first-stage body using an $^{11}/_{16}$-inch or $^{9}/_{16}$-inch torque wrench. Tighten the hose clockwise to a torque of 40 inch-pounds.
3. Connect the first-stage regulator to a source of low-pressure (500 psig) breathing air. While firmly holding the free end of the second-stage hose, carefully open the air source control valve, allowing a small quantity of air to flow through the open hose. This will flush any dust or debris from the interior of the hose. Close the air source control valve.
4. Attach the second-stage regulator to the free end on the second-stage hose. While holding the inlet fitting (item 10) with a $^{3}/_{4}$-inch wrench, use and $^{11}/_{16}$-inch torque wrench to tight the swivel nut clockwise to a torque of 40 inch-pounds.

NOTE: If the octopus regulator is to be used, attach the octopus hose to the first-stage body as described in steps 1 through 4 above. DO NOT connect any other hoses (pressure gauge, low pressure Inflator hose) until all first and second-stage testing is complete.

B. Second-Stage Adjusting and Testing

In conjunction to this subsection, refer to Table 2, "Test Bench Specifications", on page 15.

Before proceeding, read the following caution that pertains step 1.

NOTE: If the second-stage leaks when the regulator is pressurized, do not continue with the testing procedures until the leak is stopped. To stop the leak, place the $^{1}/_{4}$-inch nut driver portion of the Lever Height Adjustment Tool (LHAT) over the locknut (item 7) by passing it through the access port hole of the box bottom (item 12). Next, insert the screwdriver portion of the LHAT down through the center of the nut driver. Insert the blade of the screwdriver into the slot on the end of the retainer (item 2). See figure 10. While holding the screwdriver and retainer steady, turn the locknut (item 7) counterclockwise just until the leak stops. Remove the LHAT from the box bottom.

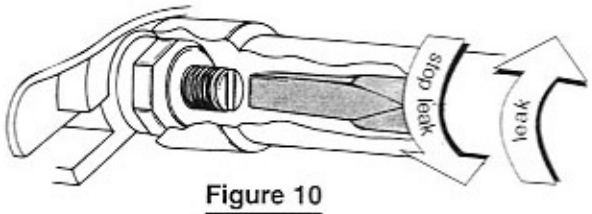


Figure 10

1. With the regulator attached to the flow bench, slowly pressurize the regulator to 3500±100 psig. The intermediate pressure gauge should indicate a "lockup" pressure of 140±5 psig.
2. If the second-stage does not leak, use the adjustment technique described in the above note to set the opening effort at its minimum level.
3. With the LHAT in place, turn the nut driver clockwise until you detect a slight leak. Then, turn the nut driver counterclockwise until the leak stops (figure 10). Remove the LHAT from the regulator.
4. **Final Reassembly**
   Lightly lubricate the O-ring (item 24) and install it on the port plug (item 25). Insert the pin end of the alignment key (item 23) into the alignment holes just above the adjustment port of the box bottom (item 12). Secure the alignment key by threading the port plug (item 25) clockwise into the box bottom until finger tight. Attach a 4mm Allen adapter to a torque wrench. Tighten the port plug (item 25) to 5 to 8 inch-pounds.
5. **Second-Stage Air Flow Test**
   With the regulator still attached to the flow test bench, repressurize the regulator to 3500±100 psig. Place the second-stage mouthpiece over the mouthpiece adapter. Slowly turn the

flowmeter control knob until the flow reaches a minimum of 15 SCFM (425 liters per minute). The reading on the Magnahelic gauge (inhalation / exhalation effort gauge) should indicate no more than +6.0" H20. If the reading is over +6.0" H_2O, refer to Troubleshooting Table 1 on pages 14 and 15 for corrective guidelines and specific procedures.

6. **Second-Stage Opening Effort Test**
   Shut off the flowmeter control knob. Slowly turn the flowmeter control knob back on while watching both the Magnahelic gauge and the intermediate pressure gauge. When the intermediate pressure gauge begins to drop below the intermediate pressure "lockup," the magnahelic gauge should indicate an opening effort of +0.6" of H_2O to 1.1" of H_2O at an intermediate pressure of 140 psig. If the opening effort is not within this range, refer to the Troubleshooting Table 1, pages 14 and 15, for corrective guidelines and specific procedures.

7. **Second-Stage Purge Flow Test**
   Turn off the flowmeter control knob. Next, while the second-stage is still mounted on the mouthpiece adapter, watch the flowmeter gauge and fully depress the purge cover. The flowmeter gauge must indicate a minimum of +7.0 SCFM (199 L.P.M). If the purge flow is less than +7.0 SCFM, refer to the Troubleshooting Table 2, pages 14 and 15, for corrective guidelines and specific procedures. When purge flow is correct, remove the second-stage from the mouthpiece adapter on the flow test bench.

8. **Leak Test**
   After final reassembly and adjustment of the second-stage regulator, the following simple test for external leaks is recommended.

NOTE: The mouthpiece of the regulator must point straight down or free-flow may result when submerged in water.

   a. With the first and second-stages attached to a high pressure air supply, submerge the entire system in a test tank of clean water.
   b. Turn on the high-pressure supply.
   c. Observe any bubbles arising from the submerged regulator over a one minute period. The recommended time is necessary due to lower bubble formation that occurs in cases of smaller leaks. Bubbles indicate a leak, which means the regulator must be disassembled to check all sealing surfaces, assembly sequence and component positioning in order to correct the problem(s).

NOTE: An alternate method for visually detecting regulator leakage is to apply a soap solution to possible leakage areas using a small, clean brush. Bubble streams will pinpoint the source of the leak. Before disassembling to correct any leaks, rinse the entire regulator thoroughly with fresh water and blow out all residual moisture with filtered, low-pressure (30 psig) air. Disassemble and remedy the problem, referring to the Troubleshooting Table as needed.

9. Pull the hose protector (item 29) in place over the inlet fitting (item 10).

10. **Subjective Breathing Test**
    In general, the properly overhauled and adjusted regulator, upon breathing in and out of the mouthpiece slowly and deeply 4 or 5 times, should deliver air to the user without excessive inhalation effort, freeflow, or "fluttering" of the second-stage diaphragm. When exhaling, there should be no fluttering or sticking of the exhalation valve. If any of these problems occur, refer to the Troubleshooting Table for corrective guidelines and specific procedures. Also, conduct a purge flow test by depressing the purge button fully. An adequate volume of air should flow through the mouthpiece that can clear the second stage of water.

This concludes the reassembly and testing of the second-stage regulator.

XI. Authorized Regulator Adjustment and Testing (Without Test Bench)

If a flow test bench is not available for testing the second-stage regulator, perform the following adjustment and testing procedures. In conjunction with this section, the technician should refer to Table 2, "Test Bench Specifications", on page 15.

A. Second-Stage Adjusting and Testing

1. After following the preliminary procedures in Section X-A, steps 1 through 4, attach a spare intermediate pressure hose (item 26) to one of the open low-pressure ports on the first-stage body.
2. Thread the intermediate test pressure gauge (PN 1116-10) onto the free end of the intermediate -pressure hose. Make sure that the bleeder valve of the test pressure gauge is open prior to pressurizing the regulator.

Before proceeding, read the following note that pertains to the adjustment of the second-stage regulator.

NOTE: If the second-stage leaks when the regulator is pressurized, do not continue with the testing procedures until the leak is stopped. To stop the leak, place the 1/4-inch nut driver portion of the Lever Height Adjustment Tool (LHAT) over the locknut (item 7) by passing it through the access port hole of the box bottom (item 12). Next, insert the screwdriver portion of the LHAT down through the center of the nut driver. Insert the blade of the screwdriver into the slot on the end of the retainer (item 2). See Figure 11. While holding the screwdriver and retainer steady, turn the locknut (item 7) counterclockwise just until the leak stops. Remove the LHAT from the box bottom.

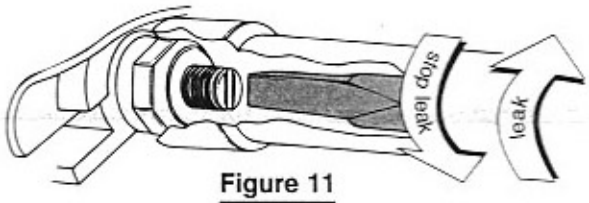


Figure 11

3. Connect the first-stage regulator to a fully charged SCUBA cylinder. Slowly pressurize the regulator to 3500±100 psig, then close the bleeder valve on the test pressure gauge. The gauge should indicate a "lockup" pressure of 140±5 psig.
4. If the second-stage does not leak, use the adjustment technique described in the above note to set the opening effort at its minimum level.
5. With the LHAT in place, turn the nut driver clockwise until you detect a slight leak. Then, turn the nut driver counterclockwise until the leak stops (figure 11). Remove the LHAT from the regulator.
6. **Final Reassembly**
   Lightly lubricate the O-ring (item 24) and install it on the port plug (item 25). Insert the pin end of the alignment key (item 23) into the alignment holes just above the adjustment port of the box bottom (item 12). Secure the alignment key by threading the port plug (item 25) clockwise into the box bottom until finger tight. Attach a 4mm Allen adapter to a torque wrench. Tighten the port plug (item 25) to 5 to 8 inch-pounds.
7. With the second-stage regulator still attached to the cylinder, depress the purge button. This should result in a moderate flow rate of air exiting from the mouthpiece. Repeat this procedure several times. Refer to Troubleshooting Guide to correct any air flow problem.
8. Next, assuming there are no air-flow problems, check the opening effort.

CAUTION: Do not allow water to enter the mouthpiece (item 15) as the water will spray over the test area.

9. While holding the mouthpiece or exhaust tee, slowly submerge the second-stage regulator, purge button facing downward and level, into a pan of clean water to a depth of about one inch above the diaphragm.
10. The submersion should cause the second-stage to free flow, indicating an acceptable, but approximate, opening effort of one-inch of water column.
11. **Leak Test**
    After final reassembly and adjustment of the regulator, the following simple test for external leaks is recommended.

NOTE: The mouthpiece of the regulator must point straight down or free-flow may result when submerged in water.

a. With the first- and second-stages attached to a high pressure air supply, submerge the entire system in a test tank of clean water.
b. Turn on the high-pressure supply.
c. Observe any bubbles arising from the submerged regulator over a one minute period. The recommended time is necessary due to lower bubble formation that occurs in cases of smaller leaks. Bubbles indicate a leak, which means the regulator must be disassemble to check all sealing surfaces, assembly sequence and component positioning in order to correct the problem(s).

NOTE: An alternate method for visually detecting regulator leakage is to apply a soap solution to possible leak areas using a small, clean brush. Bubble streams will pinpoint the source of the leak. Before disassembling to correct any leaks, rinse the entire regulator thoroughly with fresh water and blow out all residual moisture with filtered, low-pressure (30 psig) air. Disassemble and remedy the problem, referring to the Troubleshooting Table as needed.

12. Pull the hose protector (item 29) in place over the inlet fitting (item 10).
13. **Subjective Breathing Test**
    In general, the properly overhauled and adjusted regulator, upon breathing in and out of the mouthpiece slowly and deeply 4 or 5 times, should deliver air to the user without excessive inhalation effort, freeflow, or "fluttering" of the second-stage diaphragm. When exhaling, there should be no fluttering or sticking of the exhalation valve. If any of these problems occur, refer to the Troubleshooting Table for corrective guidelines and specific procedures. Also, conduct a purge flow test by depressing the purge button fully. An adequate volume of air should flow through the mouthpiece.

This concludes the reassembly and testing of the second-stage regulator.

Table 1: Troubleshooting

Problem	Probable Cause	Recommendation
Leaking or hissing sound from second-stage	1. Intermediate pressure set too high. Should be 140±5.	1. See first-stage troubleshooting guide in either SE2 or SEA Service Manual (PN 7802-08 and 7802-12 respectively.
	2. Lever (item 8) set too high.	2. Turn locknut (item 7) counterclockwise to adjust lever down.
	3. Purge button (item 19) jammed open.	3. Clean purge button (item 19) area.
	4. Lever (item 8) bent.	4. Examine and/or replace lever (item 8)
	5. Disc (item 1) dirty, damaged, or worn.	5. Replace the disc.
	6. Retainer (item 2) dirty, damaged, or worn	6. Clean or replace retainer (item 2)
	7. Inlet fitting (item 10) dirty, damaged or worn	7. Clean or replace inlet fitting (item 10)
	8. Spring (item 3) worn or weak	8. Replace spring (item 3)
Hard to breath	1. Intermediate pressure set too low. Should be 140±5.	1. See first-stage troubleshooting guide in either SE2 or SEA Service Manual (PN 7802-08 and 7802-12 respectively.
	2. Lever (item 8 bent.)	2. Replace lever (item 8)
	3. Lever set too low.	3. Turn locknut (item 7) clockwise to adjust lever upward.
	4. Sintered filter clogged.	4. Replace sintered filter
	5. Intermediate pressure hose (item 24) clogged	5. Clean or replace hose (item 24)
Low purge flow rate	1. Lever set too low.	1. Turn locknut (item 7) clockwise to adjust lever upward.
	2. Lever (item 8 bent.)	2. Replace lever (item 8)
Water entering second-stage	1. Hole in diaphragm (item 17)	1. Replace diaphragm (item 17)
	2. Exhalation valve dirty, damaged, or worn.	2. Clean or replace exhalation valve (item 13)
	3. Exhalation valve sealing area on box bottom dirty, damaged, or worn.	3. Clean or replace box bottom (item 12)
	4. Diaphragm (item 17) improperly seated between purge cover and box bottom (items 22 and 12).	4. Disassemble and reassemble properly. Be sure the thrust washer (item 18) is in place on top of the diaphragm.
	5. O-rings (items 9, 11, or 24) dirty, damaged, or worn.	5. Replace O-rings (items 9, 11, or 24)
	6. Cracked or damaged box bottom (item 12)	6. Replace box bottom (item 12)

Table 1: Troubleshooting (continued)

Problem	Probable Cause	Recommendation
External air leaks	1. Inlet fitting (item 10) loose. 2. Intermediate pressure hose (item 26) loose. 3. O-rings (items 9 or 24) not seating 4. First-stage fittings loose	1. Tighten inlet fitting (item 10) 2. Tighten intermediate-pressure hose (item 24) 3. Replace O-rings as needed, or examine O-ring sealing surfaces. 4. Tighten fittings.

Note: Immerse pressurized regulator in water to locate the source of the leak. If leaks are detected depressurize system before tightening loose fitting plugs or hose

Table 2: Test Bench Specifications

Test	Condition	Acceptable Range
Leak test	3500±100 or 3000±100 psig	No leaks allowed
Intermediate-pressure	3500±100 or 3000±100 psig	140±5
Intermediate-pressure creep	3500±100 or 3000±100 psig	5 psig max between 5 to 15 seconds after cycling regulator (purge)
Opening effort	Supply pressure 140±5 psig	.6 to 1.1 inches of water
Flow effort	15 SCFM at 140±5 psig inlet pressure.	6 inches of water or less
Purge flow	140±5 psig inlet pressure	7.0 SCFM flow rate (minimum)

Table 3: Torque Specifications

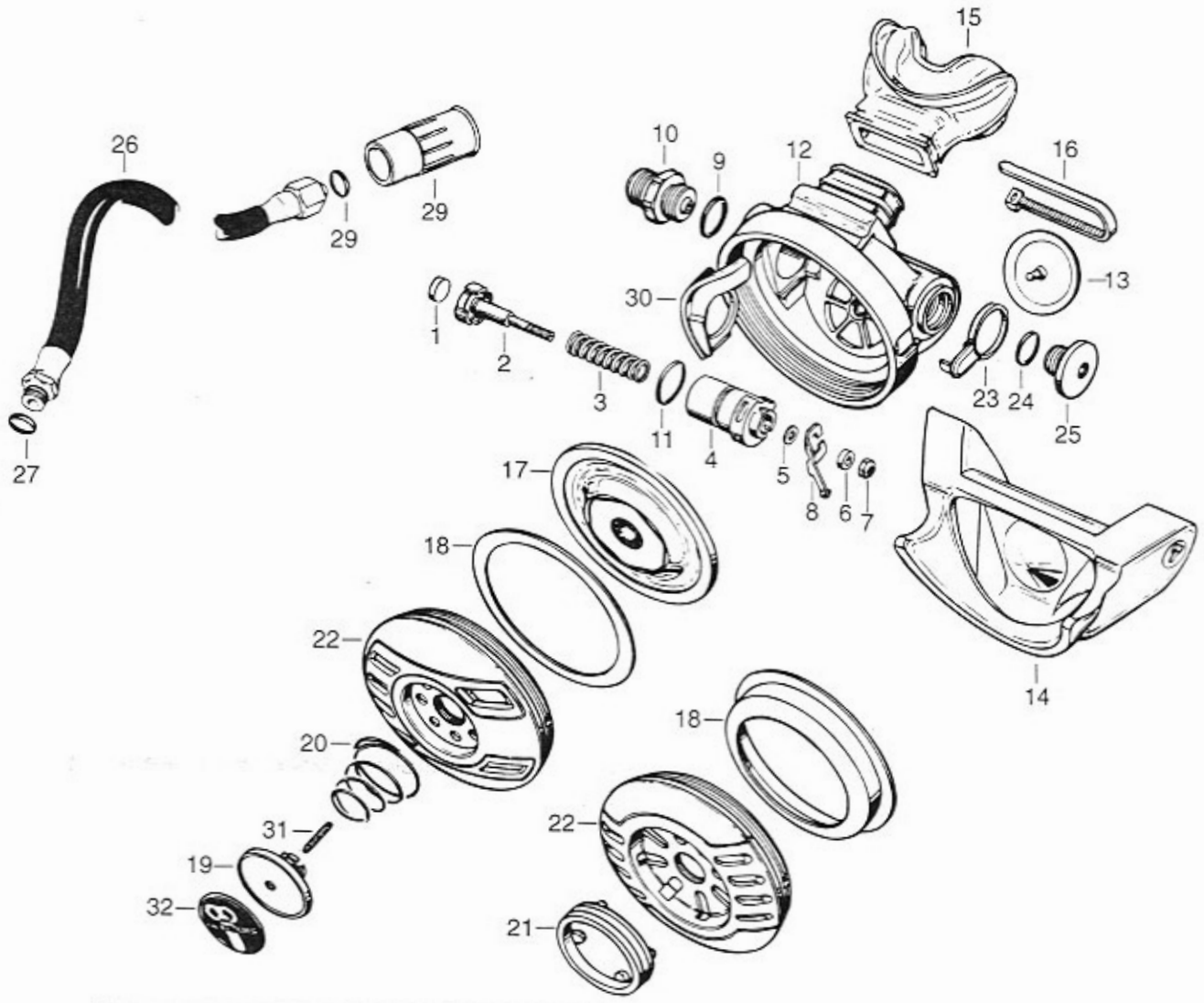
Part # / Item #	Description	Torque Specification
1004-44 / 10	Inlet fitting	50 inch-pounds
1003-24 / 25	Plug	5 to 8 inch-pounds
1005-35 / 26 1048-35 1016-39	Hose end fitting (SE3, SEA4) Hose end fitting (C22, Aquarius) Hose end fitting (C22 Octopus)	40 inch-pounds

Table 4: Tool list

Part Number	Description	Application
7803-00	Aqua-Lung® Repair Manual	All U.S. Divers Regulators
1019-40	Box Top Wrench	Conshelf SE3, 22, 22 Octopus Box Top Removal
1003-06	Box Top Wrench	SEA4 Box Top removal
1004-89	Box Top Wrench	Aquarius Box Top removal
1100-05	Disc and Retainer Wrench	Disc and Retainer
1016-84	Lever Height Adjustment Tool	Second-stage adjustment
	$^{11}/_{16}$-inch open end wrench	Hose end fitting loosening
	$^{3}/_{4}$-inch open end wrench	Inlet fitting removal
	4mm Allen wrench	Second-stage port plug removal
	0-120 in-lb torque wrench with a. $^{11}/_{16}$-inch open crows foot b. $^{3}/_{4}$-inch open end crows foot c. 4mm Allen key	a. Tightening hose end fitting b. Tightening inlet fitting c. Tightening second-stage port plug

Table 5: Lubricants and Cleaners

Lubricant/Cleaner	Application	Source(s)
Dow Corning 111 (pure silicone grease	All O-rings; threaded metal parts	U.S. Divers Co., PN 0501-16 Dow Corning Corporation P.O. Box 1767-T Midland, MI 48640 1-800-248-2481
Ultrasonic cleaning tank with ultrasonic detergent	Metal, reusable plastic and rubber parts	Various. List of suppliers available from U.S. Divers Technical Service department.
Oakite #31	Brass and stainless steel parts	Oakite Products, Inc. 50 Valley Road Berkeley Heights, NJ 07922
Distilled White Vinegar	Brass and stainless steel parts	"household" grade
Liquid Dishwashing liquid	All reusable parts	"household" grade
Snoop	Leak testing	Nupro Company 400 E. 345th Street Willoughby, OH 44094



Key #	Part #	Description
1	*1085-10*	*Disc*
2	1049-03	Retaining
3	1085-15	Spring
4	1005-14	Insert
5	8450-22	Washer
6	1025-17	Spacer
7	*1025-10*	*Locknut*
8	1085-13	Lever
9	8200-14	O-ring
10	1004-44	Inlet Fitting
11	*8200-15*	*O-ring*
12	1005-03	Box Bottom, Black
	1005-04	Box Bottom, Octopus
13	*1005-22*	*Exhalation Valve*
14	1004-59	Exhaust Tee
15	1058-38	Mouthpiece
16	*1049-13*	*Clamp*
17	*1005-17*	*Diaphragm*
18	8210-32	Thrust Washer, C22/SEA4
	1003-75	Cone, Blue, SE3
19	1003-45	Purge Button
20	1014-36	Spring
21	1003-55	Color Ring, Blue, SE3

Part numbers in ***BOLD ITALICS*** indicate standard overhaul replacement part.

Key #	Part #	Description
22	1005-05	Box Top, SE3
	1005-64	Box Top, SEA4 (w/insert)
	1007-05	Box Top, C22
	1073-05	Box Top, Aquarius
	1077-05	Box Top, Pioneer
	1007-06	Box Top, Octopus
23	1003-89	Alignment Key
24	*9570-25*	*O-ring*
25	1003-24	Plug
26	1005-35	Hose, SEA4
	1020-35	Hose, SE3
	1048-35	Hose, C22
	1016-39	Hose, Octopus, 39"
27	*9570-25*	*O-ring, SEA4/SE3*
	8200-11	*O-ring, C22/Octopus*
28	*9573-10*	*O-ring, SEA4/SE3*
	8200-10	*O-ring, C22/Octopus*
29	1004-67	Hose Protector
30	1005-23	Baffle
31	8307-03	Adjustment Screw
32	1005-84	Decal, SEA4
	1003-84	Decal, SE3
	1003-94	Decal, SE3 Supreme
	1007-84	Decal, C22
	1007-88	Decal, Octopus
	1073-06	Decal, Aquarius
	1077-06	Decal, Pioneer