

**SS521-AG-PRO-010**

**0910-LP-115-1921**

**REVISION 7**

# **U.S. Navy Diving Manual**



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**SUPERSEDES SS521-AG-PRO-010, REVISION 6 CHANGE A, Dated 15 October 2011.**

# U.S. Navy Dive Computer

## 2B-1 INTRODUCTION

Navy Dive Computers (NDCs) are wrist or lanyard mounted devices that provide real-time decompression guidance to the user based on the user's preceding dive history. NDC use allows great flexibility in diving, increasing the amount of available bottom time by compensating for time spent at depths shallower than the maximum achieved depth, the depth that must be used to apply traditional decompression tables for square dives. Five distinct NDC variants, one of which is shown in Figure 2B-1, are currently authorized on the ANU for use in different types of diving ranging from open circuit air ( $N_2$ - $O_2$ ) to closed circuit  $N_2$ - $O_2$  and He- $O_2$ .



Figure 2B-1. Navy Dive Computer.

**2B-1.1 Purpose.** This appendix provides general guidelines and procedures for NDC diving operations. For detailed physical operation and maintenance instructions, see the associated NDC's approved Technical Manual. For operational planning, refer to Chapter 6.

**2B-1.2 Scope.** This chapter covers NDC general characteristics, dive procedures, and unique decompression aspects for the use of the NDC in lieu of standard tables for various UBAs. The specific NDC characteristics and set points are contained in the respective O&M manual. Multi-Level diving unique to Naval Special Warfare under its own procedural guidance is exempt from the requirements of this chapter.

## 2B-2 PRINCIPLES OF OPERATION

The NDC provides real time decompression guidance to the diver underwater and displays the following vital information:

- Depth
- Temperature
- No-decompression time remaining before incurring stops

- Decompression stop depth and time at stop
- Total remaining decompression time
- TBT from left surface
- Ascent rate bar graph with warnings
- Current set point

#### 2B-2.1 Definitions:

1. Set point: The prevailing diver inspired oxygen fraction or oxygen partial pressure assumed by the NDC. The NDC set point matches the specific performance parameters of the UBA which the NDC supports. Some NDC variants incorporate automatic depth-dependent transition set points. The NDC set point is displayed in terms of the following set point designators:
  - f21: set point designator for constant inspired O<sub>2</sub> fraction of 0.21 (21% O<sub>2</sub>). The designator for open circuit air is f21.
  - p0.7 or p1.3: set point designators for constant inspired O<sub>2</sub> partial pressures (ppO<sub>2</sub>) of 0.7 or 1.3 atm, respectively. Used with NDCs for EC-UBA diving.
2. Ceiling: The deepest depth of any required decompression stop indicated by a NDC. The prescribed decompression stop must not be violated, hence the term “ceiling”.
3. Desaturation Time: Remaining time on surface before a subsequent dive is no longer considered a repetitive dive; time before an allowed ascent to altitude. Varies from 1 to 24 hours depending on the residual inert gas loading upon surfacing from the last dive and the time elapsed since surfacing from the last dive.
4. Governing NDC: The NDC with the most conservative indication of the prevailing decompression obligation in a buddy pair or group of divers that must follow the same decompression schedule. Example: the computer with the shortest remaining no-stop time if all computers are no-stop or the computer with the longest indicated remaining decompression stop time; in post-dive surface mode, the computer with the longest desaturation time.

**2B-2.2 Function.** All NDC variants operate the Thalmann Exponential-Linear MK 15/16 Decompression Model (EL-MK 15/16 DCM), but the different variants are configured with different factory software settings to tailor algorithm operation for the type of diving supported by the NDC. The NDCs have no user configurable settings with the exception of the AIR III-79. This variant has programming mode enabled, which allows divers access to the pre-dive prediction mode. Refer to the AIR III-79 O&M Manual for further information on programming mode function. Each NDC updates the algorithm with a depth and time sample every second and uses the algorithm output to support a variety of functions including countdown of time remaining in No-Decompression status or countdown of time required at decompression stops.



- 2B-2.3 Safety.** It is critical divers monitor their NDCs every two to three minutes throughout the dive. Divers must ensure they are breathing the appropriate gas for the set point indicated on the NDC.

After ascent to a depth shallower than a prescribed decompression stop depth, the NDC will count down the omitted stop time faster than at the omitted stop depth because the inert gas partial pressure at the shallower depth is less than at the missed stop depth. The NDC will not apply the required penalty to compensate for omitted decompression. Diving supervisors must check NDC status for omitted decompression immediately upon diver surfacing.

**Example:** A diver on open circuit air surfaces by omitting a :04 stop at 10 fsw. After two minutes on the surface, the stop clears, and all warnings disappear.

### Warning

**The NDC variant used must match the rig/diluent/dive method being performed. Catastrophic decompression sickness could result if the wrong NDC is selected.**

Each diver must use the same NDC throughout any given series of dives. A clean diver who replaces a diver unable to make a repetitive dive should use the NDC of the diver that he is replacing. This NDC will prescribe unnecessarily conservative decompression guidance for the clean diver, but will serve as a backup for the repetitive diver should that diver's NDC fail (see [paragraph 2B-4.1](#)). Any diver that loses the data on his NDC before desaturation is complete shall not dive within 24 hours of his last reached surface time (His inert gas level is unknown).

- 2B-2.4 Advantages.** The NDC credits the diver for time spent at depths shallower than the maximum depth of the dive. This greatly increases bottom time.

**Example 1.** A ship's husbandry diver after :120 at 25 fsw drops a tool to the bottom at 58 fsw. The standard table would not allow the diver to descend to retrieve the tool since the table would be a 60 fsw for :120, a prohibited exceptional exposure dive. An NDC, however, would show almost unlimited no-decompression time remaining after :120 at 25 fsw, and allow the diver to descend, retrieve the tool, and return to work at the 25 fsw worksite. NDC use would eliminate a need to swap divers to retrieve the tool.

**Example 2.** A diver inspecting a submerged buoy must examine the anchor system at 130 fsw, then perform :30 of maintenance on the buoy itself at 50 fsw. A typical square air table would give the diver a total of :10 of no-decompression bottom time, including time at the 50 fsw worksite. In comparison, after a :10 anchor inspection at 130 fsw, the NDC would allow the diver almost an hour of remaining no-decompression time upon ascent to the 50 fsw worksite.

- 2B-2.5 Disadvantages.** The diving supervisor is not in direct control of the diver's decompression status.

**2B-2.6 Use.** Table 2B-1 contains the operational characteristics of the currently approved NDCs.

**Table 2B-1.** NDC Characteristics.

NDC / Color (Note 1)	Inert Gas / UBA	Set Point, Depth (D)	Depth Limit	Total Decompression Time Limit (Note 2)
NSW III Black	N <sub>2</sub> O <sub>2</sub> -EC-UBA -Air	f21, D < 78 fsw p0.7, D ≥ 78 fsw	150 fsw	15 minutes
NSW III 50/12 1.3 Air Black	N <sub>2</sub> O <sub>2</sub> -EC-UBA -Air	during descent: f21, D < 50 fsw; p1.3, D ≥ 50 fsw during ascent: p1.3, D > 12 fsw f21, D ≤ 12 fsw	150 fsw	Note 3
EOD III Grey	N <sub>2</sub> O <sub>2</sub> -EC-UBA	during descent: p0.7, D < 34 fsw; p1.3, D ≥ 34 fsw during ascent: p1.3, D > 12 fsw p0.7, D ≤ 12 fsw	150 fsw	40 minutes
AIR III-79 Yellow (Note 4)	N <sub>2</sub> O <sub>2</sub> -Air	f21 throughout	190 fsw	15 minutes
NSW HE III 200-1.3 Blue	HeO <sub>2</sub> -EC-UBA	during descent: p0.7, D < 32 fsw; p1.3, D ≥ 32 fsw during ascent: p1.3, D > 12 fsw p0.7, D ≤ 12 fsw	200 fsw	Note 3
<b>Notes:</b> <ol style="list-style-type: none"> <li>1. A dive series started on an NDC variant and breathing medium (N<sub>2</sub>-O<sub>2</sub> or He-O<sub>2</sub>) must stay on that variant until the Desaturation time from that dive/series of dives is expired.</li> <li>2. Limits are based on the exceptional exposure lines from standard tables, oxygen exposure limits, or limits imposed by other approved procedures. Most NDC dives have much longer in-water times than table dives, therefore increasing the overall risk of the dive. The goal of the NDC is to significantly reduce or remove the need for in water decompression stops by using its flexibility to stay No-Decompression.</li> <li>3. In accord with approved NSW multi-level diving procedures.</li> <li>4. Legacy NDCs designated "AIR III" are governed by AIR III-79 procedures.</li> </ol>				



## 2B-3 DIVING

**2B-3.1 Pre-Dive.** Maintenance and pre-dive checks should be completed IAW the appropriate NDC O&M manual. Dive supervisors should check for the following:

- Correct NDC for dive method being performed
- NDC is paired to the diver if performing a repetitive dive
- NDC is on
- Battery status is within O&M recommendations
- NDC is in surface mode
- NDC is attached to the diver or a piece of equipment that would not be ditched
- If programming mode is enabled (AIR III-79 only) verify conservatism is set to zero.

**2B-3.2 Dive.** General bottom time planning for single dives may be undertaken using the Air tables in [Chapter 9](#) or EC-UBA tables in [Chapter 16](#). Once the NDC dive starts, however, the dive supervisor will not know the diver's remaining no-decompression or decompression time unless in communication with the diver.

For ease of dive planning, dive supervisors may elect to limit the maximum depth and remaining no-decompression time, or the maximum time at a specific ceiling. This allows the divers flexibility in conducting underwater tasks throughout the water column rather than being held to an arbitrary square table. For buddy pair, or group diving, the governing NDC sets the limitations.

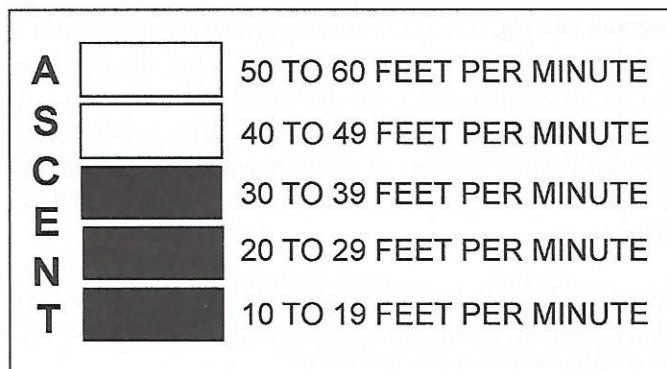
**Example:** A dive supervisor for a square table dive would brief, "no deeper than 60 fsw, no longer than 50 minutes". A dive supervisor for an NDC dive would brief, "no deeper than 60 fsw, no less than 3 minutes remaining no-decompression time," or alternatively, "leave bottom after incurring no more than :05 of total decompression time".

Most NDCs do not transition to dive mode until a depth of 2-5 fsw is reached. If the NDC does not transition by 10 fsw, the diver must abort the dive and surface. If the faulty NDC is a repetitive NDC, the diver assigned that NDC shall not dive until a minimum of 24 hours has elapsed following his last reached surface time.

Divers must ensure they are breathing the mix displayed by the NDC to avert omitting significant decompression or being directed to perform an unnecessarily long decompression. NDCs are designed to transition set points within 2 fsw of their respective transition depths. A diver with an NDC that does not transition shall follow the same EP and abort criteria as a diver with a UBA that fails to transition

**2B-3.3 Ascent.** Prior to leaving bottom, determine the governing NDC.

Divers shall monitor the NDC ascent rate indicator to ensure they do not exceed the 30 fpm ascent rate limit. The NDC ascent rate indicator is a bar graph as illustrated in Figure 2B-2. At any point in time, the graph is filled to a level that indicates the current ascent rate. The bars of the graph flash as a warning when the ascent rate exceeds 30 fpm. In the event of such a warning, the ascent rate should be slowed until the warning flashes cease.



**Figure 2B-2.** NDC Ascent Rate Bar Graph showing ascent rate of greater than 30 fpm. Text included here for explanatory purposes is not included in the actual NDC display.

**2B-3.4 Decompression.** Each NDC variant is designed to accommodate the set points of a particular UBA.

The governing NDC shall be used to determine decompression. It is possible that a different NDC can become the governing NDC at a shallower stop. All NDCs must be checked upon reaching and before leaving any stop.

- Ascend to the governing NDC ceiling and complete the required stop time.
- Check all NDCs cleared the ceiling.
- Ascend to the next ceiling. Determine governing NDC.
- Prior to leaving last stop, ensure all NDCs are back to No-Decompression.
- Divers pass NDC information to dive supervisor upon surfacing.

**Caution** **Divers should avoid strenuous exercise during decompression.**

**2B-3.5 Post-Dive.** Any diver who has exceeded the limits of the NDC or had significant UBA issues that caused inspired ppO<sub>2</sub> to fall more than 0.15 atm below pO<sub>2</sub> set points shall be observed for signs of DCS. Such a diver requires observation after surfacing, but need not be treated unless symptoms of decompression sickness occur.



NDC post dive maintenance is performed IAW the NDC operation and maintenance manual. Divers shall keep their NDCs with them or in a marked place to prevent their use by different divers before desaturation time is complete.

**2B-3.6 Time to Fly/Ascent to Altitude.** The NDC displays desaturation time. This is the time until algorithm compartments are back to baseline. Any diver that loses the data on his NDC before desaturation is complete shall not fly until a minimum of 24 hours has elapsed following his last reached surface time.

**2B-3.7 Repetitive Diving.** The NDC desaturation time applies to repetitive dives. A dive undertaken with an NDC showing remaining desaturation time is considered to be a repetitive dive. Only no-decompression repetitive dives are authorized. A diver may make an unlimited number of dives provided that all dives in the series remain no-decompression. A diver planning to conduct an NDC decompression dive must wait until the desaturation time on their NDC is clear prior to making the dive.

A diver conducting an NDC repetitive dive may dive with a clean NDC diver provided they are diving the same rig/mix/NDC variant. In this case, the repetitive NDC would be the governing NDC.

## **2B-4 DIVING ISSUES/EPs**

UBA specific EPs must be followed. The following EPs pertain only to the decompression requirements in NDC dives that differ from those for dives undertaken with standard square tables.

### **2B-4.1 Loss of NDC:**

1. Abort dive.
2. Use the buddy diver NDC as the governing NDC.
3. In the event of a single diver losing his NDC, or both NDCs failing, the diver(s) must weigh the risk of DCS from immediately surfacing. Obviously if the diver(s) know they are well inside no-decompression limits, they should abort the dive and ascend following the slowest bubble. The diver(s) should be observed for one hour after surfacing.

**2B-4.2 Asymptomatic Omitted Decompression.** Procedures for management of asymptomatic omitted decompression are summarized in [Table 2B-2](#). More detailed procedures for specific types of cases are given in Sections [2B-4.2.1](#) through [2B-4.2.3](#).



**Table 2B-2.** Initial Management of Asymptomatic Omitted Decompression for NDC Dives.

Deepest Decompression Stop Omitted	In-water Status	Surface Interval	Action	
			Chamber Available	No Chamber Available
Any	Diver in water	Without surfacing	Descend 10 fsw deeper than missed stop; perform stops every 10 fsw for the longer of :10 or the time required to remain 10 fsw deeper than ceiling (note 1)	Descend 10 fsw deeper than missed stop; perform stops every 10 fsw for the longer of :10 or the time required to remain 10 fsw deeper than ceiling (note 1)
Inadvertent Surfacing from Last Stop	Surfaced	Any	Descend to missed stop; manually double stop time  -or- TT5 for SI <:05 TT6 for SI >:05	Descend to missed stop; manually double stop time
Inadvertent Surfacing from Deeper than 20 fsw with Multiple Stops Missed	Surfaced	Any	TT5 for <:30 missed TT6 for >:30 missed	Descend 10 fsw deeper than missed stop; perform stops every 10 fsw for the longer of :10 or the time required to remain 10 fsw deeper than ceiling (note 1)
<b>Notes:</b> 1. When diving p1.3 EC-UBA, the diver may elect to descend to re-transition the EC-UBA and/or NDC to 1.3 ppO <sub>2</sub> before returning to the missed stop.				

**2B-4.2.1 In water stops missed without surfacing:**

1. Descend as necessary to transition EC-UBA or NDC set points to match.
2. Travel to a depth 10 fsw deeper than the depth of the missed stop and stop for a minimum of :10.
3. Continue decompression to surface with a stop every 10 fsw for the longer of :10 or the time required to remain 10 fsw deeper than the indicated ceiling.
4. Observe diver for one hour after surfacing.

**2B-4.2.2 Inadvertent surfacing with missed last or only stop:**

1. Stay on EC-UBA if applicable, while on surface.
2. Note remaining stop time indicated on NDC.
3. Descend as necessary to transition EC-UBA or NDC set points to match.

4. Travel to missed stop and stop for double the previously noted remaining stop time.
5. Observe diver for one hour after surfacing.

**2B-4.2.3 Inadvertent surfacing with multiple missed stops:**

1. Stay on EC-UBA, if applicable, while on surface.
2. Descend as necessary to transition EC-UBA or NDC set points to match.
3. Travel to depth 10 fsw deeper than the depth of the missed stop and stop for a minimum of :10.
4. Continue decompression to surface with a stop every 10 fsw for the longer of :10 or the time required to remain 10 fsw deeper than the indicated ceiling.
5. Observe diver for one hour after surfacing.

**2B-4.3 In-Water DCS.** If chamber immediately available, surface and treat on a minimum of TT6 IAW [Chapter 18](#).

If a chamber is not immediately available:

1. If diving a p1.3 UBA and the afflicted diver's UBA or NDC has transitioned to p0.7 mode at its shallow transition depth, descend deep enough to transition the UBA and NDC to p1.3 mode. Travel to a depth 10 fsw deeper than the current stop depth and assess the afflicted diver for relief of symptoms. Descent to a maximum depth 20 fsw deeper than the current stop depth may be completed if symptoms are not relieved.
2. Remain at depth of relief for :10.
3. Take a stop every 10 fsw for :10 or the displayed stop time, whichever is longer. Stops may be lengthened beyond :10 as necessary to control symptoms.
4. Complete the last stop at 20 fsw for a minimum of :10 or the displayed stop time, whichever is longer.
5. Transport to recompression chamber. If diver remains asymptomatic, administer a TT5. If diver is symptomatic, administer a TT6 IAW [Chapter 18](#).

**2B-4.4 Exceeded limits (unplanned exceptional exposure).** The NDCs were designed and limited to different depth parameters based on the estimated risks of DCS associated with dive profiles allowed within the limits. Exceeding the set limitations of the NDC given in [Table 2B-1](#) may cause the diver to incur a much higher risk of DCS than is acceptable. If the limits are exceeded:

1. Follow decompression as prescribed by the NDC.
2. Observe the diver on the surface for one hour.
3. The diver should be accompanied by a person with knowledge of diving-related illnesses for a period of six hours after the dive.
4. Treat any symptoms as original symptoms IAW [Chapter 18](#).