ADE - Advanced Diving Environment

User manual

For version: 1.1.0
Re-worked: 11.01.2023 by Tsardev

NOT FOR REAL WORLD USE

Preamble

Since the degredation of the original ADE mod over time, the mod has became non-working. It has been re-worked and made availible again in a stable and uplifted user friendly experience. I have gone through and updated this user manual with the up to date information, and will continue to do so.

At the moment the revised mod contains all updated and correct basic calculations (except for decompression/tissue saturation and ambient temperature, those are placeholders) to fully simulate real world diving and enhance the players experience, especially when planning a dive.

This guide will only scratch the surface of diving and focuses on its use in Arma.

Some compromise had to be made, which is using open circuit calculations on a closed circuit system like the Arma rebreather. I guess if one can see past that inaccuracy, a lot of fun is guaranteed.

Compromises made for Arma will be marked with "***ATTENTION***" in this guide.

Tsardev is overhauling the user manual, the majority of the original information in here remains unchanged by the original Developer for ADE. I am simply helping to contribute within the community and create an updated user manual for our favorite dive mod.

Tons of support to the community members who helped make ADE a stable mod again.

Table of contents

Gear

ADE brings new gear to Arma. In order to dive properly it should be worn as complete as possible. Since ADE adds its own rebreather, modularity and coexistence with the vanilla system is ensured. If you want to use ADE, use its rebreather, if not use the vanilla one. It works locally so even in a multiplayer mission, each player can choose his favorite system. ADE will only fire up with the mod rebreather equipped.

The gear has the following Arsenal names and can be found in the following categories:

- Diving goggles (ADE) [Glasses]
- Rebreather (ADE) [Vest]
- 6 liter single and double cylinders with different gases (misc) [Misc]
- Dive computer (ADE) [Terminal]
- Wetsuit (ADE) [Uniform]
- Diving bag (ADE) [Backpack]

Cylinders are connected with the ACE self interaction.

The dive computer has to be in the GPS slot.
The key to toggle it can be bound in the CBA keybinds → Advanced Diving Environment → Toggle dive computer.

ATTENTION

“ADE uses an open circuit as the base for calculations, that means a system in which the used air leaves the system (the bubbles). Open circuit systems are very popular amongst sports divers.

Arma uses a closed circuit rebreather, a system in which the used air does not leave the system, but gets enriched with Oxygen again. Since there are no bubbles, it is used by the military.

This leads to the compromise of using OC calculations for CC rebreathers, but I guess that's ok.”

Dive physics

As everyone finds formulas boring, I will try to do it in a quick rundown. A lot of this is done by the dive computer but for planning and understanding it's good to know them.

Ambient pressure

Ambient pressure is the pressure at a certain depth. It is the pressure of the water above the diver, as well as the pressure of the air above it. It is linear.
Ambient pressure roughly calculates as:

$$p_{amb} = (depth/10) + 1$$

Example:
Ambient pressure at a depth of 20 m?

$$p_{amb} = (20\,m{:}\,10) + 1$$
$$p_{amb} = 3\,bar$$

Partial pressure of a gas component

Partial pressure is the pressure, the component of a gas has. It calculates as:

$$ppComponent = Ambient\ pressure * Percentage\ of\ gas\ component$$

Example:
Partial pressure O2 for compressed air at 20 m?

$$Percentage\ of\ O2\ in\ CA = 21\%$$
$$ppO2 = 3\,bar * 0{,}21$$
$$ppO2 = 0{,}63\,bar$$

Maximum Operating Depth (MOD)

MOD describes the depth at which the Oxygen partial pressure gets to 1.4 bar. This is where O2 gets toxic and limits the diver to go deeper. If you want to do so, choose a gas with lower O2 percentage (gases are listed in the next chapter). MOD calculates as:

$$MOD = ((1.4\,bar{:}\,Percentage\ O2) * 10) - 10$$

Example:
MOD for a gas with 15% O2?

$$MOD = ((1.4\,bar{:}\,0.15) * 10) - 10$$
$$MOD = 83.3\,m$$

Gas amount in the cylinder

The gas amount calculates as:

$$gas\ amount\ =\ cylinder\ pressure\ *\ cylinder\ volume$$

A reserve of 50 bar is only to be used in case of an emergency, so don't plan with it.

Example:

Usable gas amount in a 6 l 300 bar cylinder?

$$effective\ gas\ amount\ =\ 250\ bar\ *\ 6\ l\ =\ 1500\ l$$

$$reserve\ =\ 50\ bar\ *\ 6\ l\ =\ 300\ l$$

Surface air consumption rate (SAC)

The SAC is hard coded to:

- **15 l/min at sea level for normal speed**
- **25 l/min at sea level for "sprinting"**

Ambient air consumption rate (AAC)

Air consumption is ALWAYS dependent on ambient pressure!
To find out the air consumption at a certain ambient pressure (e.g. depth), it calculates as:

$$AAC\ =\ SAC\ *\ p_{amb}$$

Example:

Air consumption per minute at a depth of 20m when diving normal?

$$p_{amb}\ =\ 3\ bar$$

$$SAC\ =\ 15\ l/min$$

$$AAC_{20m}\ =\ 15\ l/min\ *\ 3\ bar$$

$$AAC_{20m}\ =\ 45\ l/min$$

As you can see, diving deeper drastically increases air consumption!

Remaining dive time

Dive time is the time you can dive before you run out of breathing gas. This is useful for dive planning.

$$remaining\ dive\ time\ =\ effective\ gas\ amount\ /\ AAC$$

Example:

How long can you dive normal with 6 l 300 bar at 10 m?

$$p_{amb}\ =\ 2\ bar$$
$$SAC\ =\ 15\ l/min$$
$$AAC_{20m}\ =\ 15\ l/min\ *\ 2\ bar\ =\ 30\ l/min$$
$$effective\ gas\ amount\ =\ 250\ bar\ *\ 6\ l\ =\ 1500\ l$$
$$dive\ time\ =\ 1500\ l\ :\ 30\ l/min\ =\ 50\ min$$

Tissue saturation

If the diver dives for a longer period of time, or deep, or with a high percentage of N2 in the gas, his blood will saturate with Nitrogen. Once the blood is highly saturated, the diver will have to do what is called a "decompression stop". This is a stop for a certain time on a certain depth, in order to remove excessive Nitrogen slowly from the blood. While decompression is necessary, it is important to slowly ascend to the decompression depth and stay there for the decompression time in order to prevent the Nitrogen from washing out fast, as this can lead to pain, mechanical damage of the arteries, paralysis and death. This is known as decompression sickness or "the bends". It is comparable to shaking a bottle full of carbonated water and opening it fast in one go. Avoid this at all cost!

ATTENTION

The current model of tissue saturation is work in progress and will be replaced by a real world (RW) algorithm. Therefor RW decompression tables can't be used.
For deco depth and time check the dive computer!
RW ascend rates are super slow (I think the Navy uses 60 feet per minute = 0,15 m/s). For Arma purposes safe ascend speed is up to 1 m/s. This can be achieved by ascending with "X".

Breathing gases

ADE simulates various different breathing gases. These differ in their mixture quite drastically. Choosing the right gas is essential in dive planning. Currently implemented gases are:

Cannister Name	Max Depth (Meters)	Max Gas Time Surface (Min)	% O2	% N2	% HE	N2! Depth (Meters)
Compressed Air	25		21	78	1	51.5
EAN40	30	240	40	60	-	48.3
EAN36	34.4	216	36	64	-	44.6
EAN32	40	192	32	68	-	41.4
EAN28	47.1	168	28	72	-	38.6
Heliox21	66.2-110	126	21	-	79	-
Heliox12	123.3-150	72	12	-	88	-
Heliox8.5	150-178.2	51	8.5	-	91.5	-
Trimix 10/70	100-130	TBD	43	38	19	-
Trimix 12/65	75-92	TBD	12	23	65	-
Trimix 15/55	60-75	TBD	15	30	55	-
Trimix 18/45	45-60	TBD	18	37	45	-
Trimix 21/35	30-45	TBD	21	44	35	-

EAN x:
x is the percentage of Oxygen in the mix, the rest is Nitrogen. No Helium is present.

Heliox x:
x is the percentage of Oxygen in the mix, the rest is Helium. No Nitrogen is present.

Trimix x/y:
x is the percentage of Oxygen in the mix, y the percentage of Helium. The rest is Nitrogen.

Dive computer

The dive computer is a super useful tool. It reduces the workload by keeping track of important data and warns the diver of imminent danger. It has to be in the GPS slot in order to work. A GPS is built into the computer. The keybinding for it can be found in the CBA keybindings under "Advanced Diving Environment", "Toggle dive computer". Currently only one overlay is available and it is fixed to the bottom right of the screen. A night mode and custom positioning is planned.
Let's have a look at the different values shown by it:

Time: Local time of day in 24h format
CRS: Course
Tank: Cylinder pressure
Press: Ambient pressure
Depth: Depth below sea level
Asc: Ascend rate, negative for descend
DT: Passed dive time
RDT: Remaining dive time on current depth
Deco at: Decompression depth
Deco for: Decompression time
Deep at: Deepstop depth
Deep for: Deepstop time
MOD: Maximum operating depth
ppO2: O2 partial pressure
ppN2: N2 partial pressure

Warnings: Warnings will be shown with red text in the open space below MOD.

Possible warnings are:

Warning text	Sound effect	Reason
!ppO2!	Yes	ppO2 > 1.4 bar
!ppN2!	No	ppN2 > 3.5 bar
!LOW AIR!	No	Remaining cylinder pressure < 50bar
!ASC RATE!	Yes	Ascend rate to deco depth is too high
!DECO!	Yes	Depth lower than deco depth

Dangers

Diving can be great fun, but it can get dangerous as well. In order to avoid those, a good preparation is key. The following are what I would rate the biggest dangers:

Danger	Caused by	How to avoid
Oxygen toxicity Is deadly	Oxygen partial pressure > 1.4 bar	Ascend to lower depth. Use different breathing gas.
Nitrogen narcosis Is not deadly	Nitrogen oartial pressure > 3.5 bar	Ascend to lower depth. Use different breathing gas.
Decompression sickness Is first painful and later deadly	Ignored decompression stops as well ascend rate > 1m/s	Do deco stops, low ascend rate.
Lack of breathing gas Is deadly after 2 min	Empty cylinder	Check air usage, keep a reserve.
Loss of orientation Is not deadly	Loss of orientation	Don’t dive alone

Dive planning

A well planned dive minimizes the risks and is essential if you want to just pack what you need.

What you need to think about:

- **Diving distance**
- **Depth**
- **Air consumption**
- **Gas amount**
- **Rally point in case someone gets lost**
- **Landing zone on shore**

Diving distance and speed:

- **Normal diving speed is about 8.5 min/km → ca. 7 km/h → ca. 2 m/s**
- **Sprint diving speed it about 6.5 min/km → ca. 9.2 km/h → ca. 2.5 m/s**

Dive planning is essentially using all the previous learned stuff to tailor the dive to your needs. Sometimes you need to flip those formulas for your needs. Let's do some examples for problems you might face.

Example 1

How can you cover more distance? Normal or sprint?
Say you have a single cylinder(6 l) with 300 bar pressure and want to dive at 25 m.
Solution:

$$total\ gas\ amount\ =\ 300\ bar\ *\ 6\ l\ =\ 1800\ l$$

You subtract the emergency reserve of 50 bar:

$$effective\ \ gas\ amount\ =\ 250\ bar\ *\ 6\ l\ =\ 1500\ l$$

Now we get out ambient pressure at 25m:

$$p_{amb}\ =\ (25\ m:\ 10)+1\ =\ 3.5\ bar$$

Now let's find out the ambient air consumption at 25 m for normal and sprint speed:

$$AAC_{Normal}\ =\ 15\ l/min*\ 3.5\ bar\ =\ 52.5\ l/min$$
$$AAC_{Sprint}\ =\ 25\ l/min*\ 3.5\ bar\ =\ 87.5\ l/min$$

Now that we got this lets calculate the dive time:

$$dive\ time_{normal}\ =\ 1500\ l:\ 52.5\ l/min\ =28.57\ min$$
$$dive\ time_{sprint}\ =\ 1500\ l:\ 87.5\ l/min\ =17.14\ min$$

Finally let's find out the distance we cover:

$$distance_{normal}\ =\ 28.57\ min:\ 8.5\ min/km\ =ca.3.36\ km$$
$$distance_{sprint}\ =\ 17.14\ min:\ 6.5\ min/km\ =ca.2.63\ km$$

You will have a better endurance if you dive normal!

Example 2

Can you dive at this depth and reach the destination?
You want to dive 3 km and have a double 6 l cylinder. You dive at normal speed and plan to dive at 30 m. Is it possible?
Solution:
Let's get our gas amount first. Since we use a double bottle, the cylinder volume is 12 l:

$$effective\ gas\ amount\ =\ 250\ bar\ *\ 12\ l\ =\ 3000\ l$$

Now the ambient pressure:

$$p_{amb}\ =\ (30\ m:\ 10)+1\ =\ 4\ bar$$

The air consumption at 30 m in normal speed is:

$$AAC_{normal}\ =\ 15\ l/min\ *\ 4\ bar\ =\ 60\ l/min$$

We need about 8.5 minutes for a km. How long do we need for 3:

$$dive\ time\ needed\ =\ 3\ km\ *\ 8.5\ min/km\ =\ 25.5\ min$$

Let's see if we can reach it:

$$dive\ time_{normal}\ =\ 3000\ l:\ 60\ l/min\ =50\ min$$

We can reach it. In fact we can nearly do double the distance!

Example 3

How deep can you dive with EAN 40? Will you hit O2 toxicity or N2 narcosis first?
First let's see how the mixture is:

$$O2\ =40\ \%\ =0.4$$
$$N2\ =\ 60\ \%\ =\ 0.6$$
$$He\ =\ 0\ \%\ =\ 0$$

Now let's write down the safe limits:

$$ppO2\ =1.4\ bar$$
$$ppN2\ =\ 3.5\ bar$$

The ambient pressure for those partial pressures is:

$$ppO2:\ \%\ O2\ =\ ambient\ pressure\ for\ O2\ tox$$
$$1.4\ bar:0.4\ =\ 3.5\ bar$$
$$ppN2:\ \%\ N2\ =\ ambient\ pressure\ for\ N2\ narc$$
$$3.5\ bar:\ 0.6\ =\ 5.83\ bar$$

Get the depths:

$$p_{amb}\ =\ (depth/10)\ +\ 1$$

Switch for depth:

$$depth\ =\ (p_{amb}\ *\ 10)-10$$
$$depth\ for\ O2\ tox\ =\ (3.5\ bar\ *\ 10)-10\ =\ 25\ m$$
$$depth\ for\ N2\ narc\ =\ (5.83\ bar\ *\ 10)-10\ =\ 48.3\ m$$

We will hit O2 toxicity first. This limits us to a maximum operating depth of 25 m.

Mission Building / Mod Making

If the player starts underwater, use the NATO diving goggles (G_B_Diving)!
Equip player with the ADE rebreather.
In order to start a mission with already connected cylinders, make sure to set the following variables in a script for each player using ADE.
Each player can have a different breathing gas if wished.

```
sleep 1;                                  //Wait a second just in case
adeVarCylinderVolume = 6;                 //Cylinder volume in liter. 6 for single, 12 for double
adeVarCylinderPressure = 300;             //Cylinder pressure in bar
adeVarGasamountInLiter = 1800;            //Gas amount is cyl. volume x cyl. pressure
adeVarPercentO2 = 0.21;                   //Percentage of O2 in the gas (must not be 0)
adeVarPercentN2 = 0.78;                   //Percentage of N2 in the gas
adeVarPercentHe = 0.01;                   //Percentage of He in the gas
adeVarDiverWithoutGas = 0;                //Sets the timer for diver without gas to 0
adeVarTissueSaturationMultiplier = 2.5;   //How fast tissue is saturated with each gas
adeVarAirUsageSetting = 6;                //How much oxygen is used
adeVarSprintMultiplier = 1.2;             //Adjusts sprint gas usage
adeVarDecoDiminish = 5;                   //Decreases time required at decompression stops
```

ADE Dive Table

Max Operating Depth (MOD)			Planned Time at Depth (PDT) (minutes)											
Consumption Factor (RDT)	Gas Mixture	Depth (m)	10	20	30	40	50	60	70	80	90	100	110	120
59.88		10	1	1	1	1	1	2	2	2	2	2	2	3
39.93	EAN40	20	1	1	1	2	2	2	2	3	3	3	3	4
29.93	CA*, EAN32, EAN36	30	1	1	2	2	2	3	3	3	4	4	4	5
24.00	EAN28	40	1	1	2	2	3	3	3	4	4	5	5	5
19.97		50	1	2	2	3	3	4	4	5	5	6	6	7
17.12	Hx21, Tx21/35	60	1	2	2	3	3	4	5	5	6	6	7	8
14.98	Tx18/45	70	1	2	3	3	4	5	5	6	7	7	8	9
13.30	Tx15/55	80	1	2	3	4	4	5	6	7	7	8	9	10
11.97		90	1	2	3	4	5	6	6	7	8	9	10	11
10.88		100	1	2	3	4	5	6	7	8	9	10	11	12
9.97	Hx12, Tx12/65	110	2	3	4	5	6	7	8	9	10	11	12	13
9.20		120	2	3	4	5	6	7	8	9	10	11	12	14
8.55	Tx10/70	130	2	3	4	5	6	8	9	10	11	12	13	15
7.98		140	2	3	4	6	7	8	9	11	12	13	14	16
7.45	Hx8.5	150	2	3	5	6	7	9	10	11	13	14	15	17

Tank Count

Notes:

> This chart seeks to offer a simplified table for planning how much and what type of diving gas you will need. Make sure to round up to the nearest depth. Always use the least deep gas mix unless seeking a gas-specific effect.

> This chart does not account for increased air consumption from excertion, ascent, descent, and decompression stops.

> To use this chart, first choose the maximum planned depth; this determines your gas mixture options. Then, choose how long you plan to be at that depth. The resulting intersection of depth and time will tell you how many tanks of your determined gas mixture to bring.

> Tank count was calculated using PTD / RDT at depth and then rounding up.

*** Compressed air will cause nitrogen narcosis at 30 m, and lose its oxygen concentration at 60 m. In effect, its maximum operating depth is 30 m.**

Gas Mix Abbreviations:

CA - compressed air
EAN - enriched air nitrox
Hx - heliox
Tx - trimix

Consump. Factor (RDT):

Decimal minutes of remaining dive time for a fresh cylinder at a given depth.

Credits

Original Mod Devs: MadMax / SOCM N. Brody
Original User Manual Author: MadMax
Mod Revive Dev: Excludo
User Manual Rewrite Author: Tsardev
Script Re-write Devs: Tsardev / Mooch
ADE Dive Table Author: Zoms101