



DIVING ASSISTANT

USER GUIDE

Version: 2.1 (EN346)
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Product website: <http://www.scubadivesoftware.com>
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Special thanks !

We would like to thank all the researchers, scientists and divers who make diving as safe as today, and without their work this application could not be created.

Thanks to the contribution of many people, among others Dr Albert A. Bühlmann, Haldane J.S., Workman R.D., Baker E.C., Hamilton R.W., Lambertsen C.J., Arieli R., Butler F.K., Kenyon D.J., Peterson R.E., Harabin A.L., Beers D.M., Shykoff B.E., Bornmann R.C., Wienke B.R., O'Leary T.R., Hyldegaard O., Kerem D., Melamed Y. and many many other prominent people and organizations working for diving i.e. CMAS, DAN, NOAA and many others, the processes occurring during diving are better understood by us. This allowed for many years to improve the rules and principles related to diving, the benefits of which all divers around the world use today.

Piotr Orlewicz



1 IMPORTANT INFORMATION.

1.1 PURPOSE OF THE SOFTWARE.

This Software is intended for assisting in the planning of dives, for analysis of dives performed and for supporting the diving training process.

Using the Software to plan dives requires completion of diving training at one of the recognized diving organizations, such as CMAS, PADI, BSAC, SSI and others..

1.2 WHAT IS NOT THE DIVING ASSISTANT SOFTWARE.

The software can not be the sole or basic tool for planning dives. Before diving, the results of the program must be verified with at least one additional source, such as non-decompression tables or a personal dive computer. In case of any doubts, we recommend contacting your diving organization. The knowledge gained during diving training should have always perior.

1.3 DISCLAIMER.

Use of this software does not guarantee that there will be no risk of DCS or other injuries during the dive. Individual divers have different limits that can not be fully predicted or simulated.

Due to the high risk associated with practicing diving-related sports, the User agrees that it uses the Software at its sole risk. The authors of the Software disclaim all responsibility for the occurrence of diving accidents and their consequences.

Additional information can be found in License Agreement.

1.4 BEFORE USING THE SOFTWARE.

Before using the Software, You must read this documentation and accept the terms of the License Agreement. Current documents are available on the product web page.



2 BASIC INFORMATION.

2.1 SOFTWARE PROPERTIES.

Area	Functionalities
Saturation and decompression algorithms	<ul style="list-style-type: none"> Saturation and decompression calculation algorithms based on ZH-L16 (Albert A. Bühlmann) Deep stops: Pyle, SSA/CMAS, NAUI, GF, Safety stops, Support for isobaric counter-diffusion risk (ICD) <p>Build-in M-Values:</p> <ul style="list-style-type: none"> ZH-L16A (16/17 compartments), ZH-L16B (modified 17 compartments –typical for determining non-decompression tables, ZH-L16C (modified 17 compartments) – typical for dive simulation.
Atmospheric pressure	Adaptive algorithm based on NOAA and ISA formulas.
Gas toxicity	<p>Toxicity of oxygen:</p> <ul style="list-style-type: none"> CNS indicator of oxygen toxicity for the nervous system, UPTD and VC pulmonary oxygen toxicity, gas narcosis: models standard, common and conservative. <p>Partial pressure limits: NOAA, Toxicity limits: NOAA, multi-day tables, Vital capacity: based on work of Harabin and Arieli.</p>
Simulation modes	<p>Calculations:</p> <ul style="list-style-type: none"> conservative, dynamic. <p>Profiles:</p> <ul style="list-style-type: none"> multi-level, altitude diving, multi-gas diving. <p>Sampling:</p> <ul style="list-style-type: none"> every 1 minute (at constant depth), every 0,1m (depth change).
Other limits	Limit of maximum depth, Limit of maximum diving duration.
Supported gases in breathing mixes:	Each blend based on: Oxygen, Nitrogen, Hel. Build-in definitions of typical mixes: Air, Nitrox (30-50%), selected Trimix. Blend editor: any proportions of Oxygen, Nitrogen, Helium.
Environment setup:	Selection of type of water: sfresh and salt, Setup of altitude or atmospheric pressure.
Units of measurement:	Metric SI (bar,m,l,hPa,atm,at,mmHg), Imperial USCS (psi,ft,cf,inHg).

Table 1:Basic properties of the Software



2.2 MINIMUM SYSTEM REQUIREMENTS.

Diving Assistant application requires instalation on PC with Microsoft Windows operating system. The platform must meet the following minimum requirements (table below).

In subsequent versions the requirements may change, so please check the current information on the product page.

Hardware requirements	Minimum	Recommended
Procesor	Intel Pentium (Sandy Bridge) or newest	Intel i5 (at least 2 nd generation)
Operating memory (RAM)	Minimum 2GB	4GB
Free space on hard disk	Minimum 50GB	100GB
Graphics adapter	HD resolution graphics adapter (1920x1080), 24 th. colors	HD graphics adapter, 32th. of colors
Network adapter	Any network card with connection to the public Internet network	Network adapter 100/1000MB with connection to the public Internet
System requirements	Minimum	Recommended
Operating system	Windows 7 SP1, Windows 8.1, Windows 10 Home	Microsoft Windows 10 Pro
.NET platform	Microsoft .NET 4.5 lub wyższy	Microsoft .NET 4.7.1
Common runtime environment	CLR 4.0 or highest	CLR 4.0
Visual Studio redistribution package	15.0	15.6 (included in setup program)

Table 2: System minimum requirements



3 USER INTERFACE.

Currently, the application is available only on Microsoft Windows. The user interface is based on standard windows.

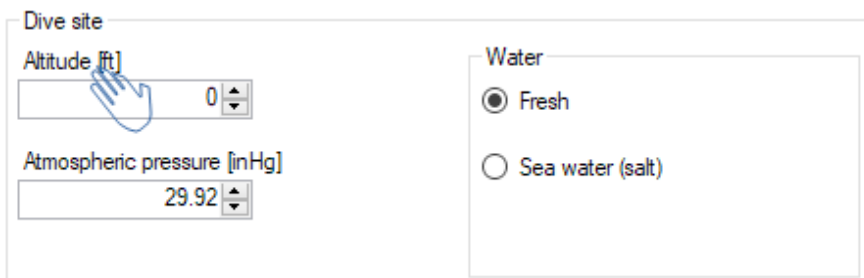
Control is via mouse and keyboard. The application can work with the use of touch screens, but it was not optimized for them.

Quick functions are placed in the menu at the top of the application, while the basic functional modules are located across the tabs.

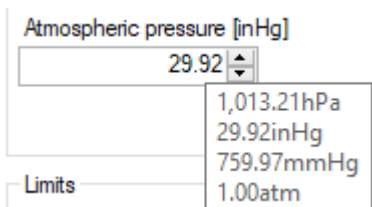
3.1 MEASUREMENTS UNITS.

This application allows the use of both metric and imperial units (SI, USCS). During calculations, units are automatically converted to basic values, which may cause insignificant rounding errors.

Displayed units can be switched by pressing the mouse button on the field label or column heading. If a given control allows you to change units, then the mouse cursor should change (hand) on the label of this field.



In addition, when you hover over the control, values in different units will appear in the tool-tips.





In the user plan, values can be entered with units. After entering the value, it will be automatically converted into a unit appropriate for the given column.

User dive plan						
		Action Type	Cylinder	Depth [ft]	Time [min]	Description
		Diving		30.00ft	10min	
		Diving		15 m	0min	
		Diving		0.00ft	0min	

Parameter	Supported viewing units	Units recognized during input
Altitude	m ft	m ft
Atmospheric pressure	hPa mmHg inHg atm	hPa mmHg inHg
Depth	m ft	m cm mm ft in "
Duration	min sec	day d hr h min sec s ms μs ' "
Gas pressure, hydrostatic pressure	bar psi	
Volume	l	
Capacity	cf	

Table 3: Displayed and recognized units of measurement

Symbol	Name	Description
m	meter	Unit of length, also used to determine altitude and depth.
ft	feet	Unit of length, altitude and depth, 1m ≈ 3.2808ft.
in	inch	Unit of length 1in = 1/12ft = 2,54cm
l	liter	Unit of water volume and gas capacity, 1l = 1dm ³ .
cf, cuft	Cubic foot	Unit of volume and capacity used in imperial system 1cf ≈ 28.32l.
bar	bar	Unit of pressure. 1bar is equivalent to Standard Atmospheric Pressure and approximately the pressure exerted by 10m of water.
psi	pound per square inch	Unit of pressure in imperial system, 1psi ≈ 0,0689bar.
Pa	pascal	Unit of pressure in SI, 1hPa = 1mbar = 100Pa.
mmHg	millimeters of mercury	Pressure unit, commonly used in meteorology. These units are also used in medicine and physiology, for example in the description of the oxygen transport process in hemoglobin. The pressure is given under conditions of 0°C. 1mmHg ≈ 133.32Pa.
inHg	inch of mercury	Atmospheric pressure unit in the imperial system, based on mercury density at 0°C 32°F. Note, that in the past mercury density at 60 ° F was used. 1inHg ≈ 3386.39Pa.
msw	meter of salt water	A pressure unit defined as the pressure exerted by sea water at a given depth, 1msw = 0.1bar.

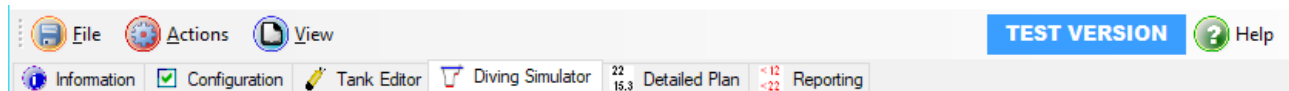


Symbol	Name	Description
fsw	foot of salt water	A unit of external pressure determined by the pressure exerted by sea water at a given depth, 1fsw ≈ 0.3064msw.
at	technical atmosphere	Unit of pressure, 1at ≈ 980.66hPa.
atm	Physical atmosphere	Unit of pressure, 1atm is equivalent to standard pressure at sea level, 1atm = 1013.25hPa.
min, sec	minute, second	Duration unit.
UPTD	unit pulmonary toxicity dose	Arbitrary units used to determine the dose of pulmonary oxygen toxicity.
K	Kelvin	Absolute temperature SI
°C	Celsius degree	Commonly used thermometric scale, 0°C = 273,15K
°F	Fahrenheit degree	Imperial unit of temperature scale, 32°F = 0°C, 212°F = 100°C
°R	Skala Rankine'a	Imperial thermometric scale, equivalent to Kelvin in SI, 0°F = 459,67°R

Table 4: Popular units of measure used in diving

3.2 PROGRAM MENU.

The program menu contains utility functions and quick access to the most popular program functions.



3.2.1 MENU FILE.

- Save plan.**
 Saves the current dive plan to a file in XML format. This file can be used to analyze data in other systems that support XML.
- Save chart.**
 Allows to save the graph of the dive profile to a file in one of the popular formats (BMP, JPG, PNG, GIF and TIF). The graph is saved in a different resolution than on the screen (1280x768).
- Save M-Values.**
 Saves the so-called M-Values to a file in XML format.
- Save cylinders.**
 Saves the currently defined tank sets to XML. Several different sets can be defined, which can be loaded as needed.
- Load cylinders.**
 Loads previous saved tank sets into the system. New cylinders are added to the current setup in the program. No tanks will be deleted.
- Print.**
 Sends diving plan report to the printer. This option is not always available.



- **Print preview.**
Allows to check how the printout of the dive plan report will look like. The option is not always available.
- **Licence → Reset.**
Forces the reset of current license data and attempts program to download it again. The option requires restarting the application.
- **Licencja → Unregister.**
Permanently deletes the current license. In order to continue using the certain copy, you will need to re-register application.
- **Exit.**
Close the application.

3.2.2 ACTION MENU.

- **Verify.**
Verifies and if possible corrects the user's plan.
- **Recalculate.**
It starts the simulation and generates a new dive profile based on the user's plan, including stops and threat analysis.

3.2.3 MENU VIEW.

- **Tabs view.**
It allows to hide some of the functional tabs of the application.
- **Simulation tab.**
The items in this menu allow to change the orientation of the panels on the planning tab and to hide the selection of the tank set.
- **Tool-tips.**
Allows to show or hide tool-tips..
- **Advanced charts.**
Opens the window of the advanced graph module.
- **Documentation.**
Open documentation windows.

3.2.4 MENU HELP.

- **User guide.**
Display user guide.
- **Release information.**
Displays a document with a history of changes and information about the release of the Software.

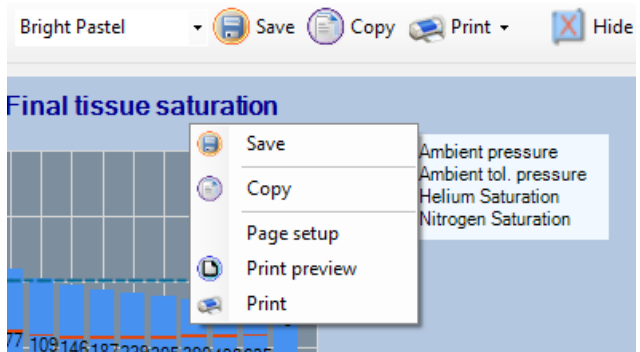


- **License.**
Displays the License Agreement. Please note that the current license is always available on the product web page.
- **About.**
Displays the version of the application and all components of the Software, the version of the operating system and .NET platform.

3.3 COPYING AND SAVING CONTENT.

The contents of report, tables and advanced charts can be copied to the clipboard for use in other programs (eg Word, Excel, Calc). To do this, select the cells to copy and use the copy icon or the context menu (right mouse button).

Action	Depth [m/ft]	Expo T [d/h:m]
Begin	0.0m	
Surface	0.0m	



The contents of the tables (User Plan, Dive Plan, Detail Data) are copied to the clipboard in the following formats:

- **CSV (Comma-Separated Values)**
Text, values separated by commas, 8-bit international coding.
- **Unicode Text**
Text format, values separated by tabs, 16-bit international coding, saving in UTF-8 encoding.
- **DIF (Data Interchange Format)**
A universal data exchange format designed by Software Arts. To support international characters, the program may use local character encoding. The used decimal separator will be compatible with the local computer settings.
- **HTML**
The data is copied and saved as the HTML table. Uses UTF-8 character encoding. The format is suitable for transferring data between different spreadsheets as well as for viewing data (i.e. in a web browser).
- **Excel XML**
Data is converted into the open Excel XML format. It is an ideal format for transferring data to Microsoft Office.

Advanced charts can also be copied to the clipboard and saved in the following graphic formats:



- **EMF (Enhanced Metafile)**
Vector graphic format, supported by many graphic editors and office suites. Stores the graph image without losing quality regardless of scaling.
- **BMP (Bitmap)**
Raster graphics format.

oraz dodatkowo zapisywane w formatach:

- **JPG (Joint Photographic Experts Group)**
The format gives a small file size, but with a slightly lower quality.
- **GIF (Graphics Interchange Format)**
Lossless recording format, however with a low color palette.
- **PNG (Portable Network Graphics)**
A popular raster format that uses lossless compression.
- **TIF (Tagged Image File Format)**
A graphic format that stores extended information about channels and a color profile.

The simulation report can be saved and copied in all formats available for tables (simulation data) and additionally as:

- **XPS (XML Paper Specification)**
The format for storing and viewing documents available in Microsoft Windows systems starting from the version of Windows Vista. In general, no external applications are required to open it, and the appearance of the document should be identical to that of the physical printout.

In addition diving report can be copied into clipboard in:

- **RTF (Rich Text Format)**
Popular text document format.

Depending on the scope and nature of the data, not all formats may be available. With some regional settings, special and international characters may be lost.

Some formatting may be lost when saving and copying. To ensure the best compatibility, text documents should have left and right margins of no more than 1 cm.

3.4 DIAGNOSTICS.

The program provides additional diagnostic data. They contain much more data and can therefore be displayed only for a specific item in the detailed plan. They contain, among others, the data of the saturation of individual tissues, physical and physiological properties of gases, current diving parameters.



Diving Assistant 2.1 LionFish - User guide

Descent	14.5m	0:00.400	20:58.400	2.0119bar	2.4395bar	0.0m	8.2m	01:17
Des	Diagnostics:							
Des	Descent: Depth=14.74m PGas=2.46bar T=00:21:59.2000000 Te=0.40sec LastDepth=14.74m DiveDepth=14.74m PrevDiveDepth=--							
Des	Air: MOD=56.0m M=1.29g/l TC=0.026W/m*K NI=0.79 EI=0.706 - Powietrze							
Des	21% Oxygen (O2): A=32 Z=16 Ze=8 M=1.429g/l kW=0.023ml/cm3 kO=0.112ml/cm3							
Des	79% Nitrogen (N2): A=28 Z=14 Ze=7 M=1.251g/l kW=0.013ml/cm3 kO=0.067ml/cm3							
Des	Deco=0m DecoGF=0m Deep=Buhlmann/8.2296m/60sec Safe=2.7432m/180sec Pabmtol=0.563bar PambtolGF=0.563bar Ceiling=0.00m CeilingGF=0.00m							
Des	PO2=0.516bar MaxPO2=0.516bar MOD=67.36m OTU=0 CNS=0.00							
Des	CompSet[34]: Pambtol=0.563 TargetGF=1.000 PambtolGF=0.563							
Divit	Compartment-01: Nitrogen ht=240.00sec a=1.260bar b=0.5050 Pbeg=1.503bar Pgas=1.943bar Te=0.40sec Pcomp=1.503bar Pamb=0.123bar GF=24.15% Pambgf=0.123bar							
Divit	Compartment-02: Nitrogen ht=480.00sec a=1.000bar b=0.6514 Pbeg=1.398bar Pgas=1.943bar Te=0.40sec Pcomp=1.398bar Pamb=0.259bar GF=32.36% Pambgf=0.259bar							
Divit	Compartment-03: Nitrogen ht=750.00sec a=0.862bar b=0.7222 Pbeg=1.288bar Pgas=1.943bar Te=0.40sec Pcomp=1.288bar Pamb=0.308bar GF=40.03% Pambgf=0.308bar							
Divit	Compartment-04: Nitrogen ht=1,110.00sec a=0.756bar b=0.7725 Pbeg=1.185bar Pgas=1.943bar Te=0.40sec Pcomp=1.186bar Pamb=0.332bar GF=47.00% Pambgf=0.332bar							
Divit	Compartment-05: Nitrogen ht=1,620.00sec a=0.620bar b=0.8125 Pbeg=1.094bar Pgas=1.943bar Te=0.40sec Pcomp=1.094bar Pamb=0.385bar GF=54.47% Pambgf=0.385bar							
Divit	Compartment-06: Nitrogen ht=2,298.00sec a=0.504bar b=0.8434 Pbeg=1.023bar Pgas=1.943bar Te=0.40sec Pcomp=1.023bar Pamb=0.438bar GF=61.10% Pambgf=0.438bar							
Divit	Compartment-07: Nitrogen ht=3,258.00sec a=0.441bar b=0.8693 Pbeg=0.966bar Pgas=1.943bar Te=0.40sec Pcomp=0.966bar Pamb=0.456bar GF=65.72% Pambgf=0.456bar							

There are two ways to view additional information:

- by selecting a row in the detailed data table and hover the mouse on the first column; after about a second, a tool-tip with diagnostic information will be displayed,
- by pressing the right mouse button on any cell in the detailed data table; in contrast to the first method, the diagnostic window will not hide automatically, but only when you press the mouse button again.



4 MAIN FUNCTIONALITIES.

4.1 CONFIGURATION TAB.

4.1.1 DIVING SITE.

- **Altitude.**

The program allows simulation of altitude dives. Please note that altitude diving is very difficult and involves additional risks. They require special training.

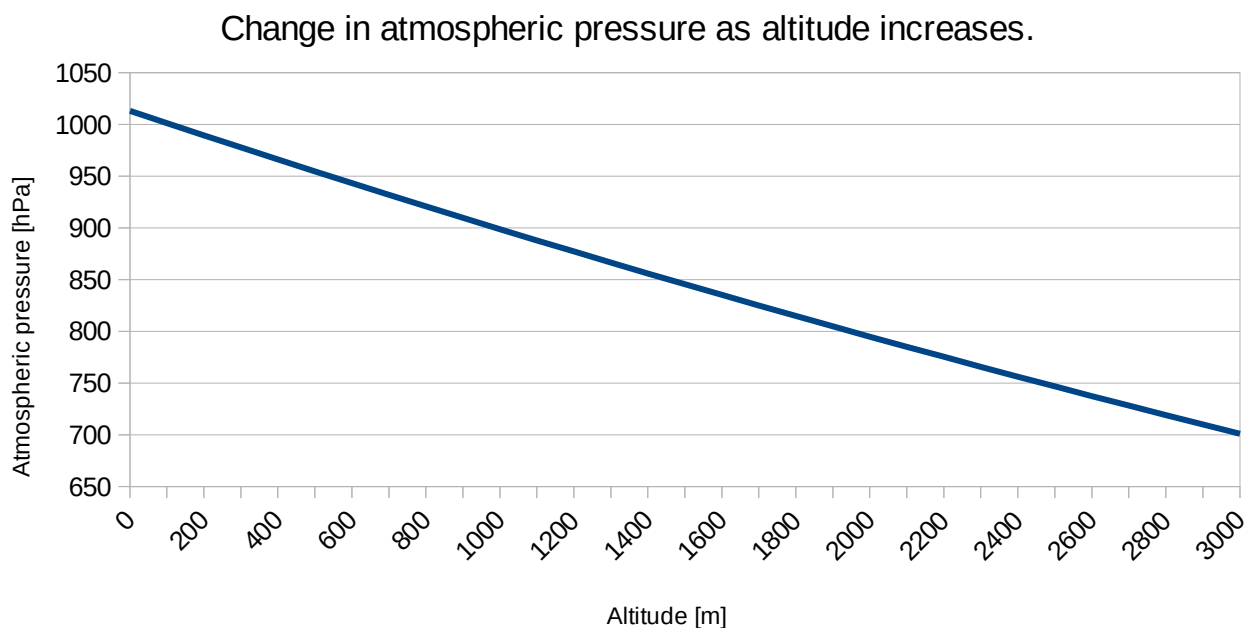
This option is only available for fresh water. The range of acceptable values is from 0 to 3000m / 9842ft.

The change in altitude affects tissue saturation levels and decompression stops. A special adaptive algorithm also adjusts the depth of the safety stop.

The atmospheric pressure is automatically calculated with the change in altitude.

- **Atmospheric pressure.**

This is an alternative method of setting for altitude dives. Knowing the current atmospheric pressure, you can perform a more accurate simulation of the dive. The range of acceptable values is from 0 to about 701hPa / 526mmHg / 20.71inHg. The reduction in pressure when the altitude increases is close to linear. However, the program performs more accurate calculations using a special algorithm based on the formulas of ISA and NOAA.



Graph 1: Change in atmospheric pressure with change of altitude

- **Water type.**

There are two possible options: fresh and sea water. It was assumed that in the case of salt water



simulation should take into account diving in the sea or ocean, therefore in the case of this option, altitude diving is turned off and the depth of safety stops is increased due to highest waving.

4.1.2 LIMITS.

- **Depth limit.**

Limits the maximum depth of the dive. The limit should be set according to your diving certificate. In general, basic training allows diving to a depth of 18m / 60ft or 20m / 65ft, while advanced divers can dive to a depth of 30m / 100ft or 40m / 130ft.

Diving above these depths is considered technical and requires special training and professional diving equipment.

- **Maximum dive time.**

The maximum dive time should be set to the value that corresponds to your experience, the depth of the dive and the type of used equipment. For most dives, the 1h limit will be appropriate.

- **Maximum END.**

Maximum depth of diving on the air, at which the symptoms of nitrogen narcosis should not occur. This value will be taken into account when diving on different gas blends. For most divers, 30m / 100ft or 40m / 130ft are appropriate.

- **Diving day.**

In the case of a series of subsequent dives, enter the number of the dive day. This value influences the setting of the maximum oxygen dose safe for our pulmonary system. NOAA recommendations are used.

- **Limit of CNS.**

The limit of oxygen dose safe for our central nervous system. The limit is especially important for dives on enriched air nitrox and deep diving. *It is not recommended to set this value to 100%, because it can be an additional threat in the event of a rescue operation.* We recommend setting the value to around 80%.

- **Minimum pressure of gas in the cylinder.**

Specifies the value of the reserve of the breathing gas in the cylinders. Depending on the type of diving and equipment, the value can be set to 1/4 or 1/3 of the capacity or set the reserve pressure. *Please note that this option may cause difficulties when diving with a gas change.*



4.1.3 SIMULATION SETUP.

This section allows to select the appropriate algorithms that will be used during simulation and the generation of a diving profile.

- **Decompression → Calculation mode.**

Allows to setup the mode of diving profile generation.

In the conservative mode, immersion and ascent curves are not taken into account and the bottom time is extended accordingly, which makes the plan more conservative. It is suitable for novice divers, because partially mitigates so called "the yoyo effect".

In the dynamic mode, the descent and ascent rates are taken into account. The generated plan is more accurate.

- **Decompression → Variant.**

It allows you to choose one of the so-called variants of M-values. Variant A is the most aggressive, while option C generates the most conservative profiles. *For the simulation of normal dives, it is recommended to set the C variant.* Variants A and B can be used during training and developing own non-decompression tables.

- **Deep stops.**

In order to increase the margin of safety, the program allows to enter additional deep stops. The use of the stops flattens the dive profile, which reduces the risk of DCS, but makes the bottom time a bit longer. Regardless of the algorithm, tissue saturation is always checked before each stop. If they are not saturated enough, the stop will be omitted to do not cause the opposite effect.

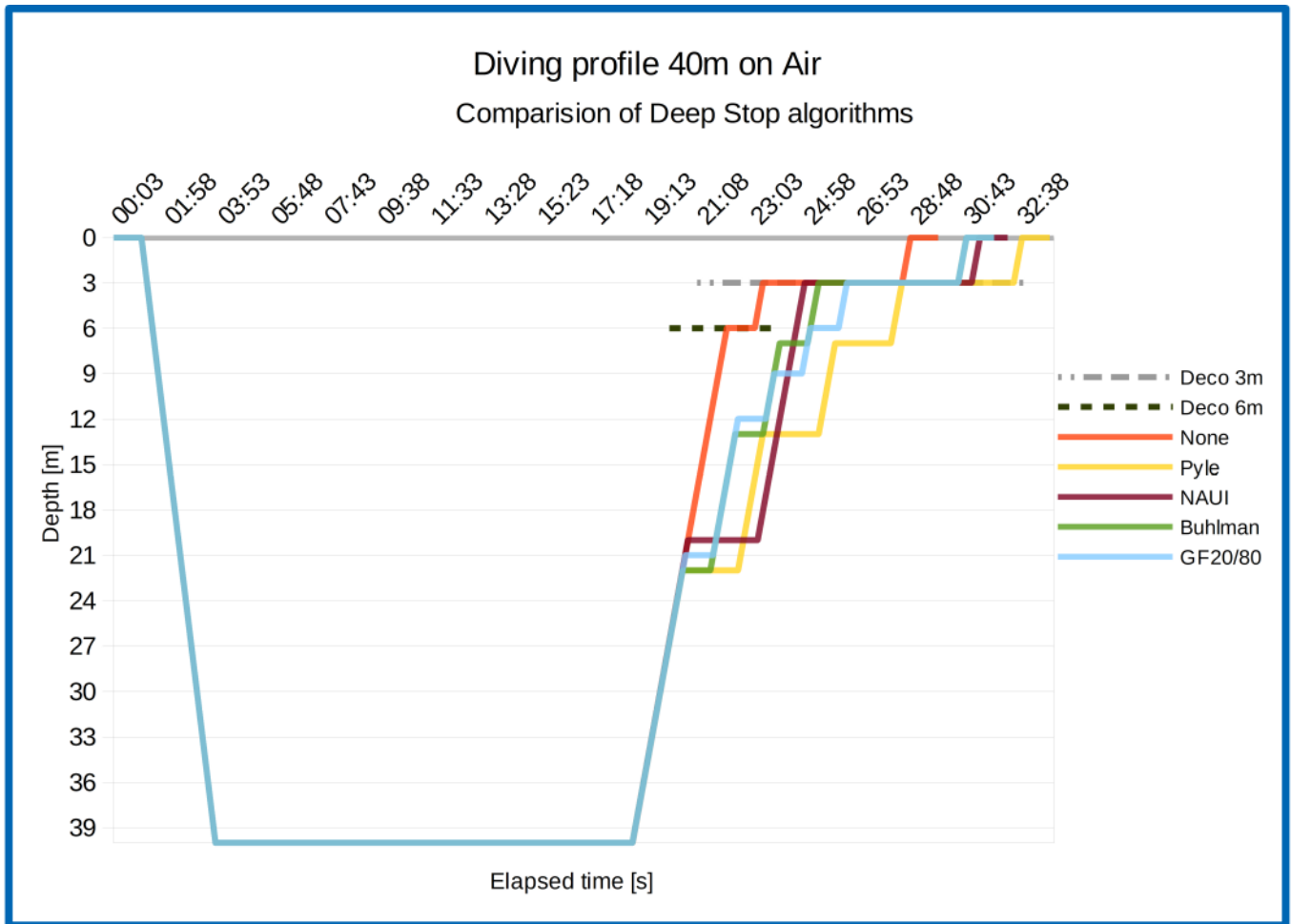
There are four available algorithms:

Pyle – the simplest algorithm developed by the creator of deep stops Dr. Richard Pyle,

SSA/CMAS (Buhlman) – similar to Pyle stops, but based on total pressure rather than depth, which allows better depth adjustment,

NAUI – deep stops according to the recommendations of the NAUI organization, introduces one additional stop to the profile, which is properly taken into account in the calculation of the safety stop,

GF – additional stops based on the so-called gradient, developed by Erik C. Baker; for this method, you must also set the minimum and maximum percentage of the gradient.



Graph 2: Diving profiles on air up to 40m for different deep stop algorithms

- **Air consumption.**

Determines the individual rate for air consumption on the surface. On this basis, the program simulates consumption of the of breathing gas used underwater. The correct value is determined experimentally during a normal dive. Beginner divers should specify this value for not less than 20l / min. Some advanced divers can reduce the demand to about 15l / min.

The section also allows you to enable the automatic switching to the atmosphere and the filling of cylinder sets between dives.
- **Gas narcosis.**

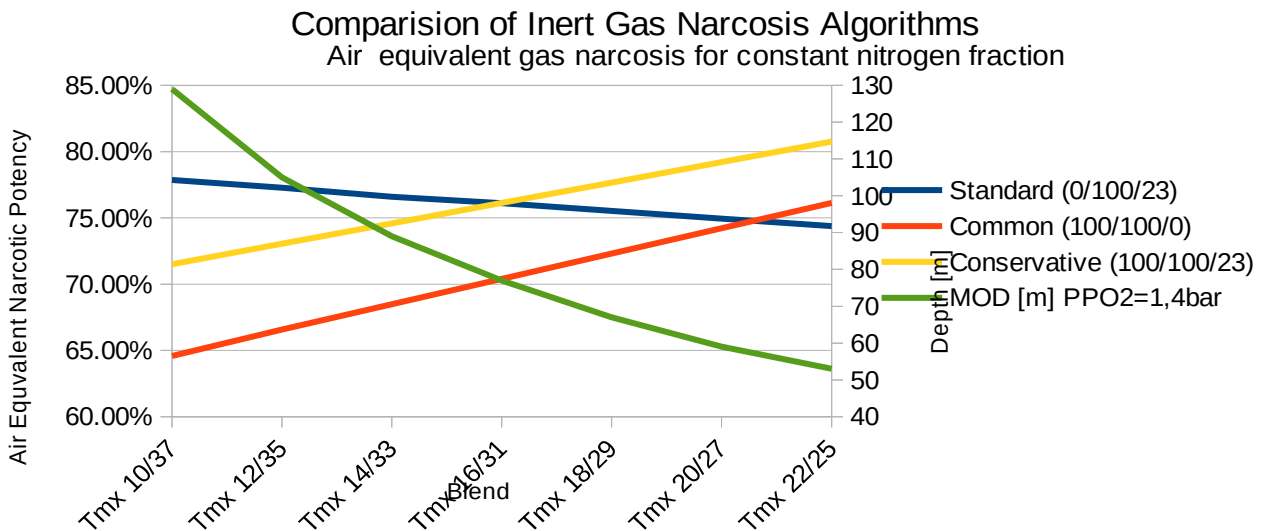
The program allows to choose one of the available algorithms for calculating the relative narcosis of diving gases. We have three options to choose from:

 - Standard** - assumes that the effect of narcosis is caused only by inert gases, to determine the relative potentials of narcosis, the Meyer-Overton formula is used, according to which helium is more than 4x less narcotic than nitrogen. For most cases, this algorithm generates the most conservative results, but it should be noted that it does not include oxygen.
 - Common** - this is the most popular method of calculating the narcoticity of gases, assumes that oxygen has the same potential and nitrogen, and helium after taking into account the inverse effect associated with high pressures, has a negligible effect on the increase of the narcotic effect.

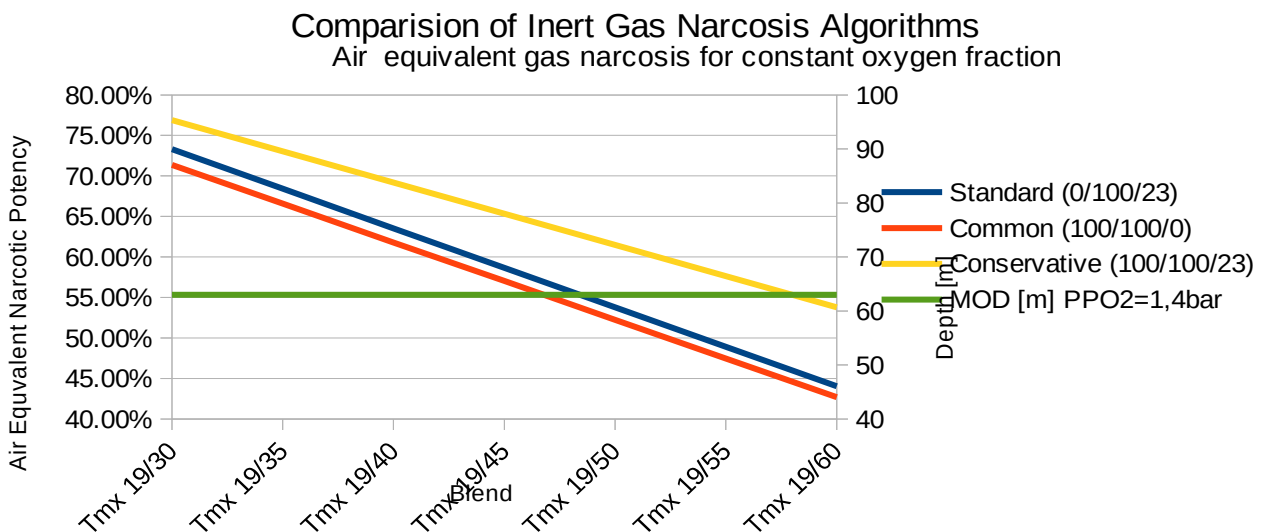


Conservative -based on the Meyer-Overton correlation and assumes that the narcoticity of oxygen and nitrogen is identical. *Note, the name of the algorithm indicates a conservative approach to potentials, however, it can be misleading to the result of relative narcoticity.*

For reasons of safety, we recommend using an algorithm that generates the most conservative results for a given dive.



Graph 3: Comparison of algorithms for determining the narcoticity of gases at a constant nitrogen fraction



Graph 4: Comparison of algorithms for determination of gas narcosis potency at a constant oxygen fraction



4.2 TANK EDITOR TAB.

The module is used to configure diving cylinder and breathing gas sets. You can create several sets that will then be switched during the simulation of the dive profile.

The left panels (Blend configuration, Cylinder configuration) are used to determine the parameters for the newly added sets. The right panel contains a list of already defined sets and allows you to manipulate them.

The list of defined sets is automatically saved in the configuration after the program has been properly completed.

4.2.1 BLEND CONFIGURATION.

Blend configuration

% O2 % N2 % He

% Oxygen: 14

% Nitrogen: 53

% Helium: 33

MOD [m]: 88.97m MOD [ft]: 291.90ft

ENP [fN2]: 0.7459 ENP [%]: 75%

Description: Hypoxic Trimix (Heliar) 14/33 TMx1433

Standard blends: Trimix 14/44

Program allows to define any gas blends based on Oxygen, Nitrogen and Helium. The percentage of the fraction of individual gases in the blend is set using convenient sliders or numeric controls. The program makes sure that the sum always gives 100%, in such a way that:

- the change of the oxygen fraction is first filled up with nitrogen and then with helium,
- the change of nitrogen is first filled up with helium, and then with oxygen,
- the change of fraction of helium is first leveled with nitrogen, and then with oxygen.

There are also available several build-in gas blends:

- air,
- nitrox 32,
- nitrox 36,
- nitrox 40,
- nitrox 50,
- oxygen,




- trimix 14/44,
- trimix 14/60,
- trimix 19/40,
- trimix 21/20.
- trimix 21/33.

For given gas blends, the basic parameters are displayed, such as gas properties, narcosis potency or maximum operating depth and description.

4.2.2 CYLINDER CONFIGURATION.

Cylinder configuration



Initial pressure [bar]

Volume [l]

Capacity [cf]

Configuration type

Single

Twin

Stage

Typical cylinders

Similarly as for gas, the application allows to define different cylinder configurations. It is necessary to set the working pressure of the cylinder, the volume of water in liters (for the European system) or the capacity in cubic feet (American system). In addition, you should choose whether the set is single or twin, or optionally that it is stage often used for technical dives or as additional protection. It is also possible to choose one of the predefined sets:

- single cylinder, working pressure 200bar, volume 12, 15 or 18l,
- single cylinder, working pressure 3000psi (~207bar), capacity 80cf (~11l), 100cf (~14l) i 120cf (~17l),
- twin, 200bar, water volume 2x8.5, 2x12 and 2x15l,
- twin, working pressure 3000psi, capacity 2x80cf (~22l),
- surface hose (air from cylinder sets on surface or directly from compressor).



4.2.3 LIST OF DEFINED SETS.

Defined cylinder set

Buttons: Add, Delete, Default, Save, Load

Cylinder set

- Air
 - [12l/84cf 200bar/2901psi, Powietrze]
 - 15l 200bar, Powietrze
- Nitrox
 - #Deco 321 2l 200bar/2901psi, Nitrox 32
 - #Deco 6l EAN40, Nitrox 40
- Oxygen
- Trimix
 - Tmx2120 15l 200bar, Nomoksyczny Trimix 21/20
 - Tmx 14/33 15l 200bar, Hipoksyczny Trimix (Heliar) 14/33
- Other

Gas composition and settings:

O2	21%	MOD	56m/184ft
N2	79%		
He	0%	Narcotic index	1.00 (100.00%)
Bld	Air		
Cyl	15l/105cf 200bar/2901psi		

Right panel contains list of defined diving cylinder sets. Tanks are organized into group by the type of gas:

- air,
- enriched air (Nitrox),
- oxygen,
- helium blends (trimix),
- others.

The buttons at the top bar are used to:

- **Add** - adding set defined in the left panels to the list,
- **Delete** - permanently deletes the selected set from the list,
- **Default** - mark the selected tank set as the default; it will be marked by the bold font in the name and additionally with square brackets,



- **Save** – store list of defined cylinder sets into XML file,
- **Load** – loads previously saved cylinder sets from XML file and adds to the current list.

One default cylinder set should always appear on the list. It will be used when simulating a dive profile if no other tank is selected. The default set can not be deleted or renamed.

For easier selection of sets, the program allows to give them your own names. To do this, first select the set with the mouse and then press the left mouse button again. The name on the item will go into the edit mode. To make it easier to find a specific set when entering a dive plan, it is best to mark them with symbols or numbers at the beginning of the name.





4.3 DIVING PROFILE SIMULATION.

The module is responsible for simulating dive profiles. It is divided into three main parts: user's plan, result plan and profile chart.

In addition, in the upper part there is a toolbar that allows to perform basic activities.



- **Validate** – starts checking the user's plan and if possible, make automatic correction,
- **Recalculate** – checks the user's plan and starts the calculation of the dive profile,
- **Clear** – clear user's plan,
- **Advanced charts** – opens advanced charts module window,
- **Save** – saves selected cells into file in one of available format,
- **Copy** – copies selected cells into clipboard.

4.3.1 INPUT DATA.

The system simulates diving based on input data. It is enough to enter just basic information, such as the expected time at a given depth, and optionally select a set of diving cylinders with the appropriate gas and enter a comment.

Both the depth and time field takes data in different units and automatically converts them into basic units.

If you make a mistake, you can edit the data or delete the selected row with the button [DEL] . After completing the input data, you may verify the plan (*Validate*) or immediate start profile recalculation.

User dive plan

		Action Type	Cylinder	Depth [ft]	Time [min]	Description
		Begin		0.00ft	1min	
		Diving	12/84cf	60.00ft	25min	immersion to wreck
		Ascent		18.00ft		
		Diving	#Deco 6l EAN40,	18.00ft	3min	accelerated deco
		End		0.00ft	1min	
*				0	0	



In the case of more complex plans, you can also select the appropriate actions, which allows you to plan for example, two dives on one profile. The following actions are available:

- **Begin** - means start the simulation, it always occurs at the beginning of the plan,
- **Descent** - means immersion to a certain depth, immersion time will be selected automatically during simulation,
- **Diving** - diving at constant depth,
- **Ascent** - means ascent to a certain depth, time will be calculated automatically,
- **Surface** - means ascending to the surface, in this step you can specify the time for the next dive,
- **End** - the end of the simulation, always occurs at the end of the plan.

4.3.2 RESULT PLAN OF THE SIMULATION.

After recalculating the input data, the resulting dive plan is generated. It is available in the panel *Result plan*. It contains basic data (the runtime).

		Action	Depth [m/ft]	Duration [h:mm:ss]	Tank pressure [bar/psi]	PPO2 [bar/psi]	END [m/ft]	CNS [%]	OTU
01:00		Descent	60.00ft	01:13	2,833psi	8.55psi	60ft	0.03	
02:13		Diving	60.00ft	25:00	798psi	8.55psi	60ft	3.35	
27:13		Ascent	23.91ft	01:06	725psi	5.26psi	24ft	3.40	
28:19		Ascent	19.00ft	00:11	716psi	4.72psi	19ft	3.40	

Pressure of blend in tank is at dengerouse level, P = 50bar/725psi, V = 592l/21cf

The result plan contains following information:

- **Time** - beginning time for this action,
- **Action** - the type of action, apart from those available in the user's plan, may appear additional values, such as decompression, deep and safety stops or change of the cylinder set,
- **Duration** - duration of given step,
- **Gas pressure** - the gas pressure in the cylinder at the end of the step,
- **PPO2** - partial pressure of oxygen in the gas blend at the end of a given step,
- **END** - equivalent narcotic depth according to the chosen algorithm,
- **CNS** - the total percentage of the used exposure of oxygen to the nervous system,
- **OTU** - the total amount of oxygen units for the pulmonary system,

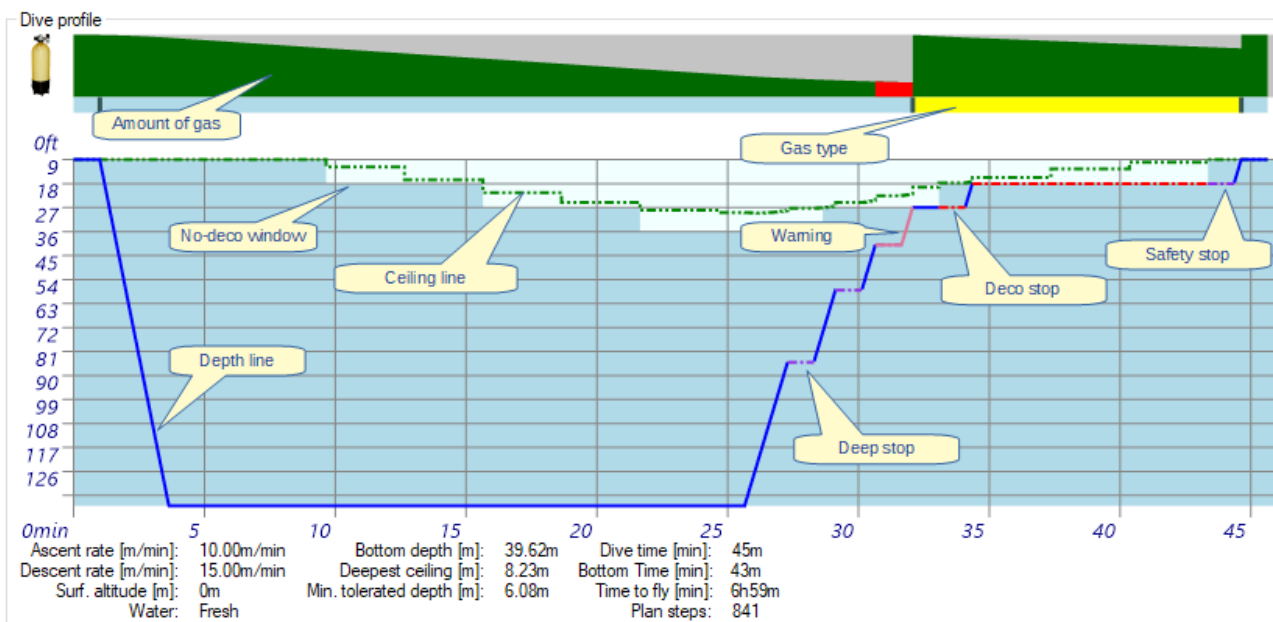


- **VCD** – percentage reduction in the vital lung capacity, *values above 4% are considered irreversible*,
- **Tank** – selected cylinder set,
- **Remarks** – the comment from the input plan, supplemented with potential warnings; in the case of threats, in individual columns red warning icons may appear.

In selected columns, it is possible to switch the displayed measurement units.

4.3.3 DIVING PROFILE.

In addition to the tabular form, the generated dive profile is also presented graphically. It allows you to better understand the simulation and provides several additional information, such as a decompression window and a minimum safe depth.



In the bottom part additional diving parameters are presented.

- Ascent speed,
- Descent speed,
- Altitude of the diving site,
- Water type,
- Bottom depth,
- first decompression stop,
- Minimum safe depth (ceiling),
- Total time of diving plan,
- Bottom time,

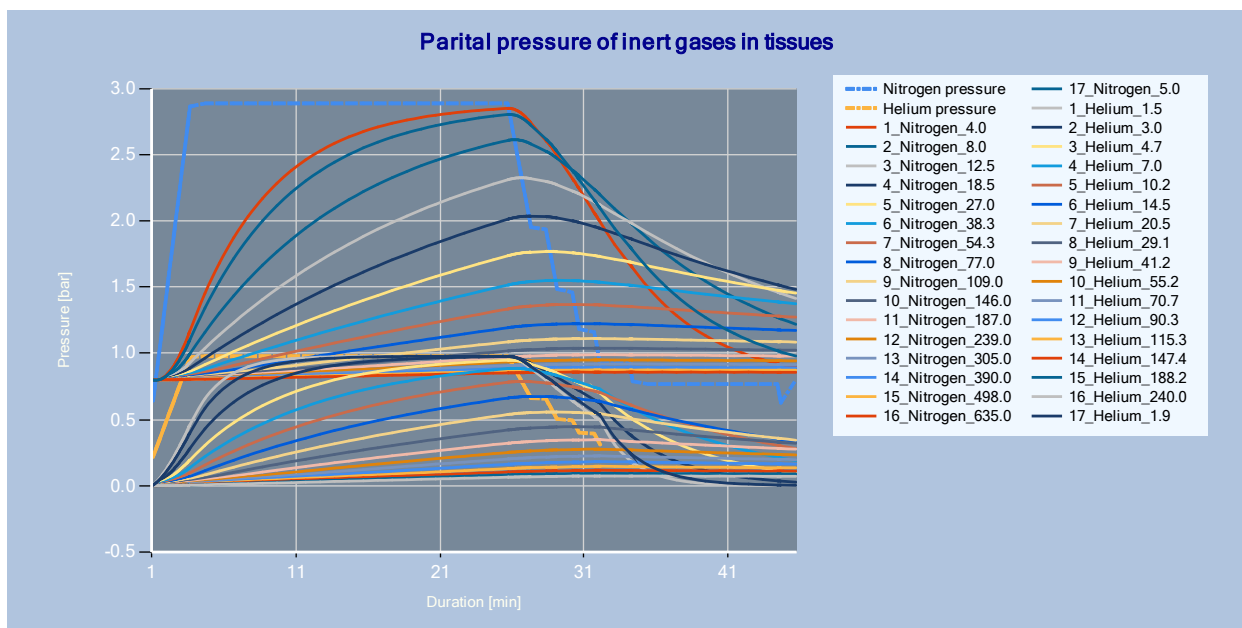


- Minimum time to fly, **please note that it is recommended to use 12 or 24 hour times, in accordance with the current recommendations of diving organizations,**
- Number of samples - number of simulated diving profile samples, they are available on the detailed plan tab.

4.3.4 ADVANCED CHARTS.

In addition to basic dive profile graph it is also available as a set of advanced charts. They are available from the toolbar described at the beginning of the chapter (page 24).

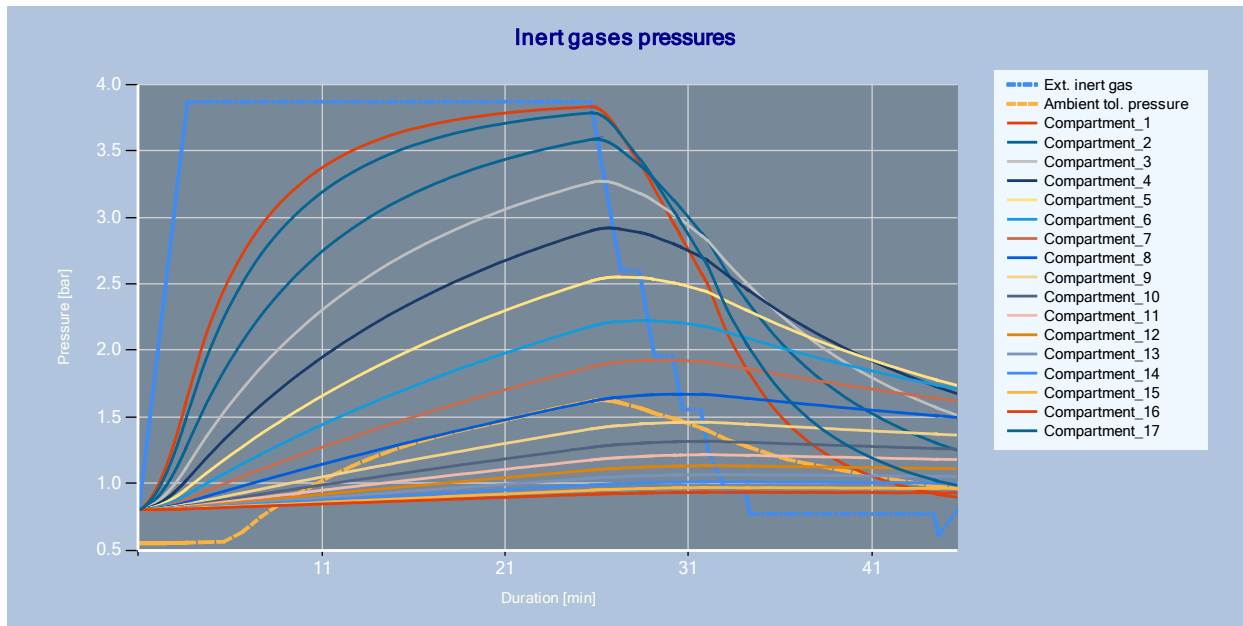
- **Inert gas partial pressures in tissues** - It shows the change in pressure over time for each gas component for each tissue separately.



Graph 5: Sample advanced plot of variation of the partial pressures of the inert gases in the tissues during the dive

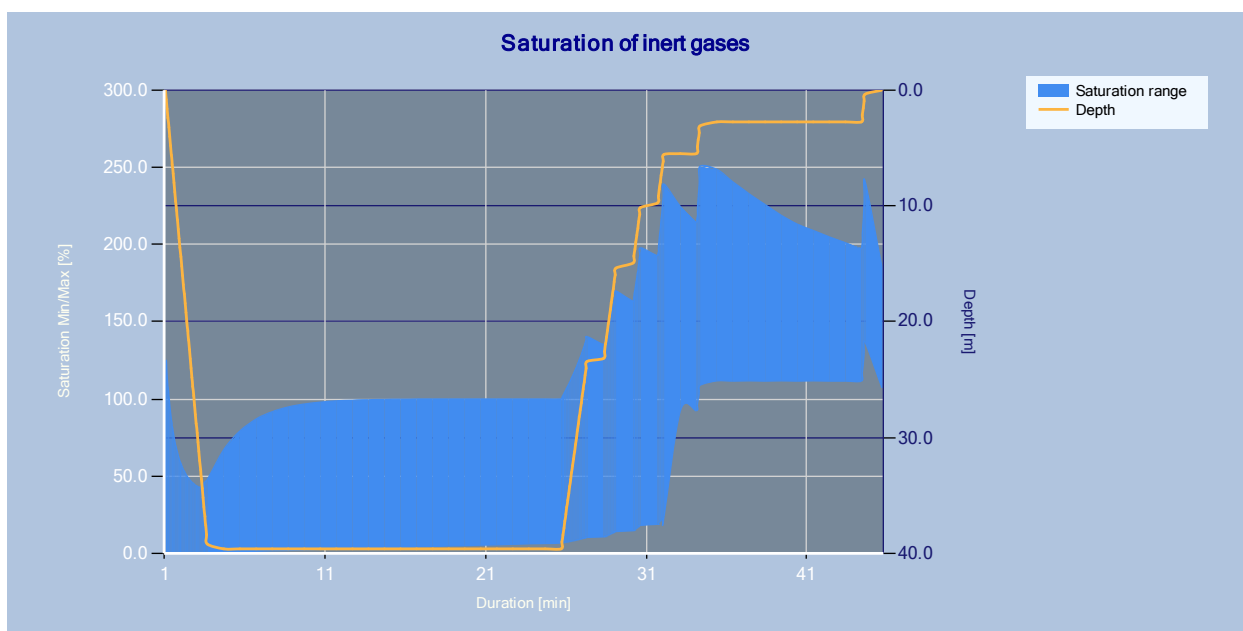


- **Inert gas pressures** – graph of change in the total pressure of inert gases for individual tissues,



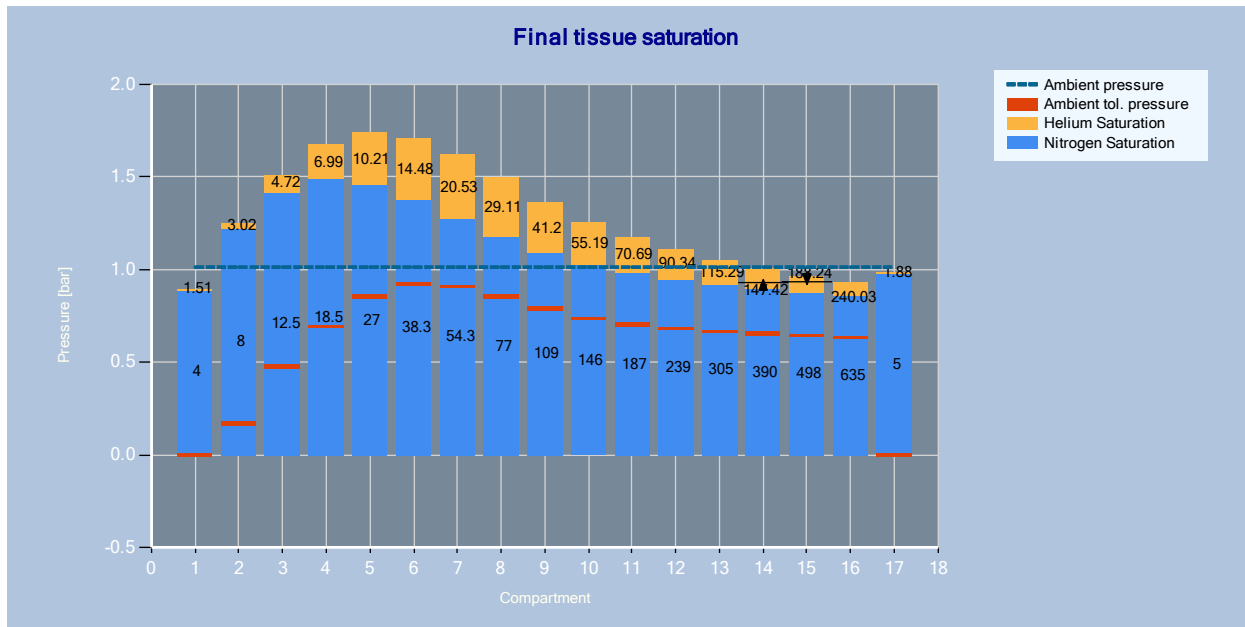
Graph 6: An example chart of the change in the total pressures of inert gases in the tissues during the dive

- **Inert gas saturation** – visualization of the saturation gas saturation in percent in the diver's body during the entire dive, shown as a range of the values from the least to the most saturated tissue,



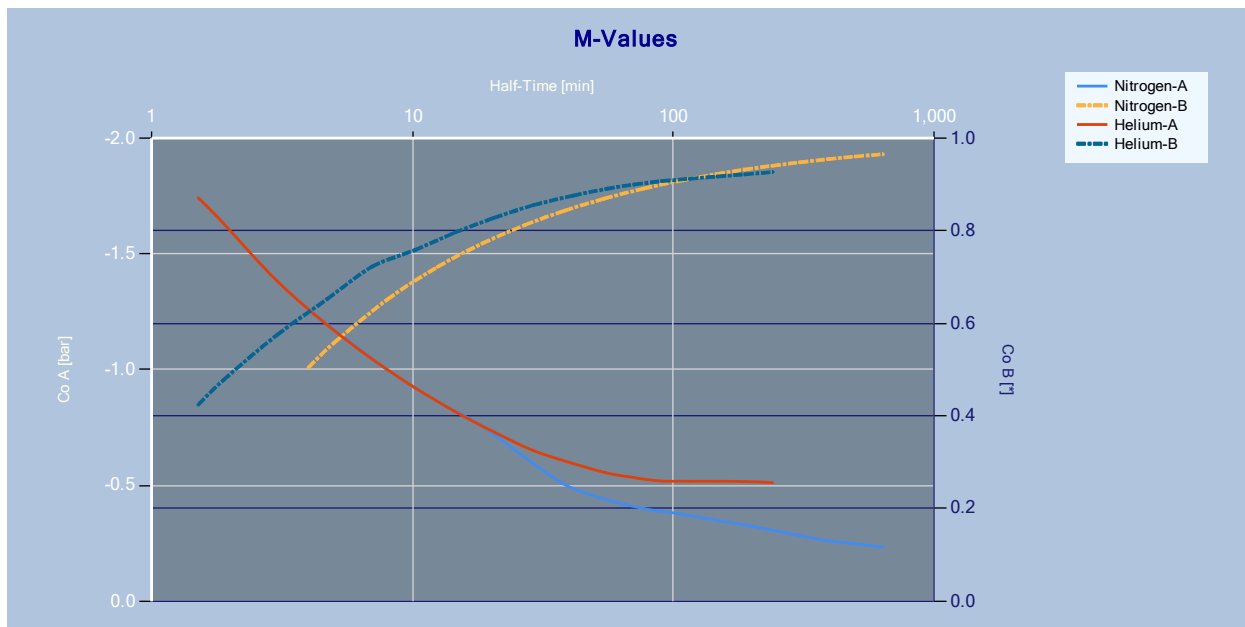
Graph 7: An example of chart of the saturation of inert gases in tissues

- **Final tissue saturation** – a column chart showing the saturation of individual tissues by inert gases at the end of the dive plan,



Graph 8: The final saturation of tissues for an exemplary dive

- **M-Values** – chart of m-Values for selected decompression algorithm.



Graph 9: Advanced chart of decompression coefficients (M-Values) for ZHL-16C variant



4.4 PROFILE DATA TAB.

This functionality allows you to review the detailed parameters of the dive profile for each step. It is much more extensive than the profile table on the simulation tab. There is also a diagnostic mode that allows you to view system internal data for selected rows – page 13.

Dive profile data <input type="checkbox"/> Auto row size								
Save Copy Recalculate < 23m User plan Reporting								
	Action	Depth [m/ft]	Expo Time [d'hh:mm:ss.mss]	Dive Time [d'hh:mm:ss.mss]	Beginning Preassure [psi]	Gas preassure [psi]	Next Deco Stop [m/ft]	Next [m/ft]
▶	Begin	0.0ft	0:00.000	0:00.000	14.6959psi	14.6959psi	0.0ft	
	Surface	0.0ft	1:00.000	0:00.000	14.6959psi	14.6959psi	0.0ft	
	Change cylinder	0.0ft	0:00.000	0:00.000	14.6959psi	14.6959psi	0.0ft	
	Change cylinder	0.0ft	0:00.000	0:00.000	14.6959psi	14.6959psi	0.0ft	
	Descent	0.3ft	0:00.400	0:00.400	14.6959psi	14.8386psi	0.0ft	
	Descent	0.7ft	0:00.400	0:00.800	14.7349psi	14.9808psi	0.0ft	
	Descent	1.0ft	0:00.400	0:01.200	14.7739psi	15.1230psi	0.0ft	

- **Action** – type of diving action,
- **Depth** – depth at the end of sample,
- **Exposure time** – duration of given sample,
- **Dive time** – total duration of a given dive, one plan may contain several subsequent dives,
- **Initial pressure** – ambient pressure at the beginning of a given sample,
- **Gas pressure** – gas pressure after reduction to ambient pressure at the end of given sample,
- **Next deco** – depth of the next decompression stop,
- **Next deep** – depth of the next deep stop,
- **No-decompression time** – the remaining dive time without the required decompression,
- **Time to fly** – theoretical minimum time on the surface, before the flight, **please note, this value may be confusing for gas blends other than atmospheric air, in practice, it is not recommended to use a break shorter than 12 or 24 hours before the flight, depending on the type of diving activity - recommendations of diving organizations should be strictly respected,**
- **Ceiling** – the minimum safe depth to which a diver can perform an emergency ascent at a given moment without an increased risk of decompression sickness,
- **V tank** – the amount of the remaining breathing gas at the end of the sample,
- **P tank** – pressure of the remaining gas in the current cylinder set,
- **Rock bottom** – the amount of gas needed in the event of an emergency situation necessary for a safe ascent, *this value can be misleading for gas switching dives,*
- **END** – equivalent narcotic depth calculated according to the selected algorithm,



- **Total CNS** – the total percentage value of the maximum permissible oxygen exposure to the nervous system, *we recommend not to exceed 80%*,
- **Total OTU** – the total number of oxygen pulmonary exposure units, depending on the diving activity, the permissible dose may vary,
- **Drop in vital capacity** – percentage decrease in vital capacity of the lungs, **values above 4% are considered to be irreversible damage to the lungs**,
- **Deepest possible stop** – the theoretical maximum depth at which the stop will start the process of reducing the gas saturation of tissues, above this depth all tissues will continue to saturate with inert gases,
- **Leading saturation %** – percentage saturation of gases for the most saturated tissue,
- **Leading saturation** – as above, but given in absolute values of pressure,
- **Target GF** – target gradient value, significant when GF was selected as deep stop algorithm,
- **Altitude** – altitude of dive site,
- **Blend** – type of the current gas blend,
- **Water** – water type,
- **Number of compartments** – number of theoretical tissues (compartments), counted for each gas component separately,
- **Total duration** – total time from the beginning of dive plan,
- **Remarks** – comments and warnings related to given sample.



4.5 DIVE SIMULATION REPORT.

For each diving simulation, the program automatically generates a report in the form of a document adapted for printing. It is available on a separate tab "Reporting". The application provides a few simple actions related to the report:

- **Preview** – generates a print preview and show it in the Documentation Window,
- **Drukuj** – send a report to the printer,
- **Save** – allows to save the report in the XPS format, which is supported by most computers with Windows operating system, without installing additional utilities,
- **Kopiuuj** – copies the entire report to the operating system clipboard to provide the report content to popular document editors and spreadsheets.



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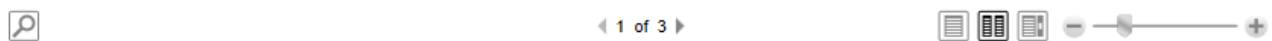
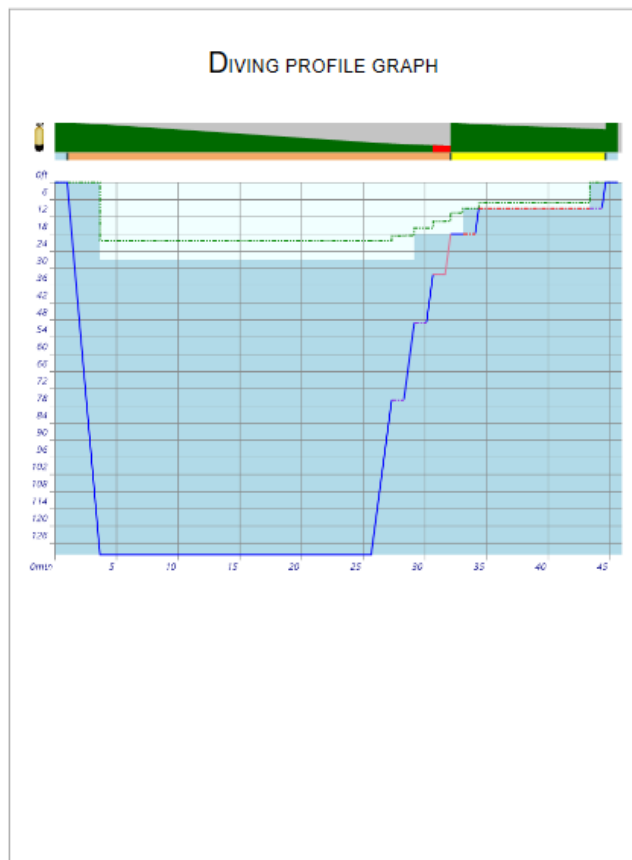
REPORT OF DIVING PROFILE SIMULATION.

INFORMATION METRIC

Diving site:	
Diving type:	
Author:	
Date of the report:	Monday, April 9, 2018
Comment:	

Number of dives:	1	Total duration of plan:	0:45:38.2
Altitude:	0m	Bottom time:	0:43:37.8
Atmospheric pressure:	1.013 258hPa	Maximum depth:	33.8m
Water type:	Fresh	Descent stop:	5.2m
		Safe depth:	3m
		Theoretical time to fly:	8:09:00

Signature





5 THE MOST IMPORTANT KNOWN LIMITATIONS.

Full simulation of diving is a very complex process. Each application has some limitations that the diver should be aware of. Below are the most important known limitations of this Software.

5.1 LIMITATIONS OF SIMULATION.

- **Diver's limits.**

Each diver, depending on the training, general physical condition, current state of health, tiredness and many other factors has other limitations that can not be accurately reproduced by computer algorithms or procedures. **The program uses typical settings of algorithms and limits, which, however, does not guarantee the occurrence of decompression sickness or other injuries during the dive.**

- **Rock bottom.**

The current version of the software has implemented the so-called rock bottom reserve of breathing gas for dives on one gas (one cylinder). *In case of multi-gas diving currently it is not possible automatic calculation of gas reserve using this method.*

- **Gas narcosis.**

The application allows you to choose from several possible algorithms for calculating the narcoticity of gases. *If you are not sure which setting of the algorithm for calculating the gas narcosis potency is best for you, consult with your dive instructor.*

- **Oxygen toxicity.**

Oxygen toxicity is calculated only in the acceptable partial pressure range for the dive. After it is exceeded, calculations may be interrupted or incorrect.

- **Isobaric counter-diffusion (ICD).**

The program has only basic, simple methods of detecting the risk of ICD. *During dives with gas switching, it is imperative to follow the rules given during technical diving training, even if the calculations do not indicate the need to change the dive plan.*



5.2 TECHNICAL LIMITATIONS.

- **Formatting when saving and copying.**

When saving or copying the contents available in the application may be lost or change the formatting. This is due to the limitations of available formats and compatibility with available applications.

- **Calculation performance.**

In the case of complex dive scenarios, profile calculations may take noticeably longer. This will be more evident in the case of a large amount of depth change. During the simulation, the program can perform tens of thousands of calculations, which it records in detail in the computer's memory. This allows you to achieve high quality simulation, but it requires the right computing power of the computer.

- **Performance of operations.**

Some operations, such as copying a large amount of data to the clipboard, or formatting all rows of detailed data may take a bit more time. This may give the impression that the program has "hung up". After a short while, when the operation is completed, the system's responsiveness will be restored.

- **Connection with Internet.**

During the first start-up and registration, the program requires a connection to the Internet. Sometimes the quality of the connection is not sufficient or the required services are not available. In this case, the program will complete the operations on the next start. Until then, some features may not be available.