PCCI Hyperbaric Systems

*Innovation & Excellence in Hyperbarics*

# ODS1 - Hood Driver Operating Instructions

**(For Using Inside the Multiplace Hyperbaric Chambers)**


## 1. Application

The Model ODS2 - Hood Driver is intended for use with multiplace hyperbaric chambers. It is normally used to permit the patient to breath oxygen while the chamber is pressurized with air. However, it can be used to supply the patient with any physiologically appropriate gas, which may or may not be the same as the gas used to pressurize the chamber.

The ODS1 circuit is designed to supply a steady flow of breathing gas to the breathing apparatus used in the chamber. The breathing apparatus can be either a "Sea-Long" hood or a free-flow mask arrangement.

## 2. Theory of Operation

*300 N. Lee Street • Suite 201 • Alexandria, VA 22314 USA • Telephone (703) 861-8535 • info@pccihyperbarics • www.pccihyperbarics*

## 2.1 Definition of Terms

| | |
|---|---|
| ACFM | Cubic feet per minute at actual chamber conditions |
| ACFH | Cubic feet per hour at actual chamber conditions |
| ALPM | Liters per minute at actual chamber conditions (28.32 ALPM = 1 ACFM) |
| SCFH | Cubic feet per hour at standard conditions (pressure = 1 ATA) |
| SLPM | Liters per minute at standard conditions (pressure = 1 ATA) |
| ATA | Pressure measured in atmospheres absolute (1 ATA = 14.7 psia) |
| psia | Absolute pressure measured in pounds per square inch |
| psig | Gauge pressure measured in pounds per square inch (0 psig = 14.7 psia) |

## 2.2 Supply Circuit.

The supply circuit employs two principle elements, a supply flow circuit controlled by the "supply" valve on the control panel and a flowmeter to indicate the gas flow delivered. Gas from an appropriate supply source (50 - 100 psig) flows through the supply flow circuit, through the flowmeter (which is at approximately chamber pressure) and into the supply tubing of the breathing apparatus.

The supply circuit is designed to provide a nearly constant flow of fresh gas to the patient regardless of changes in chamber depth, changes in supply gas pressure or changes in line resistance between the control panel and the breathing apparatus. Once the supply flow is set to the desired rate on the supply flowmeter, the float position in the supply flowmeter will remain constant as the chamber depth is changed. Changes in chamber depth do, however, have an effect on the calibration of the flowmeter.

### 2.2.1 Sea-Long Hood Breathing Apparatus.

For carbon dioxide removal purposes, the hood needs to be supplied with a constant volumetric flow rate at chamber pressure (e.g. a constant ALPM or ACFH flow). The most commonly used hood flow rate is 30 ALPM. With the chamber at 1.0 ATA pressure, the supply flow meter reads in ALPM directly. At increased chamber pressures the flowmeter reading must be divided by the square root of chamber pressure (expressed in ATA) to arrive at the correct value for the true hood ALPM flow rate. The float positions appropriate to 30 ALPM hood flow rates at 1.0, 2.0 and 3.0 ATA chamber pressures have been marked with the adjustable pointer flags. These should be set at 30, 42 and 52 respectively.

Hood supply flow rate chart pasted on right hand side of the supply flowmeter shows graphically how to set the desired supply flow rate at intended treatment pressure. Chart shows characteristics of four different hood supply flow rate curves at various chamber pressures. Flow chart has proven to be a very “Handy Tool” when setting the desired flow rated at required chamber pressure.

Hood supply flows that are too high are unlikely to be hazardous to the patient, although they will be wasteful of breathing gas and produce unwanted noise inside the chamber. However, flows that are too low can lead to carbon dioxide accumulation in the hood and must be avoided. Never use a hood flow rate less than 30 ALPM except on the advice of personnel competent in the management of diving breathing gases. Carbon dioxide accumulation produces hypercapnia, which, in addition to its own direct effects, also increases the chances of an oxygen seizure. With a normal adult patient, a hood flow rate of 30 ALPM will result in an inspired CO2 partial pressure of around 2.0% surface equivalent (7.6-mmHg partial pressure). Higher hood flow rates will result in proportionally lower inspired CO2 partial pressures; lower hood flow rates in higher inspired $CO_2$ partial pressures.

The preceding discussion may seem complicated. However, in practice the operation of the supply flow circuit is quite simple. For most applications, hood flows of 30 ALPM or slightly more will be quite adequate. In most cases, the supply flow can be adjusted so that the flowmeter float is at the level indicated for 30 ALPM at the maximum planned chamber depth and left at that point. The actual flow delivered will be 30 ALPM at the maximum planned depth, usually the treatment depth, and will be slightly higher at shallower depths. For example, if the supply flow is set to deliver 60 ALPM at 3.0 ATA, the actual ALPM flows produced will vary from 30 ALPM at 3.0 ATA to 52 ALPM at surface pressure (1.0 ATA).

### 2.2.1 Free Flow Mask Breathing Apparatus.

Due to the very small dead space in a breathing mask, it can be supplied with a lower flow rate than a Sea-Long hood providing it is used with a breathing bag in the supply piping. The breathing bag allows the supply gas to accumulate when the patient is exhaling and provides the high peak flow needed during inhalation. The recommended supply flow rate is nominally 30 ACFH. The proper settings for 1.0, 2.0 and 3.0 ATA are 15, 22, and 26 SLPM respectfully.

The breathing bag should be monitored periodically to insure that it is not collapsing which would indicate that the supply flow is too low for the patient's breathing rate. With the supply and exhaust flows set optimally, the breathing bag volume should decrease during inhalation and re-fill during exhalation.

### 2.3 Exhaust Flow.

Exhaust gas from the breathing apparatus flows to an open accumulator assembly located in the chamber. This accumulator consists of a tee in which one branch is connected to a 1" ID hose (accumulator) that is open to the chamber atmosphere on the end opposite the tee. The purpose of the accumulator is to absorb the peak exhalation flow from the patient and maintain reasonably low exhalation breathing resistance. The accumulator is opened to chamber atmosphere so that an incorrect exhaust flow setting on the ODS control panel will not affect the patient's breathing effort or allow a breathing hood to collapse.

Gas from the accumulator is constantly being removed via the "exhaust" controls on the ODS1 control panel. Since the accumulator is open to chamber atmosphere, any excess ODS1 exhaust flow over breathing apparatus exhaust flow is made up by chamber gas entering the accumulator. Conversely, if breathing apparatus exhaust flow exceeds ODS1 exhaust flow, the excess simply bleeds into the chamber.

**********************************CAUTION*********************************

Please note that <u>at depths of less than 1.5 ata pressure (16 fsw), breathing apparatus exhaust flow will normally exceed ODS1 exhaust flow.</u> In that situation, some exhaled gas (usually oxygen) is being dumped into the chamber. The amount of oxygen dumped into the chamber should not be enough to significantly effect the chamber oxygen level except in the unlikely event of a prolonged stay in 1.0 to 1.5 ATA depth ranges. However, this situation must be monitored, especially if any electrical devices are being used in the chamber. If electrical devices are to be used in the chamber, the exhaust hose from the control panel should be connected to a suction source so that proper ODS1 exhaust flow can be maintained at all times.

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The ODS1 exhaust flow is regulated by the "exhaust" needle valve on the control panel. Exhaust flow is indicated by the associated flowmeter. Normally, exhaust flow in this type of circuit should be at least 1.5 times supplying flow. Since the exhaust flowmeter, like the supply flowmeter, always operates at chamber pressure, the chamber pressure affects its calibration in an identical manner.

The exhaust needle valve should require minimal readjustment once initially set. Once set to produce the desired exhaust flow rate at the maximum normally used depth, it normally can be left at that position. However, the flowmeter indications should be monitored periodically to make sure that some change has not occurred in the circuit that would change the flows.

**2.4 One-Way Valves.**

The one way valves used with a constant flow mask are there to maintain proper flow direction in the mask. The one-way valve used in the Sea-long hood is rarely need to maintain proper flow direction. Its primary function is to generate the gentle (about 1 cm water) backpressure required to keep the hood properly inflated.

### 2.5 Respiratory Overpressure and Underpressure Protection

**2.5.1 Overpressure Protection.**
Respiratory overpressure protection measures are provided as follows:

Sea-long Hood

a) The accumulator assembly provides an open exhaust via the exhaust one-way valve.
b) The Sea-long neck-ring assembly employs a friction fit that normally will separate at about 3 to 4 cm water pressure.
c) A 10-cm water relief valve is provided on the supply hose.

Constant Flow Masks

a) The accumulator assembly provides an open exhaust via the exhaust one-way valve.
b) The mask lifts off the patients' face.

**2.5.2 Under-Pressure Protection.**
Respiratory under-pressure protection for both Sea-long hoods and constant flow masks is provided by the air gap inherent in the accumulator assembly. In the event of a supply flow interruption, the gas required for the exhaust flow is drawn from the chamber atmosphere.

## 3. OPERATING PROCEDURES

1. Check the breathing apparatus to be used for proper arrangement of supply and exhaust tubing and fittings. (Refer to drawing 003 or 004)

2. Connect the supply and exhaust hoses to the hood or mask.

3. Set the proper supply flow for the intended treatment pressure and breathing apparatus as follows:

| Treatment Pressure | Sea-Long Hood (SLPM) | | Constant Flow Mask (SLPM) | |
|---|---|---|---|---|
| (ATA) | Supply | Exhaust | Supply | Exhaust |
| 1.0 | 30 | 45* | 15 | 23* |
| 1.5 | 36 | 54* | 18 | 27* |
| 2.0 | 42 | 63 | 21 | 32 |
| 2.5 | 47 | 70 | 23 | 35 |
| 3.0 | 52 | 78 | 26 | 39 |

* Rate not possible without external vacuum. See section 2.3, "Exhaust Flow" for more information.

The values above are based on 1 acfm for a hood and 0.5 acfm for a mask. See section 2, "Theory of Operation" for other flow rates.

4. Verify flow from the breathing apparatus by feel and then place it on the patient. Take care to

ensure that the supply and exhaust hoses are not kinked or crimped anywhere and are firmly connected to the breathing apparatus and all other connection points.

*******************************WARNING*********************************
Never place a breathing apparatus on a patient without the presence of supply flow. Without supply flow, the $CO_2$ level in the apparatus can quickly build to hazardous levels.
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5. Begin the treatment, always keeping the console "exhaust" flowmeter reading at least 1.5 times the "supply" flowmeter reading, except for the 1.0 to 1.5 ATA depth range where this is not possible. Once the maximum treatment pressure is reached and the exhaust flowmeter is set, it can be left in that position for the next treatment (if done at same pressure.)

6. Periodically observe the supply and exhaust flowmeters, breathing hood or bag and the hose and tube connections for proper operation.

7. Upon completion of the dive, remove the breathing apparatus from the patient, THEN turn off the "supply" needle valve. The "exhaust" needle valve can be left at the desired position for the next dive.