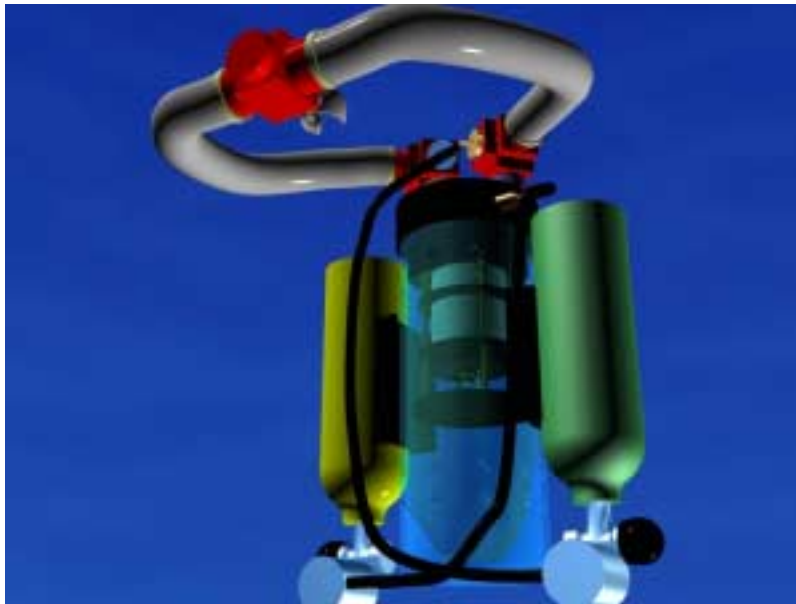


**MK-I**

***FROG***

**HANDBOOK**

Version 1.0



**WHAT YOU NEED TO KNOW**

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# INTRODUCTION

## Why did I produce a rebreather?

In over fifty years of diving, I never found a rebreather that met my needs. I had to modify an existing unit. With over 9000 rebreather dives and 10,000 hours underwater it was my common practice to “customize” units. If you want something done right, do it yourself. All I needed was a breathing loop and then add parts. The FROG is a primary breathing loop that you can configure into the unit you want. I call the FROG my “underwater all terrain vehicle”. I want to make specific dives. I plan the dive, assess the needs and configure my FROG. I can change it for every dive. All it takes is:

1. Knowledge; I know what it takes to do the dive.
2. Skills; I have developed the skills to do the dive.
3. Discipline; I must use the knowledge and skills appropriately.

I learned about diving by doing. There were no instructors or textbooks and few people with any experience. I, along with a few others, learned what not to do one injury at a time. It was trial and error with punishment for mistakes. I was lucky; the sea gods liked me and dealt out little punishment for my many transgressions. The big mistakes were really painful. Some of my friends were not so lucky or fell out of favor with the sea gods and they paid the final price. My father wanted me to follow in his path in show business. He named me Barnum Bailey. The summer of 1941 he took his family to Key Largo Florida to open a theater. I saw the ocean for the first time as the greatest toy ever made. The sea gods called and I went. It was all down hill from there. I wanted to be a sea creature. I have spent most of my life pursuing that goal. Now let us get to it, why do I dive a rebreather?

1. Predictable dive time: I can plan more accurately as I know how many minutes of dive time the unit can provide.
2. Warm, moist breathing gas: No dry throat.
3. Quiet operation: I can hear much more.
4. Extended operating time.
5. Gas economy: I can use smaller, lighter cylinders.
6. Gas variety: I have a choice of several gasses.
7. Body heat retention: I can dive longer with less body heat loss.
8. Buoyancy stability: I can maintain buoyancy with less effort.
9. Environmental impact: I can dive with little disturbance to the habitat.

What I do not like about rebreathers.

1. Configuration: Why do they put a box around the unit?
2. Servicing: I just want to use it. It is no fun poring absorbent.
3. Cleaning: Nothing gets as messed up as a rebreather.
4. Maintenance: If it takes more than changing the batteries it is too much.
5. Operator demands: I want to be a sea creature, not an astronaut.
6. Training programs: How many degrees do you need?
7. Technical materials: What is this, brain sugary?
8. Certification requirements: I am now a brain surgeon.
9. Institutional acceptance: Yes I am an expert.



I started diving rebreathers for the military in 1953. My experiences led to contract and commercial work. I taught military and commercial divers to use rebreathers. I covered my sport rebreather diving with commercial scams. In 1992 I designed a surface rebreather. A year later I started on the FROG. From 1993 to present I have conducted market research and a development effort to produce a viable rebreathing loop for sport divers. The FROG is the product of that nine-year effort. The FROG was first tested as the GATOR and PROBE in several locations. Dr. Lance Rennka and associates have tested three units at The Scott Carpenter Man in the Sea Program in Kay Largo Florida for four years. Several ANDI dealers conducted field test on prototype GATORS. The result of the field-testing has led to the product FROG. I had a lot of help in making the FROG. I will identify the contributors in the credits. The most influential was the sea gods as they have been with me from the start. The sea gods set the rules and they enforce them, sometimes with a vengeance. For the uninformed the rules are:

1. Life happens, you have to respond.
2. You cannot plan for every thing that can happen.
3. Knowledge is the best problem-solving tool.
4. Skill will give you the best results.
5. Discipline will provide the answer.
6. Risky behavior is for the tough.

I have been there, got the scars to prove it. If you are still reading this it means you have discipline. Use your discipline to get the knowledge and develop the skills the less painful way, get instruction from a FROG sanctioned instructor. Our finest are listed on the [WWW.FROGDIVER.COM](http://WWW.FROGDIVER.COM) website under *Training*. Enjoy your FROG, I made it so you could have fun in the sea. Be nice to the sea creatures or suffer the wrath of the sea gods. If you see me diving my FROG, just go your way and enjoy. I do not want to be disturbed.

Barnum "Barney" Bailey Lambert  
CEO, Lambert Rebreather Technology



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# INSTRUCTIONS

**If you purchased your FROG over the Internet,  
*Please read this handbook carefully.***

**If you purchased your FROG from a dealer,  
The dealer will assist with this section.**

I know that it is much more fun to just dump out the parts and solve the puzzle of where things go. You are welcome to do that and lots of luck. For the slow learners, I suggest that you follow the boring instructions. Remember that you are “assembling” a final product that is uniquely yours. Every assembler comes up with a different configuration. For the breathing loop, I suggest you make no changes without careful consideration. Ask your instructor for recommendations. It is your choice, but please be informed. These instructions will help you get the breathing loop assembled in a standard configuration. I suggest the location of the ancillary components. Your needs may dictate some changes. Again check with your instructor. You are not “bothering” the instructor with your questions. Besides, if the instructor works for or owns a dive shop, they want to see you to sell you more goodies. OK, now take the items from the box and check to see if you have all of the items on the inventory sheet. If you do, we are off to a good start. If not, email me at [rebreather@frogdiver.com](mailto:rebreather@frogdiver.com) and I will get you the missing part. You may proceed with the other assembly in the interim. So let us get started...

## INVENTORY

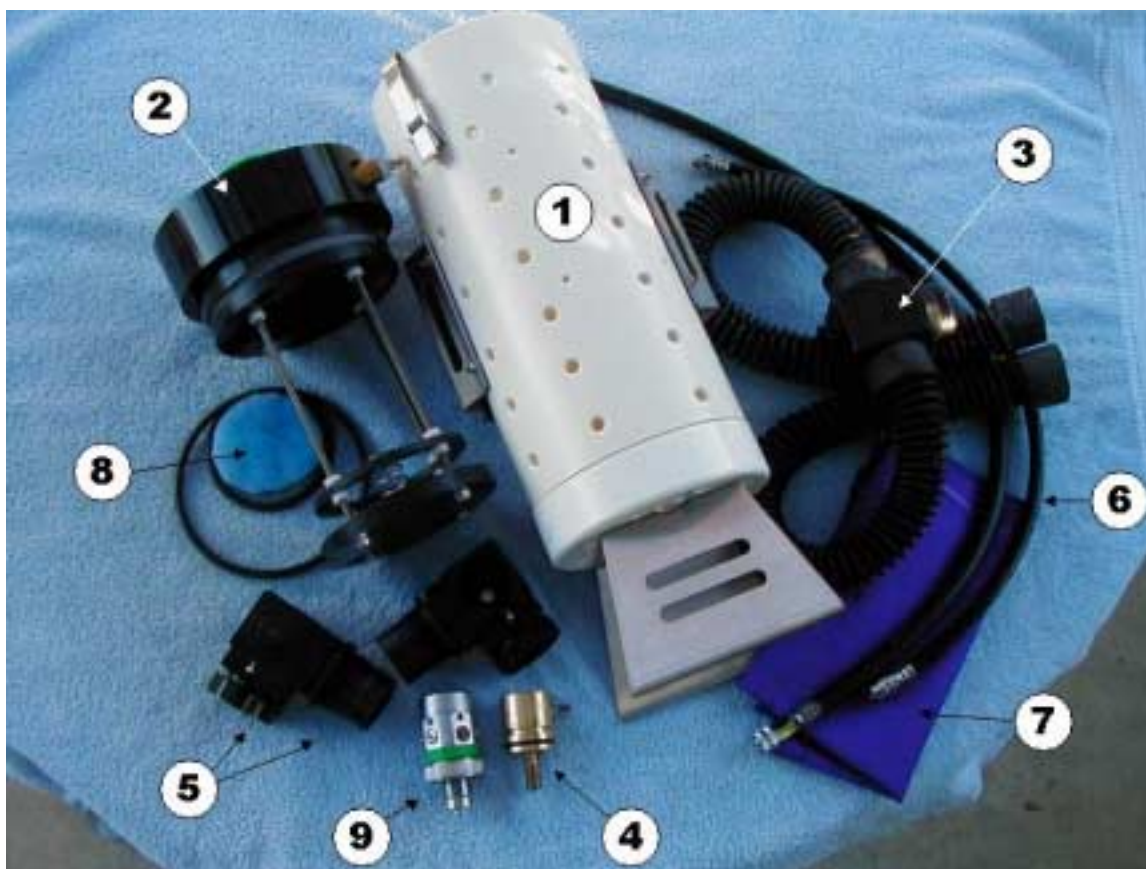
- A. Proceed if you have all of the parts.
- B. Packages: Open the packages in the order indicated. Follow the instructions in the package marked *Open this Pack First*. Proceed through all of the packs.
- C. Options: You have to choose the following additional items to use with your frog.
  1. Buoyancy Compensator; Check with your instructor to insure it will provide the proper lift.
  2. Gas cylinders; these are determined by what you plan to do. Again the instructor can help.
  3. Oxygen monitor; you really need this or you are flying blind. I suggest a unit with oxygen content display and alarm. A decompression algorithm is a good thing. A down load capability to save your dives will prove a worthy investment. Your instructor can show you several products that will work.
  4. A second NITROX decompression meter is a good investment.
  5. You really need an open circuit bail out system with at least a 12 CF gas supply. I use a 20 CF bail out cylinder.
  6. A last suggestion; secure all loose hoses with restraints and take the recommendations of your instructor as to needed ancillary items.



# Components

The following details the parts that are included with this FROG.

1. Housing, with attachments
2. Manifold, with demand and relief valves and the scrubber cage
3. Mouthpiece, with breathing hoses
4. Oxygen gas injector valve
5. Two elbows for breathing hoses
6. Two low-pressure hoses with quick disconnects
7. One counter lung
8. Two O-rings and one filter pad
9. One oxygen high-pressure regulator



# ASSEMBLY

## Mouthpiece

The mouthpiece comes pre-assembled with the breathing hoses attached. Remove the mouthpiece from the sealed bag and inspect for security. Note the on/off valve can be moved. Rotate the valve counterclockwise or left to open. Rotate the valve clockwise or right to close. Keep the valve closed when not in use. The cap at the end of the valve can be removed to adjust the relief valve pressure. Once it is set, be careful to rotate the valve by the knurled ridge so as to not change the setting. This valve should be cleaned and set after every day of diving. Figure 1 displays all the parts of the mouthpiece. Figure 2 displays the parts of the relief valve. All of the parts must be lubricated with silicone grease before assembly. Do not over torque the mouth bit retaining screws. The O-ring provides a good seal if the two parts come into contact. When the breathing hoses are attached to the manifold elbows, the on/off valve stop must be down. Figure 3 demonstrates how to attach the breathing hose to the manifold elbow. Check to see that the O-ring is in place before securing the hose-retaining nut.



*Figure 1 – Mouthpiece parts*



*Figure 2 – Relief valve parts*



*Figure 3 – Attach the breathing hose to the manifold elbow*

## Manifold

The manifold comes with the demand regulator and backup relief valve assembled. Note Figure 4 illustrates parts of the demand regulator. The relief valve parts illustrated in Figure 2 are the same as the relief valve in the manifold, except the spring is different. A dummy plug is installed into the electronics port. This plug is removed when the electronics are installed. Keep this plug so the unit can be used without the electronics.



*Figure 4 – Demand regulator parts*

## SCRUBBER CAGE

The scrubber cage comes attached to the bottom of the manifold by four nylon nuts and stainless rods. Figure 5 illustrates the parts associated with the scrubber cage. Note the O-ring and filter pad. These should be cleaned after every use. The O-ring should be lubricated with a fine coating of silicone grease.



*Figure 5 – Scrubber cage, filter pad, scrubber and scrubber O-ring*

## BREATHING HOSE ELBOWS

The elbows come without the Oxygen gas injector or monitor plug installed. Figure 6 displays the elbows, oxygen injector and plug. The oxygen injector is to be installed into the exhale elbow. With the manifold placed with the relief valve near you, the exhale elbow is installed into the manifold on the left of the demand regulator cap. (See figure 7) Before installing the elbows into the manifold, check to see if the O-rings are in place. Lubricate O-rings with a liberal amount of silicone grease before inserting into the manifold. Screw the retaining nuts down to bottom the elbows, finger tight. Do not over-tighten. The O-rings seal the connection. The elbows should be allowed to move to adjust the placement of the breathing hoses. The gas injector and dummy plug is O-ring sealed. Lubricate the seal with silicone grease before installing into the elbows. Secure the gas injector and dummy plug with the small hex head screw in the elbow. Use care to insure the screw is going into the retaining slot. It should bottom with no resistance. Do not over-tighten.



*Figure 6 – Breathing hose elbows, oxygen injector and plug*



*Figure 7 – Assembled manifold*

## HOUSING

The housing comes with the manifold to housing latches installed. (See Figure 8) Two gas cylinder S/S brackets and a bottom S/S bracket are also installed. You will notice that the gas cylinder brackets are offset to one side of center. The offset side is the side that goes toward your back. Place your B/C on this side. You will install the gas cylinders of your choice on the side brackets. A bail out, open circuit gas cylinder can be installed across the bottom, inside the bracket. Discuss this with your instructor.



*Figure 8 – Main housing*

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# SERVICING THE FROG MK-I

**Do not attempt these procedures without instruction  
from a FROG sanctioned instructor**

Your FROG is now assembled and you have completed a course of instruction on the use of the FROG. You have your certification to learn. This is really when the fun begins. Log your dives for the future so you can look back and enjoy them.

## A. TRANSPORT AND STORAGE:

Transport to and from a diving location can provide many interesting situations. You really want to have all of the parts when you get to the dive location. If you did not bring it, you want find it there. A checklist of all needed items is a good thing. Check every item in as you pack and out as you unpack. A storage list is just as valuable, put the storage list on the outside of the container. Many containers can double as a transport and storage box. Tools; they go with the unit, everywhere the unit goes. Cleaning agents and replacement disposables are a must. The following cautions should be observed:

## B. SERVICING:

1. High-pressure gas requires special handling. Clean all fittings and connections prior to use. Oxygen is an excellent “oxidizer”. Oxygen supports combustion of most any fuel. Grease, oil and any petroleum product you will encounter will burn at a high temperature if exposed to high-pressure oxygen. You need to review all of the instruction notes concerning handling or storage of anything that comes in contact with any gas rich in oxygen and under high pressure.
2. Clean the breathing path after every use. Use a recommended bacterial cleanser. Wash the parts clear with clean fresh water to remove the cleaning agent. Never use a breathing path that someone else has used without a thorough cleaning. The FROG uses a disposable scrubber. Always change the scrubber between individual users. The scrubber is a great environment, warm and moist, to hold bacteria and viral agents. Follow all Government Regulations as to the handling of “Biohazards”.
3. Filling high pressure gas cylinders requires attention to detail. Gas cylinders are pressure rated and the valving is unique to the specific gas. All gas cylinders should be “labeled” as to the gas in the cylinder. Gas mixing, “blending” requires specific training. Check with your instructor before attempting to mix breathing gas.
4. Always use the pre dive and post dive checklist you developed with your instructor.
5. The FROG components are manufactured to meet all government and institutional specifications. You need to be aware of the specific limitations and performance criteria of the parts you select. Discuss this with your instructor.
6. Your instructor will demonstrate what adjustments you can make to the breathing loop components. Always check with your instructor before disassembling any component.



## Low Pressure Hoses

Servicing the FROG requires little time but great attention to detail. Filling gas cylinders can be accomplished with the cylinders on the unit. Follow standard gas handling procedures when filling. Pay attention to Figures 9 and 10 when attaching the dilute and oxygen low pressure hoses. Make sure the oxygen gas regulator is attached to the hose in figure 10. Placement of the oxygen cylinder is a matter for choice due to the selection of cylinders. You may choose to place the oxygen cylinder on the left or right of the housing. In some cases you may choose to place the oxygen cylinder on the bottom to facilitate larger dilute and bail out cylinders. The FROG comes with a DIN fitting on the oxygen regulator. This is to reduce the possibility of connecting the regulator to the wrong gas cylinder.



*Figure 9 – Dilute gas connector*



*Figure 10 – Oxygen connector*

## Scrubber installation

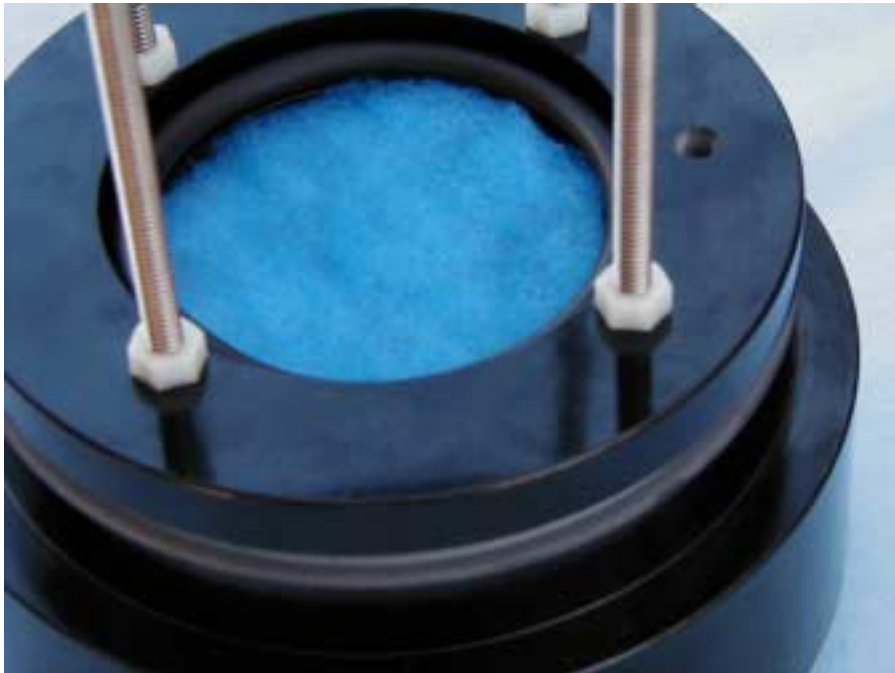
Figures 11 through 15 illustrate the scrubber installation onto the manifold. Figure 11 displays the necessary parts. Figure 12 shows the bottom, inside of the manifold and the dummy plug bottom. A small O-ring should be secure to the bottom of the plug. This O-ring holds the plug in the manifold and must be removed to remove the plug. This plug must be in the manifold if the electronics are not used. Figure 13 shows the filter and scrubber O-ring in place. The scrubber is lowered into the cage and seated against the O-ring. The bottom plate is then installed by sliding down and turning to lock into the holding slots. Figure 15 shows the scrubber installed.



*Figure 11 – Scrubber installation parts*



*Figure 12 – Inside of the manifold and the dummy plug bottom*



*Figure 13 – Filter and scrubber O-ring in place*



*Figure 14 – Bottom plate holding slots*



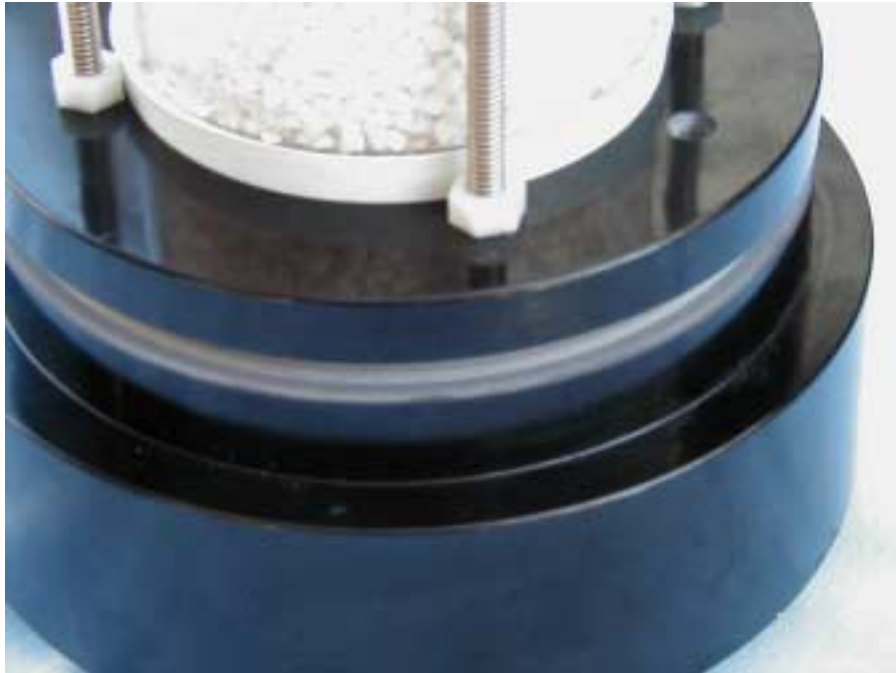
*Figure 15 – Installed scrubber*

## Counter Lung Installation

The counter lung is placed over the scrubber as shown in Figure 16. Insure the manifold O-ring seal is in place as shown in Figure 17. Slide the counter lung over the manifold flange and O-ring as shown in Figure 18. Figure 19 shows the top of the housing. Make sure the inside of the housing is clean and lubricated with a coating of silicone grease. Figures 20, 21 and 22 show the installation of the manifold with counter lung into the housing. Line up the draw latches and secure by pulling down both latches.



*Figure 16 – Counter lung placed over the scrubber*



*Figure 17 – Manifold O-ring seal in place*



*Figure 18 – Counter lung over the manifold flange*



*Figure 19 – Top of the housing*



*Figure 20 – Insert manifold with counter lung*



*Figure 21 – Seat manifold to housing*



*Figure 22 – Line up draw latches and secure*

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# FROG ADJUSTMENTS

## A. GAS FLOW ADJUSTMENT:

To perform this procedure you will need to purchase the in line flow meter. As shown in Figure 23, the flow meter is placed in line with the oxygen hose to the flow control valve. The oxygen gas cylinder is turned on and the flow rate is observed on the gage. If the flow is to be adjusted, remove the plug on the back of the elbow (*Figure 24*) with a hex drive and place a common screwdriver into the hole. Figure 25 shows the valve and screwdriver in place. As shown in Figure 23, turn the screwdriver to adjust the gas flow. Observe the flow meter to note the change. This is a micrometer valve that requires several turns to change the flow one liter per minute. When the flow is set, remove the screwdriver and replace the plug. Remove the in line flow meter and reconnect the hose to the valve.

## B. PRESSURE CHECKS:

To perform this test you will need a differential pressure tester with adaptors.

Figure 26 shows the tester and the mouthpiece. Figure 27 shows the tester pressure adapter installed in the mouthpiece. In this configuration, you can perform the following test:

1. Mouthpiece relief pressure. Open the mouthpiece and turn on the dilute gas cylinder. Depress the demand regulator cap. Note the opening pressure on the gage.
2. System relief valve pressure. Place your hand over the mouthpiece relief valve exhaust port and depress the demand regulator cap. Note the opening pressure on the gage.
2. Close the mouthpiece and depress the demand regulator cap to inflate the system. Note the pressure drop over time. The pressure should not drop below 3 in water pressure in 3 minutes.

Remove the pressure adapter and install the vacuum adapter as shown in Figure 28. With the mouthpiece open, draw a vacuum on the mouthpiece adapter and note when the demand valve activates.

Remove the vacuum adapter and turn off the gas cylinder pressure. Close the mouthpiece after the last test.

NOTE: All adjustments should be made by a qualified technician or as your instructor taught you to perform. The above checks are used to confirm the settings before and after a dive.



*Figure 23 – Gas flow meter*



*Figure 24 – Elbow plug*



*Figure 25 – Valve with screwdriver in place*



*Figure 26 – Pressure/vacuum tester*



*Figure 27 – Pressure test*



*Figure 28 – Vacuum test*

# OPERATING YOUR FROG

Your course of instruction provided the necessary knowledge and allowed you to develop some basic skills that are required to successfully operate the FROG. It is paramount that you follow the instructional criteria and observe the rules set fourth by the certifying agency. As you use your FROG you will gain more knowledge and enhance your skills. As you progress you will enjoy your FROG more and more. Becoming a sea creature is a transformation of self. You will begin to feel the power of the sea as a partner that must be respected. As a sea creature, you move with the harmony of the sea. As you learn the rules and begin to fit into the living symphony, you will find a peace you have never known. Diving the FROG makes you more like a sea creature. Here are some of the things you will experience.

- A. No gas regulator scream with every breath; you can hear the sounds of the sea life. The lack of exhale bubbles thundering up through the water allows you to begin to “see” with your ears. You will loose the “breathing consciousness” of open circuit diving and begin to function as you do on the surface, with no concern or attention to your breathing. Breathing is an automatic function that is natural and with little effort. This first awareness leads you to a feeling of belonging where you never belonged before. Your dive becomes a dance to the music of the sea.
- B. As you relax into the song of the sea, you will discover that the sea creatures welcome you to their world. You are now becoming a “homeboy” with the fish, seals, rays, crabs, lobster and the multitude of living things. You move quietly through the sea disturbing nothing but the water. As you progress you learn the etiquette of the sea. Do not touch that which you do not own. No trespassing on private property. Most every inch of ocean bottom belongs to some living thing. The sea life will share their world with you, but not their home place. The smallest fish will defend their little area from all trespassers. You are learning the rules of living in inner space.
- C. Your FROG allows you to soar through the water as a bird sails on the wind. You can exhale some air through your nose and reduce the volume of the counter lung. You settle gently down toward the bottom. You plain out and breathe deep, momentarily drawing gas from the demand regulator. Your descent stops and you hang motionless. The process is called “trimming”. You slip back into your normal breathing and escape the bounds of gravity. This is the closest you will ever get to free flight.
- D. Breathing the warm moist gas from the counter lung keeps you warmer than you have ever been under water. With little loss of body heat, you can spend extended time before the exposure brings the familiar chill. Wearing less thermal protection and less weight on your weight belt allows you an increased level of comfort. Being a sea creature requires many changes. Your FROG allows you to make the changes that make the difference.
- E. Becoming a sea creature brings you in contact with the many subtle parts of the sea that you could not be a part of before. The life in one mile of California kelp bed is more numerous than all of the land life in the state. A square foot of ocean coral reef is a metropolis. In order to belong, you have to introduce yourself to the inhabitants. If you want to be accepted you have to be friendly. To become a friend to the sea life you have to learn and obey the rules. No one likes a noisy neighbor. Your FROG allows you to meet the noise limits. Silence is golden, applies underwater more than on the surface.



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# REFINEMENTS

## A FINAL SET OF “FIVE” CONCEPTS TO EMPLOY IF YOU WANT TO BECOME AN OLD FROG DIVER

### THE FIVE C’S

1. Consider: What do you want to accomplish on this dive?
2. Characteristics: What can you do with the equipment you have?
3. Confidence: Are you ready for the task?
4. Conflicts: Is your experience adequate to the task?
5. Cautions: Risky behavior is for the tough.

For those that have continued on this far with my “sea creature” thing, you stand the best chance of becoming a sea creature. I have been working on becoming a sea creature most of my life. I have a ways to go. My work on human gills has stopped for now and I am sad that it was not successful. My FROG is the best I have for now. Please use your FROG with discretion and try to be a good sea creature. Remember the sea gods are watching. I hope the sea gods like you and treat you as well as they have me. However keep an advantage, stay in touch with your instructor. A question now and then will confirm you are still around and doing something interesting. We sea creatures like to stay in touch. Have fun and enjoy your FROG.

**THE SEA IS GREAT  
THE FROG IS GOOD  
I AM HUMAN**

Barnum “Barney” Bailey Lambert

FROGDIVER



## TECHNICAL INFORMATION

The development of a life support system is a process that consumes a lot of time and money. The FROG rebreather system was developed over six years at a cost that I don't want to think about. Modular systems are an assemblage of sub components that can be rearranged to perform different tasks. Most of the FROG system came from other working systems. I have designed and developed surface breathing systems for fire fighting and hazardous materials handling tasks. That is where the money is. Sport diving is not a big enough market to justify the development cost. The FROG came out of the development process of surface systems. Component and system testing is a big cost item. Laboratory test equipment is expensive. The machine in Figure 29 is a breathing simulator with flow and pressure monitoring. The small blue box with all the colored buttons is a gas-scanning monitor for computer downloads. Together they cost over \$25,000. Figure 30 is one of the analogue displays. Figure 31 shows the CO<sub>2</sub> waveform during a scrubber test. This device can display the gas content of each breath. The scrubber used in the FROG was tested on this machine for over 5000 hours. The test protocol was: 5% CO<sub>2</sub> was introduced through the scrubber at a circulation rate of 25 strokes per minute, 2.5 liters per stroke. That is over 60 liters per minute. The three-hour scrubber let no CO<sub>2</sub> pass for 3.75 hours. At 4 hours the rebreather CO<sub>2</sub> was 0.025. The US Navy standard for maximum inhalation is 0.05. Every component in the system was tested in the laboratory and the field for five years. This performance information was confirmed through that process. If you want to build your own rebreather; just roll up your sleeves and go for it. It's what I did. (See Figure 32)



*Figure 29 – Breathing simulator*



*Figure 30 – Breathing resistance*



*Figure 31 – Carbon dioxide display*



*Figure 32 – Working*