"la tecnica al servizio dei subacquei"

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Il DECOMPRESSIMETRO® è brevettato nei principali paesi del mondo.

DCP PATENT N. 1423961.3 / N. 3.121.333 / N. 624174
N. 373979 / N. 1278472 / N. 264420
N. 911739

Berrino Printer - S. Mauro Tor.

AUTOMATIC DECOMPRESSION METER - D.C.P.®

INTRODUCTION

One of the inherent hazards of diving is the risk of the "decompression sickness" – sometimes referred to as "caisson disease" or "bends". When a diver descends, nitrogen – which constitutes 80% of his compressed air, dissolves into solution in his bloodstream via the lungs. The amount of nitrogen that goes into solution is mainly dependent upon two factors – time and depth. When the diver ascends to reduced pressure the nitrogen comes out of solution. If the saturated diver ignores the decompression rule, nitrogen bubbles will form in his tissue and bloodstream, causing the decompression sickness. This phenomenon has often been compared to uncapping a bottle of carbonated beverage. When the cap is removed, the internal pressure is relieved and the carbonic gas dissolved in the liquid begins to come out of solution – forming bubbles of carbonic gas.

Decompression tables have been established that give the diver a timed ascent schedule calculated to eliminate the dissolved nitrogen through the lungs, preventing the formation of bubbles within the tissues and bloodstream. Although the decompression tables proved adequate for the limited mobility of the helmet diver it became obvious that the tables were grossly inadequate for the unprecedented mobility of the scuba diver. The ardent scuba diver normally makes repetitive dives, multiple-depth dives, and repetitive multiple-depth dives – creating big decompression problems. In view of the great shortcomings of the standard decompression tables, as applied to scuba diving, SOS diving engineers developed the AUTOMATIC DECOMPRESSION METER (also known as "DCP", "Decompression Meter", or simply the "Meter").

The DCP eliminates the need for complicated computation and optimistic guesswork by the diver. The unit is worn by the diver and is subject to identical time/depth exposure. The meter automatically computes the time/depth/decompression factor and this information is continuously available to the diver by referring to the Meter. Proper decompression is then obtained by following the ascent schedule prescribed by the Meter.

IT SHOULD BE REMEMBERED THAT, AS THE DECOMPRESSION TABLES, THE AUTOMATIC DECOMPRESSION METER FOLLOWS A DECOMPRESSION CURVE CALCULATED TO GIVE MINIMUM DECOMPRESSION TO A HEALTHY DIVER IN TOP PHYSICAL CONDITION WITH NORMAL METABOLISM.

Divers who are in poor or marginal physical condition should avoid decompression dives or refer to decompression tables that can be adjusted to meet their needs.

The decompression curve of the DCP is calculated to allow for the normal exertion encountered by the scuba diver. Excessive or prolonged exertion at extreme depths may cause nitrogen absorption that takes the diver beyond the safe limits of the DECOMPRESSION METER.

THE AUTOMATIC DECOMPRESSION METER IS CALIBRATED FOR COMPRESSED AIR DIVES CONDUCTED FROM SEA LEVEL. It is not intended for use with mixed-gas apparatus or for high altitude diving.

DESCRIPTION

The DCP mechanism is housed in a stainless steel case with a large viewing dial and rubber wrist strap with chromed brass buckle hardware. Although it is lightweight, $11\frac{1}{2}$ oz., it will not float.

The DCP functions by mechanically duplicating the physiological phenomenon taking place in the body of the diver. It records the two essential factors governing decompression – time and depth – and displays its automatic computation with an indicating needle on the dial face.

The mechanism is a sealed Bourdon tube pressure gauge in a sealed chamber. Inside the stainless steel case is a gas-filled collapsible plastic bladder that is open to ambient pressure through one entry port and the wrist strap slots. The heart of the unit is the flow-restricting, porous ceramic element, that forms the gas passageway between the blad-

der and the sealed chamber.
On the surface both the bladder and the Bourdon tube chamber are equalized to atmospheric pressure. As the diver descends, water pressure compresses the gas in the bladder. The compressed gas in the bladder seeks passage into the lower pressure of the Bourdon tube chamber, but to accomplish this it must pass through ceramic element. As the gas slowly enters the Bourdon tube chamber the Bourdon tube actuates the indicating needle. The rate at which the indicating needle advances around the dial, duplicates, as nearly as possible, the rate of nitrogen absorption by the diver. The quantity of gas forced through ceramic element is dependent upon the time/depth factor, just as a diver's nitrogen absorption is dependent upon time and depth. Upon ascending, a reverse transference of the gas takes place: the gas within the Bourdon tube chamber is forced back through porous element into the reduced pressure of the bladder – also at a rate that duplicates nitrogen elimination by the diver. For repetitive dives the six-hour Memory Zone automatically compensates for surface time between dives and adds the residual nitrogen to the succeeding dive.

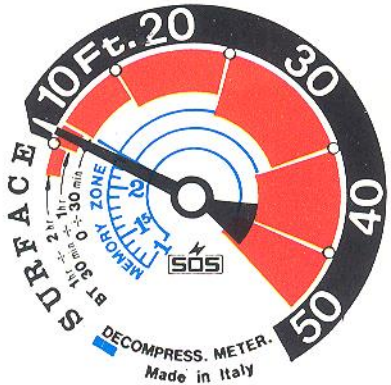
HOW TO WEAR THE DCP

The DCP is equipped with a strap that allows it to be worn on the wrist. Although the unit is relatively compact, considering its function, it may be inconvenient to wear it on the wrist in certain situations. Some divers prefer to attach it to their harness and others wear it on their upper arm. Many buoyancy compensating vests are equipped with a pocket made to hold the DCP. SOS consoles (SOS cat.: C 200/ C 300) are also designed to accomodate the DCP. This allows all instruments to be grouped together thus freeing the arms for other use.

HOW TO USE THE DCP

The Meter begins operating automatically as soon as you begin your descent. The indicator needle starts its clockwise movement with the application of time/depth. The greater the depth the faster the needle will move. On the first dive the needle starts in the BLUE rectangle at the bottom of the Memory Zone (see Figure 2 No. 1). While the needle is in the Memory Zone on your **first** dive, you can ascend from any depth without decompression stops if your dive time is less than 30 minutes indicated by the inner arrow point (B.T. 0-30 min.) (Figure 1, also Figure 2 No. 2). For maximum safety, on dives in excess of 100 feet, divers should decompress for a minimum of three minutes at ten feet even though the meter may not indicate that decompression is necessary. If your dive is between 30 minutes and 1 hour the no-decompression limit is indicated by the corresponding middle arrow point (B.T. 30 min. – 1 hr.) (Figure 1). On dives of over 1 hour and REPETITIVE DIVES, the no-decompression limit is indicated by the outer arrow point (B.T. 1 hr. – 2 hr.). (Figure 1). On no-decompression dives it is vitally important to observe the slow ascent rule (60 ft. per minute) because slow ascent is a very important part of decompression – even on so-called no-decompression dives.
When the needle enters the Red Zone it indicates that decompression will be necessary. You will note that the Red Zones start at the arrows indicating the three separate surfacing points depending upon bottom time – B.T. 0 to 30 minutes, B.T. 30 minutes to 1 hour, and B.T. 1 hour to 2 hours – regardless of diving depth (Figure 1). Repetitive dives requiring decompression call for decompression on the B.T. (Bottom Time) 1 hr. to 2 hr. scale. **ON REPETITIVE DIVES THAT REQUIRE DECOMPRESSION, SURFACE ONLY WHEN THE NEEDLE LEAVES THE 1 hr. to 2 hr. RED ZONE.**

FIGURE NO. 1
Decompression stop scale.



The blue numbers in the memory zone indicate the remaining pressure of nitrogen in the body, in bar.

Decompression with the DCP is simply a matter of following the needle. For example, if you remain at any depth or depths until the needle advances to the 20 foot increment you can ascend at sixty feet per minute (that's one foot per second), and make your first stop at 20 feet (Figure 2 No. 3). As the needle moves counter-clockwise you can ascend correspondingly, **MAKING SURE THAT YOU NEVER RISE ABOVE THE DEPTH INDICATED BY THE NEEDLE.**

As the diver begins his ascent, his body continues to absorb nitrogen. At some point during the ascent, the surrounding pressure and the nitrogen in the diver's tissues will be at an equilibrium. The DCP simulates this condition. **THEREFORE, IT IS NECESSARY FOR THE DIVER TO CONTINUE MONITORING HIS DCP DURING ASCENT.** It is possible that the DCP will move into the appropriate decompression zone during the ascent necessitating a decompression stop prior to surfacing.

You will note that the DCP is calibrated for decompression depths up to 50 feet. The 50 foot decompression range is adequate far beyond the normal time/depth possibilities of the scuba diver. (The dials illustrated in a simulated dive to 120 feet for 1 hour 05 minutes show that the first decompression stop is 30 feet (Figure 2, No. 4). If your time/depth exposure takes the needle beyond the 50 ft. mark the Meter goes off scale and will not prescribe the correct decompression. For dives that may go beyond the limits of the DCP you should use the available decompression tables.

Proper decompression depends upon an accurate depth reference. Because of this the DCP should be used in conjunction with an accurate, dependable depth gauge such as one of the SOS models. An accurate check of bottom time requires the use of a dependable diving watch.

On planned decompression dives, where more than minimal decompression is required, it is advisable to have a depth-marked decompression line in the water. The decompression line can be used as a stationary depth reference and the diver can hold at a precise depth without continuous monitoring of his depth gauge. The surface line is also ideal for suspending extra diving tanks that may be necessary for prolonged decompression.

While this booklet is not intended as a diving manual, it is necessary to point out that there are several known factors, and probably many unknown factors, that affect decompression. The decompression curve of the meter does not exactly parallel the U.S. Navy curve. However, some of the precautionary information included in the Navy Dive Manual is of a general nature and definitely applicable to decompression procedure associated with the meter.

The U.S. Navy Diving Manual, March 1970, page 84, paragraphs 18 and 19, states:

"(18) PREVENTION of decompression sickness is generally accomplished by following the decompression tables correctly. **EVEN WHEN THE TABLES ARE USED CORRECTLY, HOWEVER, UNUSUAL CONDITIONS EITHER IN THE DIVER**

A PRACTICAL EXAMPLE OF THE USE

D.C.P. SIMULATED DIVE 120 FEET FOR 1h 05 MIN.

Surface — **Time: 0**

1

Before use the D.C.P. needle will not necessarily register absolute 0 due to variations of barometric pressure as explained on page 12.

At 120 feet — **After 19 min**

2

After 19 minutes exposure including descent time, the needle has reached the red zone. At this point the diver could safely ascend to the surface.

At 120 feet — **After 39 min**

3

After 39 minutes exposure the needle has reached 20 feet zone. The diver could at this time ascend to 20 feet and decompress according to the D.C.P.

At 120 feet — **After 1h 05**

4

The 1h 05 minutes bottom time has elapsed. Now the diver can ascend until his depth gauge reading matches that of the D.C.P. which in this case is 30 feet. Here he begins his decompression allowing the indications of the D.C.P.

After 1h 14
(After Decompr. 9 min)

5

The diver has ascended to a depth of 20 feet.

After 1h 45 min
(Decompr. 40 min)

6

The diver has ascended to a depth of 10 feet.

After 2h 03
(Decompr. 58 min)

7

The diver has ascended to a depth of 10 feet. At 10 feet, the diver remains until the needle points to the point of red zone indicated on page 4. The reason for remaining at 10 feet is to eliminate adverse conditions such as surface swells.

Surface — **After 2h 20**
(Decompr. 1h 15)

8

The needle has reached the end of red zone indicated on page 4 which indicates that the nitrogen in solution has been reduced sufficiently to allow the diver to surface safely. After surfacing the needle will move slowly across the memory zone. This will automatically be added to the total decompression time of successive dives.

OR IN CONNECTION WITH THE DIVE WILL PRODUCE A SMALL PERCENTAGE OF DECOMPRESSION SICKNESS CASES. To be absolutely safe under all possible circumstances, the decompression time specified would have to be far in excess of that normally needed. On the other hand, under ideal circumstances, some individuals can ascend safely in less time than the tables specify. This statement must not be taken to mean that the tables contain an unnecessarily large safety factor, as a matter of fact, the tables generally represent the minimum decompression time that will permit average divers to surface safely from normal working dives without an unacceptable incidence of decompression sickness".

"(19) Factors in the diver which apparently favor the development of decompression sickness even when the tables are correctly followed include age, obesity, excessive fatigue, loss of sleep, alcoholic indulgence and its after affects, various illnesses, and anything which contributes to generally poor physical condition and poor circulatory efficiency. Unusually heavy exertion and extremes of temperature during the dive can have unfavorable affects. Heavy work at depths speeds up the circulation and increases the uptake of inert gas. Exercise during decompression, although it hastens the elimination of inert gas from some tissues, often increases the incidence of decompression sickness. Anything that impedes blood flow in an area during decompression can favor bubble formation. Keeping a leg or an arm in a cramped position is an example of a condition which would impede blood flow".

For this reason, knife an instrument straps should not be tightened to a degree that would restrict normal circulation. Cold is another factor. A warm diver decompresses more efficiently than a chilled diver because of cold-compensating factors within the human circulatory system. Having a proper fitting suit and keeping it in good repair is more than a simple matter of comfort; in a marginal instance it may mean the difference between adequate decompression and a trip to the chamber.

TWO DIVERS ON ONE METER?

While it is theoretically possible for two divers to share one Meter during a dive, the Meter readout is only applicable to the Meterless buddy **IF HE DOES NOT EXCEED THE DEPTH OF THE DIVER WEARING THE METER.** At greater depths even a brief exposure to slightly increased pressure (depth) by the Meterless buddy will put him beyond the safe limits of the Meter's decompression schedule. Normal diving activity makes it almost impossible to coordinate buddy diving depth to the degree required by the practice of sharing one Meter. Repetitive dives by Meter-sharing buddies greatly compounds the margin of error. Because of this, each diver should wear his own personal Meter and consider his Meter readout to be applicable only to himself.

CARE AND MAINTENANCE OF THE DCP

Although the DCP is not "delicate" it is a precision instrument and should be treated as such. Rough handling could jar the mechanism and adversely affect the function of the unit. The SOS Travel Case (SOS catalog: P 103/3) is designed to protect the Meter from physical abuse and it is air-tight to prevent internal damage when the unit is shipped by air in an unpressurized compartment. High altitude will damage the Meter, necessitating factory repairs. If you travel by air the Meter should be packed in the air-tight Travel Case or it should be carried in the pressurized cabin.

The only maintenance required by the Meter is a thorough rinsing with fresh water after sea diving. The Meter should be allowed to dry at normal temperatures before storing in the Travel Case for prolonged periods.

Avoid excessive heat and prolonged exposure to direct sunlight.

Within six hours from last dive DCP needle must be on zero. Otherwise the instrument itself can be damaged. Therefore control that the needle is not blocked outside the blue zone.

CHECKING THE EFFICIENCY OF THE DCP WITH THE 30/30 SYSTEM

(Simulated 30 minute dive to 30 meters)

The function of the DCP can be checked periodically by lowering it on a weighted line to a depth of 30 meters (98½ feet). The descent time should be about one and one-half minutes. After 28 minutes, including descent time, pull the instrument to the surface allowing exactly 2 minutes ascent time. The total simulated dive time should be exactly 30 minutes.

Upon surfacing the indicating needle should be within the efficiency check range indicated on the dial face illustration (Figure 1). If the needle fails to fall within this range (and if you are certain that you have conducted the test properly), the Meter may be out of order and should be returned to the SOS factory for repairs or adjustment.

If you do not wish to check the Meter in this manner, or if you lack the facilities to do so, the instrument can be returned to SOS for factory testing at a nominal charge to cover handling and shipping.

MEMORY ZONE

(Automatic Repetitive Dive Computation)

When you exit the water at one of the three surfacing arrow points, dictated by bottom time or repetitive dives, the needle will be in the Memory Zone (Figure 2 No. 8). The Memory Zone represents residual nitrogen from the preceding dive. It will take six hours for the needle to return to its starting point. If you dive again within that six hour period the residual nitrogen saturation will be automatically added to the prescribed decompression for the repetitive dive. REMEMBER: Repetitive dives put you on the B.T. 1 hr. to 2 hr. decompression scale.

Obviously, the Memory Zone requires that the DCP be considered a "one man machine" until the needle has returned to its starting point – 6 hours. If the Meter is used by another diver before that time, the residual nitrogen (represented by the position of the needle in the Memory Zone) will be added to his dive – shortening his no-decompression dive time or adding to his required decompression. (The numbers in the Memory Zone – 1, 1.5 and 2 – indicate the pressure of residual body nitrogen in bar. They are there for academic enlightenment and are not vital to the function or reading of the meter).

EFFECTS OF BAROMETRIC PRESSURE

At sea level, when the Meter has reached atmospheric equilibrium, the needle should be pointing within the range of the BLUE rectangle next to the letter "S" in the word SURFACE. Barometric pressure variations will influence the exact position of the needle within the BLUE rectangle. If the needle does not return to within the BLUE rectangle at sea level, the Meter should be considered out of order and returned to the factory for inspection and servicing. (A tolerance of plus or minus one millimeter is allowable).

Increases in elevation above sea level will proportionately lower the needle (counter-clockwise) **below** the BLUE rectangle. This does **NOT** mean that the Meter compensates for altitude diving. When the Meter is returned to sea level the needle should slowly return to within the BLUE rectangle.

WARRANTY

SOS products are guaranteed against any defect in material or workmanship for a period of 12 months as from the date of despatch ex works.

1 – SOS will replace free of charge any parts which are defective in respect of material or workmanship and will re-set any instruments which are out of calibration due to a fault in manufacture during the warranty period.

2 – This warranty does not include repairs or replacement of parts which have become scratched or damaged during use.

3 – The warranty is invalidated if the instrument has been dismantled or repaired other than by the manufacturer. It is also inoperative if damage has been caused by impact, incorrect use, lack of maintenance, exposure to excessive heat or excessive pressure variations.

WARNINGS

- Due to the innumerable physiological and environmental variables which can effect an individuals' susceptibility to decompression sickness, there is not guarantee that you will not get "bend" even if the DCP and appropriate decompression tables are followed.
- It must be remembered that the profile generated by the DCP is not exactly the same as the U.S. Navy decompression tables. A diver should use the DCP in connection with appropriate decompression tables, an accurate depth gauge, a dependable diving watch, especially in the instance where he will be repetitive diving, diving to excessive depth, in immoderate cold, or undergoing prolonged exertion.
- The DCP's decompression profile is designed to give minimum decompression necessary for a healthy diver, in top physical condition, with normal metabolism, diving within the specified limits of the DCP. The DCP's automatic function does not consider those variables as age, overweight, taking medicines, sickness, tiredness, excesses in eating and drinking, and in general, any poor or marginal physical condition.
- The diver must always comply with the safe rate of ascent which is not greater than 60 feet per minute.
- For maximum safety, on dives in excess of 100 feet, divers should decompress for a minimum of three minutes at ten feet even though the meter does not indicate any decompression need.
- The diver should be aware of and heed the "Deep Dive First Rule". This rule state that if repetitive dives are to be made, the deepest dive should be made first. The following dives should then be made in order of deepest to the most shallow. Some authorities have stated that there is evidence that a repetitive dive even to the depth of a previous dive, is unsafe when the total bottom time approaches the maximum no decompression limit. They believe that this type of dive can result in decompression sickness affecting the central nervous system.
- The Automatic Decompression Meter is calibrated for compressed air dives conducted from sea level. It is not intended for use with mixed gas apparatus or for high-altitude diving.
- The DCP is tested for use until a maximum depth of 180 ft. The use of the instrument at a superior depth could take it out of calibration.
- It should be remembered that, for safety diving, it is necessary to know diving problems, independently from DCP use. Besides it is recommended the attendance of diving schools.

SOS will not answer for any decompression accidents that might occur to divers who use DCP not periodically tested, or not properly used, or damaged. SOS will not answer for any accidents to divers who will not use, in doubtfull cases, the decompression tables.