

The Optimal Buoyancy Computer

*A Tool to Help Nail Buoyancy
And Improve Safety, Before You Splash*

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This educational tool is provided without restriction, with the understanding that no guarantee is made as to the accuracy of the data herein. The password to unlock the spreadsheet is listed in multiple locations throughout the tool, and the user is free to alter any formulae or data as he or she sees fit. This tool is provided without copyright or other restriction on its use or alteration.

Quick Start

How much lead do I need? Since many of you are not data geeks, much of this complex tool may be outside your areas of interest. And many of you may simply not want to wade through the entire User's Manual to get started. We get it!

So if you understand Excel at all, things are pretty logical.

If all you'd really like is to know 1) how much weight you should add, and 2) whether your bcd is big enough for that amount of lead, we've created the "QuikResults" tab for fast answers.

Start by clicking on the Diver&Dive tab (at the bottom of your screen) and proceed logically through EACH of the **gray** fields. Follow the abbreviated directions at the top. When Diver&Dive is complete, move on to the Pers Buoy tab. If you're not interested in great accuracy or in spending a lot of time with the tool, leave the fields in the Pers Buoy Tab blank. Next come the Suit, Rig and Tanks tabs. Pay attention to EVERY gray cell. Data entry is logical and will not require much inspection with the exception of finding your particular tank. Read "Tanks" notes carefully.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1																			
2		(Complete First Four Tabs FIRST)	Quick Recommendations:										11 lb lead		Not every diver is a numbers geek. This tab gives you quick access to two key numbers: Required lead, and Required BCD/Wing Lift				
3			13 to 16 lb lift																
4			Inspect cells below to determine if Quick Recommendation is right for you																
5																			
6		Weight Requirement:			(for this Salt Water Dive)														
7			Adding	10.3 lb.	leaves diver neutrally buoyant at the safety stop														
8		PLANNED GAS USE		Diver is now	3.7 lb.	buoyant at surface with PLANNED ending pressure(s)													
9																			
10																			
11																			
12																			
13			Adding	10.7 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL retained tanks to 300 psi														
14		EMERGENCY GAS USE			However, this now leaves diver	0 lb.	buoyant at 15 ft with PLANNED GAS USE												
15																			
16		BCD/Wing Lift Requirement:			for dive to 100 feet (chosen from the worst-case scenario below to be at least 2lb buoyant)														
17					Wing Size Needed for	10.7 lb.	carried lead:	16 lb. bladder		(with all weight on rig)									
18							or	13 lb. bladder		(with 2.9 lb.		transferred from rig to diver via belt/harness)							
19					Due To One of these Issues ↓			Fine tune this further on 'Wetsuit' tab											
20																			
21																			
22				Rig Buoyancy:	-13.8 lb.	surface buoyancy by itself (no diver)													
23				Alternate Rig Buoyancy:	-10.9 lb.	surface buoyancy with 2.9 lb. transferred from rig to a weightbelt or harness,													
24																			
25				Diver buoyancy at depth:	-10.9 lb.	buoyant with full tanks (at 100 feet)													
26		*** Consult 'Lift' tab to further evaluate consequences of different carried weight on lift requirement ***																	
27		WARNING! This is experimental data derived from physics formulas and modestly tested buoyancy data. Do not rely on this data alone for dive planning.																	
28																			
29																			

Then, just click on the QuikResults tab. Most of what you probably need is right there:

- 1) Lead requirement for weight pockets or weight belt
- 2) BCD lift requirements
- 3) Rig buoyancy, including a need to remove weight from a rig and transfer to a weight belt
- 4) Loss of buoyancy due to wetsuit compression at depth
- 5) And perhaps most important, an implicit acknowledgment (in C7 above) of the limits of the classical buoyancy check, when thick neoprene re-expansion leaves you excessively buoyant at the surface, despite having been neutral at the safety stop depth. It then offers a solution.

If what you see piques your interest, there are screenshots and discussion in the pages that follow, to help you get even more out of this comprehensive tool.

WARNING: When using Excel 2003, make sure that data you see applies to your situation. Areas that are blanked out in current Excel for safety are still visible and may cause confusion.

Introduction

Whether it's a basic scuba buoyancy question like, "I have a new wetsuit. How much lead should I put in my bcd?", or a complex technical one like, "Is there a way to make this doubles rig balanced?", obtaining ideal buoyancy for scuba is important to each of us.

While all training organizations give some early guidance regarding obtaining neutral buoyancy, there is often incomplete understanding of the buoyancy consequences of descending to depth, or what one can expect with the failure of a buoyancy component.

This tool examines the numbers behind each of the following challenges:

- 1) Basic Weighting for Neutral Buoyancy
- 2) Choosing a bcd/wing bladder size for your rig
 - a) Streamlining (Is it too big?)
 - b) Will your bcd float your gear if you doff it? (Is it too small?)
- 3) Creating a "Balanced Rig"
- 4) Ditching Weight

By simply entering data regarding your rig, along with your height and weight, this tool uses the same principle of compression with depth that we learned in Open Water class and combines it with limited experimental data to demonstrate what you might expect when you hit the water with a new set of gear.

The tool also provides you with data to assist you in making critical dive planning decisions regarding the need for ditchable weight and/or redundant buoyancy. With pages that provide comparative results, the tool allows you to see the buoyancy consequences of equipment failure with different types of exposure suits and different tanks, in both fresh and salt water, at both the surface and at depth, and at the beginning, middle and end of your dive.

DISCLAIMER: These spreadsheets are experimental tools using formulas created by amateur divers for educational use only! Numerous assumptions regarding buoyancy have been made with only partially tested equipment configurations. The information herein is for your personal educational use and should not be relied upon to determine the adequacy of a given equipment configuration. Consultation with a dive professional regarding equipment, weighting and performing a neutral buoyancy check should all be strongly considered before diving a new equipment configuration. Note specifically that the practice of ditching weight at depth is a controversial one, and the theoretical data in this spreadsheet should not be considered a recommendation of that practice.

In order to assess the accuracy of this tool for your personal use, we recommend that you compare the results it provides with your current weighting. To the extent that there is agreement, you may find the tool useful as you consider new gear.

Here is all you need to get started:

- 1) Your height
- 2) Your weight
- 3) The thickness of your wetsuit or your drysuit shell type and the thickness of its liner
- 4) The tank(s) you plan to dive
- 5) Your planned maximum dive depth

Additional data may enable you to fine-tune your results, as discussed on the pages that follow. Although this User's Manual assists you with great detail on many pages, the spreadsheet is actually quite easy to use once you become familiar with the data to be entered and the layout of the tool.

Spreadsheet Data Entry Conventions

Your ability to make use of these spreadsheets is predicated upon agreement with our conventions regarding buoyancy.

- Negative numbers sink. Positive numbers float.
- Zero buoyancy means floating in the water column without ascending/descending.
- "Neutral buoyancy" in this tool is based upon PADI conventions.
 - When we think of neutral buoyancy when doing a weight check, it is based upon a goal of being zero buoyant at 15 feet during a safety stop.
 - When an average-sized diver is wearing a modest amount of neoprene, this translates to floating on the surface at eye-level with a mid breath and a near-empty tank. And that translates in this spreadsheet to being about 2.2 lb positively buoyant. That is because when floating at eye level at the surface, you are supporting ~2.2 lb of your 9-10 lb skull weight above the surface of the water.
 - As you will discover, being neutral at a safety stop with a near empty tank translates to quite a different surface buoyancy when wearing thick neoprene, due to its significant re-expansion in the last 15 ft. This accounts for some of the argument among dive organizations over how a neutral buoyancy check is conducted.
 - When using this tool, aim for zero at 15 feet, and then decide if your positive buoyancy at the surface is acceptable for your configuration. If not, you may need to accept a certain degree of negative buoyancy at your stop (compensated for with BCD air), so as to minimize the chances of a rapid final ascent. Otherwise, with thick neoprene, there is a shift to possibly excessive positive buoyancy at the surface as your wetsuit expands in the last 10-15 feet.

Using The Optimal Buoyancy Computer with Microsoft Excel

Even if you are not facile with spreadsheet programs, this tool has been constructed in such a way as to guide you to the answers you need. The spreadsheet is "protected", which means that most cells cannot be altered or deleted without entering a password (listed on the spreadsheet itself—it's not a secret). Additionally, many cells have data entry "rules" that keep you from putting in numbers that will result in a nonsensical answer. Certain areas "turn white" and disappear for either wetsuit or drysuit. You may notice odd empty boxes with no data, because those cells do not apply to the configuration you have specified.

***NOTE:** With Excel 2003, formatting capabilities were limited, and you will see data in many fields that are blanked out by later versions of Excel. Be careful, and try to ignore it. Irrelevant data (such as drysuit data when you are starting with a wetsuit) may persist. Additionally, with Excel 2003, limited formatting rules may allow you to look at nonsensical results that really belong to other suit configurations. Some warnings will appear to help you.*

If you notice "####" in a field where you are expecting a number, try a different magnification. See page 46.

These protections mean that it's hard to get yourself into difficulty by experimenting. A spreadsheet is a page of "cells", each of which contain a number, or text, or a formula for computing an answer. In this tool, the places where you are allowed or expected to enter data are shaded gray boxes.

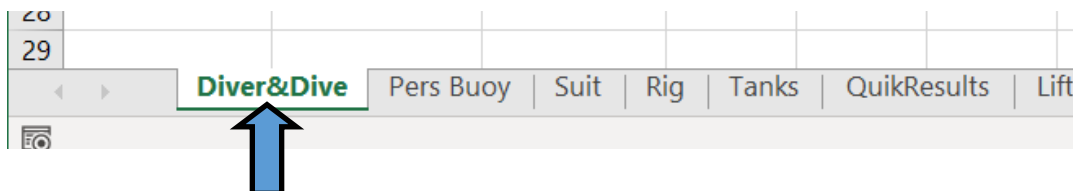
At the bottom of your computer screen when you open this tool are a series of "Tabs". Much like the tabs at the top of folders in a file cabinet, these tabs direct you to the relevant area of the tool. The tool uses data you entered in one tab to compute results in several other areas of the spreadsheet.

Because the tool is quite large, it is impossible to display all input cells and most output cells on the same screen. Therefore, it is important to proceed methodically with data entry. The tool is designed so that special input relevant to a given answer is grouped in the same tab. That means, however, that you may need to enter data in more than one area as you proceed.

It sounds harder than it really is, so let's get started!

The First Tab: “Diver&Dive”

As noted above, at the bottom of the screen are “Tabs” that will bring you quickly to a given part of the spreadsheet. Click on the “Diver&Dive” tab:



This will bring up the first part of the tool:

First, choose your units in the red-edged box at top left. When you click on a cell, a small down-arrow will appear to its right. Choose from the dropdown options that appear when you click the arrowhead.

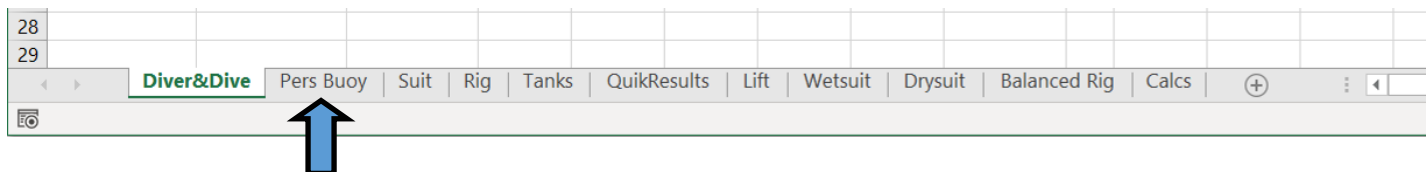
Are you working in Metric units (kg, bar, meters), or in Imperial units (lb, psi, feet)? NOTE: some cells are in one system or the other, despite your choice of units, because of diving or manufacturer convention. For example, despite choosing Imperial units, you will note that wetsuit thickness is always entered in millimeters. The Tanks tab has additional constraints regarding pressure units for metric vs. U.S. tanks.

Start by telling us what units you'll use:		
Note that some units will remain in one system or the other, by convention (e.g., wetsuit thickness is always in mm, even if you have selected Imperial)		
Units:		
Metric ← Choose from dropdown		
Diver:		
Height:	185	cm
Weight:	100	kg
Maximum Dive Depth:		
	30	meters
Water Type: Salt ← Choose from dropdown		

Next,

- 1) In the center, enter your height and weight (units will change based on selection).
- 2) Then enter the Maximum planned depth of your dive. This depth is used throughout the spreadsheet in predicting buoyancy. Note that there is a fourth-order polynomial equation used in computing neoprene buoyancy at depth. That formula produces nonsensical results below 230ft/70m. This tool should not be used for estimating buoyancy below those depths.
- 3) Finally, enter whether you are diving Salt or Fresh water

Then click the Pers Buoy tab at the bottom of your screen, to move on to the next data entry area.



Personal Buoyancy Tab

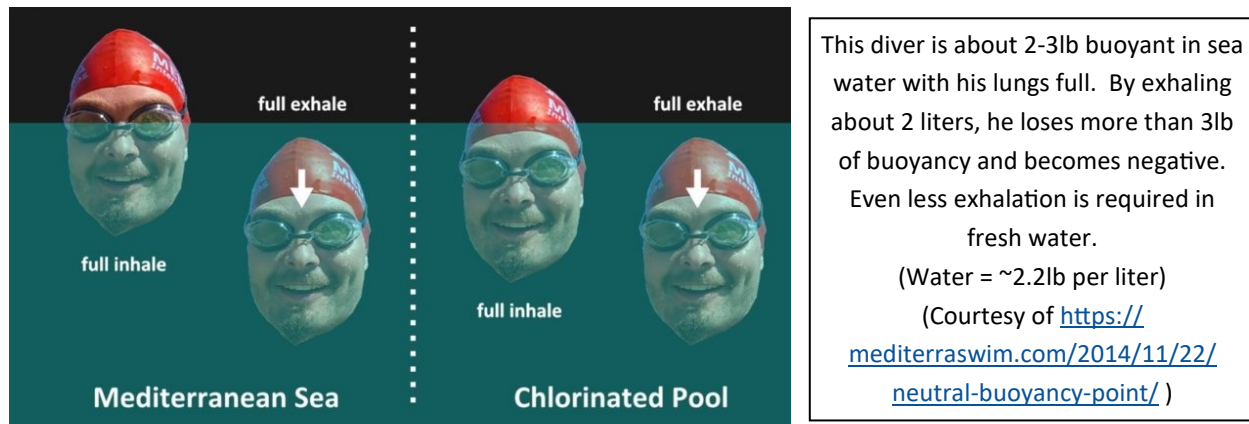
Personal Buoyancy: *This field is important if maximum accuracy is desired in determining total buoyancy and its resulting weight requirement.* Simply put, some divers with extraordinarily low body fat, heavy musculature and large bony frames are hard put to stay afloat without the redundant buoyancy of a wetsuit or bcd. Conversely, a diver of exactly the same height and weight with significant body fat and only modest musculature may have found it quite easy to float during the Open Water Diver 10-minute float test. Thus, two divers of the same height and weight may have *significantly different* personal buoyancy.

In order for a tool requiring only minimal data input to be reasonably accurate, it needs to account for this difference. Determining your Personal Buoyancy can be accomplished quickly and easily in either a pool or confined open water. Entering accurate data in this tab will make a significant difference in the tool's ability to predict your weight requirement. Without it, *differences of as much as 15 lb/7 kg* may be seen between actual weight required and weight recommended by the spreadsheet.

The Theory Behind the Tab

Any object that is neutrally buoyant drifts in the water column without upward or downward force. An object that is positively buoyant holds a portion of its weight above the water's surface. An object that is negatively buoyant drops below the surface and continues downward. *The transition point between positive and negative buoyancy occurs when an object is just awash at the water's surface.*

Keep in mind the importance of lung volume and salinity when determining your buoyancy. According to Archimedes' Principle: you are more buoyant in (denser) salt water than in fresh. You are more buoyant with full lungs than with empty ones, since you displace a greater volume.



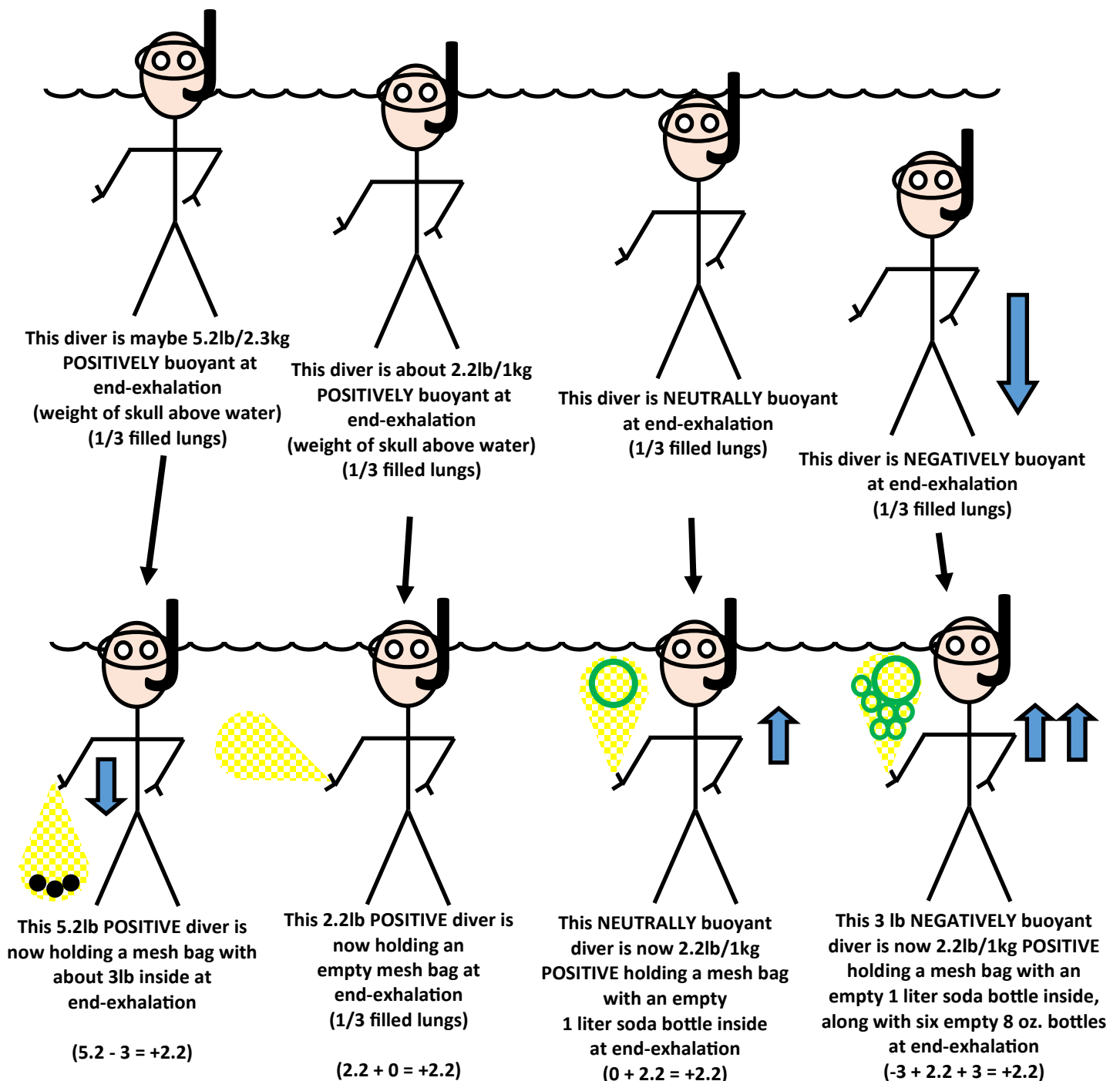
Measuring Your Personal Buoyancy

Jump in fresh or salt water in a bathing suit, mask and snorkel, holding an empty mesh bag. See if you can float at the surface with your lungs full. Now, exhale normally to resting “end of exhalation” lung volume (do NOT force a full exhalation). See if you are at “eye-level” at end exhalation. If you are above this position, add small lead weights to the mesh bag until you sink to eye-level at end exhalation.

If instead, you cannot maintain eye level position at end exhalation, add empty plastic bottles to the mesh bag and hold the bag just under the surface until it supports you at eye level at end exhalation.

Then, as discussed on page 8, enter the weight required (in pounds or kilograms), or the amount of flotation (in ounces or milliliters), on the Pers Buoy tab. Your Personal Buoyancy will be calculated and distributed to other parts of the tool.

See the next page for a graphic depiction of the theory and the measurement discussed above.



Note that it is not critical that you are able to calculate your buoyancy yourself. The tab requires only that you tell the spreadsheet the water type (salt or fresh) in which you are performing the test, and what goes in your mesh bag to make you float at eye level (in just a bathing suit, mask & snorkel). Using the theory discussed on the preceding page, the spreadsheet will compute your personal buoyancy for that water type, and convert that number to the appropriate personal buoyancy in whichever type of water you then dive.

But the math behind it is straightforward: since 2.2lb is the approximate weight of your skull contents above eye-level, the spreadsheet assumes you are 2.2lb buoyant when floating at eye level. Therefore, whatever weight/flotation you carry, minus 2.2 lb, equals your personal buoyancy. That assumption is probably accurate within 1lb/0.5kg.

Using the Personal Buoyancy Tab

Completing the data fields is straightforward. Only two entries are needed: water type, and either the weight required, or the flotation required to obtain the desired eye-level position.

Measured Personal Buoyancy			
Water Type:	Salt	<--- Did you measure your P	
Choose ONE OR THE OTHER below. Entering numbers in more than one			
Weight Needed:		LB.	<-- IF YOU FLOAT ABOVE EY
	OR↓		to pull yourself down to eye
Flotation Needed:	32	OUNCES	<-- IF YOU FLOAT BELOW EY
			did you have to add to your
Salt Water Personal Buoyancy:		0.2	LB.
Fresh Water Personal Buoyancy:		-3.8	LB.

If you float high, simply enter the weight required in cell B18. You can enter the weight as either a positive or negative number, as the formula uses the absolute value.

If you sink low, enter the required flotation in cell B21, in ounces or milliliters, depending upon your units. This must be a positive number.

Errors in data entry are highlighted in case of accidental entry in BOTH a weight cell and a flotation cell, or

in case of using the wrong sign (flotation is positive):

Measured Personal Buoyancy			
Water Type:	Salt	<	
Choose ONE OR THE OTHER below. Entering			
Weight Needed:	1.0	LB.	<
	OR↓		tc
ONE FIELD ONLY! ↑↓			
Flotation Needed:	32	OUNCES	<

Measured Personal Buoyancy			
Water Type:	Salt	<	
Choose ONE OR THE OTHER below. Entering			
Weight Needed:		LB.	<
	OR↓		tc
Flotation Needed:	-32	OUNCES	<

If the user wishes to use this tab with estimated data instead of direct measurement, Personal Buoyancy can be directly entered in Cell C31, AFTER first selecting Fresh or Salt water in Cell B14, as your personal buoyancy is different depending upon salinity, as shown on page 6.

If you float high, your personal buoyancy should be a positive value. If you sink unless you fill your lungs fully, your personal buoyancy should be a negative number for that water type.

Your manual value will **override** the calculated values in cells E26 & E27, and their background color will turn red to remind you. **"MANUAL DATA"** will appear in Column A. Nonetheless, this manual data will still be used throughout the spreadsheet in calculations.

Salt Water Personal Buoyancy:	0.2	LB.	<--- At end
Fresh Water Personal Buoyancy:	-3.8	LB.	<--- At end
Manually Entered Personal Buoyancy			
I WISH TO ENTER MY OWN			
Salt WATER			
PERSONAL BUOYANCY:			
		LB.	
Delete gray cell contents in cell C33 above, if you are using measured data			

MANUAL DATA	Salt Water Personal Buoyancy:	1.0	LB.	<--- At end
MANUAL DATA	Fresh Water Personal Buoyancy:	-3.0	LB.	<--- At end
Manually Entered Personal Buoyancy				
I WISH TO ENTER MY OWN				
Salt WATER				
PERSONAL BUOYANCY:				
		1.0	LB.	
Delete gray cell contents in cell C33 above, if you are using measured data				

After manually entering either Fresh Water or Salt Water buoyancy, the buoyancy for the other water type will automatically be calculated.

Remember to DELETE the manually entered value from Cell C31 to restore measured buoyancy. See next page for the next step in data entry: The Suit tab

The Suit Tab

The Suit tab sends critical data to the Calculations tab to determine the buoyancy of your environmental suit. Some areas will be grayed out depending upon whether you choose **Wetsuit**, **Drysuit**, or **N/A**. So make your choice in Cell D8 first. If you are diving only in a bathing suit (perhaps with gloves, booties or even a hood, but no wetsuit, choose “N/A.”

	A	B	C	D	E	F	G	H	I	J	K	L
1	Next, give the spreadsheet the information it needs to figure out how much buoyancy											
2	you are carrying with your environmental suit:											
3												
4	Gray Cells allow user data entry											
5												
6	Environmental Suit:											
7	Choose from dropdowns ↓ ↓				↓ Enter thickness							
8	Exposure Suit Type:		Wet				Component Buoyancy		See User's Manual for			
9	Shorty/Full?:		Full		8.5		mm		27.7 LB.		discussion of wetsuit	
10											Condition/Type.	
11	Additional Vest?:		No		0		mm		0.0 LB.			
12	Gloves?:		Yes		5		mm		1.3 LB.			
13	Booties?:		Yes		6		mm		1.8 LB.			
14	Hood?:		Yes		7		mm		2.8 LB.			
15	Wetsuit --> Condition/Type:		New_Soft						Total			
16			Standard - avg buoyancy loss						33.5 LB.			
17			Soft - greatest buoyancy loss;									
18			Old - 20% less buoyancy than std									
19												
20	Approx Suit Buoyancy at Surface:				33.5 LB.							

(For DRYSUIT entries, proceed to page 11)

WETSUITS:

If diving wet, next choose whether you are wearing a **Full**, a **Shorty** or a **Farmer John** wetsuit. As before, look for the dropdown arrow to the right of the box you highlight, then choose your option.

In calculating wetsuit buoyancy, the spreadsheet uses one of several formulas which approximate the compression of the wetsuit by depth. This critical phenomenon is the reason why wetsuits lose buoyancy as you descend. The amount of compression varies with wetsuit age and type of neoprene. The spreadsheet allows you to select one of three options that alter the formulas used to compute buoyancy, based upon ongoing incomplete experimentation. The user is cautioned again that this tool provides information based upon incomplete data, and one should use the spreadsheet results with caution.

Wetsuits are supplied by the manufacturers in variable thickness generally denoted in millimeters, depending upon the amount of insulation desired for the temperature of the water. Enter the thickness of your wetsuit as identified by the manufacturer.

For wetsuits of combined thicknesses (typically thicker over the chest, back and/or abdomen) enter a thickness partway between the two numbers as an estimated average thickness. For example, an 8/7 cold water neoprene suit might be entered as 7.4mm.

“Semi-dry” wetsuits with a furry inner comfort layer have additional trapped air that may or may not be fully replaced by water by dive end. Consider increasing the entered thickness.

Note that at the bottom of the gray data entry area, there is a cell labeled “Wetsuit —> Condition/Type”. As noted in the box above, this important cell determines which of the formulas are used to compute wetsuit compression with depth. When you highlight this cell, there are four options to choose from. Choose one of New Standard, New Soft, or Old for your wetsuit type, to increase the accuracy of the calculations. Entering N/A is appropriate for dives with a drysuit or bathing suit, but note that the spreadsheet will ignore your Condition/Type in any case, if you have not chosen Wetsuit above.

New Soft neoprene wetsuits marketed for comfort and stretchability are assumed to compress slightly more with depth than a New Standard neoprene wetsuit. An “Old” wetsuit is assumed to have stiffened with age (thus losing any possible added “soft” compression, and is also assumed to have lost 20% of its buoyancy due to cell deterioration. Note that your particular exposure suit may lie somewhere in between, and the buoyancy difference may exceed 5 lb/2 kg with thick neoprene. ***This calculation is one of the most critical factors for determining your wetsuit buoyancy, and thus your weight requirement. Differences between what the tool predicts and what you actually use are most likely related to this factor, erroneous wetsuit thickness or Personal Buoyancy (p. 6).*** Some manufacturers’ listed wetsuit thicknesses are “generous”. Check your own suit by gently pinching a fold of material and measuring that double thickness. Divide the answer by two, and enter that in “thickness”, no matter what the label says.

After you have entered your wetsuit type, thickness and condition, it is time to consider accessory neoprene. The lower half of the gray data entry area includes “Yes/No” dropdown boxes to allow you to quickly add or remove a hood, vest, gloves or booties. After clicking “Yes” from the dropdown box, enter the thickness(es) of the additional items. The “Additional Vest” option is inactive if you choose Drysuit, whether or not it says “Yes”.

Note your estimated Surface Suit Buoyancy in Cell E20. This value is transmitted to other areas of the tool as needed. It is determined by calculations in the Calcs tab which you may inspect, but not edit, unless you unlock the spreadsheet. For improved accuracy, consider measuring your suit buoyancy directly as described below.

Some cells may blank out based upon your selection of Wetsuit or Drysuit, depending upon whether they are applicable.

You may have separately determined your wetsuit’s exact surface buoyancy by weighting it in a bag until it just begins to submerge. You may enter that value independently, in cell D24. That entry will then override all other suit buoyancy results, so don’t forget to include hood, glove and bootie buoyancy with it.

If you only know your suit buoyancy but not your accessory buoyancies, you can let the spreadsheet estimate those buoyancies, and then add the “component buoyancy” for the desired items from Column J to your measured suit buoyancy, and enter that combined amount in Cell D24.

For maximum accuracy (since weighing your suit in a mesh bag may trap air), first measure your personal buoyancy, and then using the same technique as on pages 6-9, measure your combined buoyancy in a pool while wearing your neoprene, and then just subtract your previously measured personal buoyancy.

Environmental Suit:			
Choose from dropdowns ↓ ↓		↓ Enter thickness	
Exposure Suit Type:	Wet		Component Buc
Shorty/Full?:	Full	8.5 mm	27.7 LB.
Additional Vest?:	No	0 mm	0.0 LB.
Gloves?:	Yes	5 mm	1.3 LB.
Booties?:	Yes	6 mm	1.8 LB.
Hood?:	Yes	7 mm	2.8 LB.
Wetsuit --> Condition/Type:	New_Soft		Total
	Standard - avg buoyancy loss		33.5 LB.
	Soft - greatest buoyancy loss;		
	Old - 20% less buoyancy than std		
Approx Suit Buoyancy at Surface:		33.5 LB.	
I WISH TO ENTER MY OWN MEASURED SUIT BUOYANCY: LB.			

Approx Suit Buoyancy at Surface:	36.0 LB.
I WISH TO ENTER MY OWN MEASURED SUIT BUOYANCY: LB.	
	36 LB.

Even if you enter your own measured suit buoyancy in the gray cell, be sure to select the appropriate **Type/Condition** of wetsuit in Cell D15 (New Soft, New Standard or Old). This will preserve buoyancy adjustments with depth, as the tool uses different formulas depending upon the environmental suit type. The spreadsheet will change Cell E20 to Red, to remind you that you are using your own measured buoyancy. *For Drysuit entries, see next page. Otherwise, proceed to page 13 for Rig tab discussion.*

DRYSUITS:

Once you select **Dry** in Cell D8, you are presented with a Drysuit Material/Liner Thickness cell, two rows down:

Environmental Suit:			
Choose from dropdowns ↓ ↓			↓ Enter thi
Exposure Suit Type:	Dry	▼	Comp
Drysuit Material/Liner Thickness:	Crushed Neoprene	4.5	mm

Cell D10 in the Suit tab allows you to select one of four types of drysuits: Neoprene, Compressed Neoprene, Crushed Neoprene and Trilaminate. Each of these types behaves differently under pressure.

- Trilam is easiest: the spreadsheet assumes that the material is neutrally buoyant and total suit buoyancy is solely determined by the liner thickness and how you fill the suit (and therefore, how you adjust your entry of liner thickness—see below).
- Neoprene and Compressed Neoprene suits are hybrids: a shell of compressible wetsuit material overlaying a liner. As with any drysuit, the diver adds gas on descent to keep liner loft (and that component of buoyancy) constant, but the outer neoprene is buoyant on its own, is compressed by depth and therefore loses buoyancy the deeper you go (which necessitates more gas in the shell).

The spreadsheet treats a Neoprene suit as a 3mm standard wetsuit over a neutrally buoyant drysuit shell. The spreadsheet treats a Compressed Neoprene drysuit as a 1mm wetsuit over a neutrally buoyant drysuit shell. The outer layer of each type loses buoyancy with depth, while diver total buoyancy is kept constant by adding liner gas.

- A Crushed Neoprene drysuit has most of its compressible air cells crushed flat at manufacture. Additionally, the denser material has slight negative buoyancy on its own. The spreadsheet treats this type of suit as a drysuit with 2lb/1kg of negative shell buoyancy subtracted from the flotation provided by the liner. However, the heavier material is assumed to add slight additional trapped gas in heavier fabric folds when using a thin liner, though this effect tends to disappear with thicker liners. The formula adjusts based upon the liner thickness chosen.

Unlike wetsuits, drysuits are worn with a soft liner of variable thickness, depending upon the amount of insulation desired for the temperature of the water. These liners are not sold by thickness (unlike wetsuits), so you will have to do a little measuring to determine what value to enter in the Drysuit Liner Thickness cell.

Look at your liner, and make an estimate of its resting thickness, or “loft”. The easiest way is to gently pinch a fold of material between your fingers, estimate the thickness of that doubled-up area, and divide by two. The next step is to determine how much of that loft to enter.

Keep in mind the looseness of a drysuit with thin liners. For example, if you dive warm water with only a 1mm set of long underwear underneath, realize that you will also usually carry a thin layer of air in the folds of the suit around it. In this case, it might be appropriate to enter 2mm or more as the “Liner Thickness”.

An important next step is to determine how you dive your liner. For example, if you dive colder water with a 1/4” (6mm) or thicker liner, and you dive it compressed just short of a suit squeeze, then the loft is compressed at all times. You might choose to enter 4 or 5mm for that liner, instead of 6mm. If on the other hand you dive “full” for extra warmth (and added required weight), then you might choose to enter 7mm or even 8mm for that liner’s “thickness”. If you are not sure, start with just the measured loft of the liner you are using. ***Failure to adjust the entered liner thickness for how you dive your drysuit is the largest source of error in drysuit weight predictions for this tool.***

The spreadsheet also accounts for hood, glove and bootie thickness (but not “Additional Vest”, which is inactive, and should be grayed out when selecting Dry). Enter the thicknesses of those items in column C. Any thickness entered in Additional Vest will be ignored by the spreadsheet.

Choose from dropdowns ↓ ↓		↓ Enter this	
posure Suit Type:	Dry	▼	Comp
/Liner Thickness:	Crushed Neoprene	4.5	mm
Gloves?:	Yes	5	mm
Booties?:	Yes	6	mm
Hood?:	Yes	7	mm
Approx Suit Buoyancy at Surface:		32.3 LB.	

Note your estimated Surface Buoyancy in Cell E20. This value is transmitted to other tabs of the spreadsheet as needed. It is determined by calculations in the Calcs tab which you may inspect, but not edit, unless you unlock the spreadsheet with the password.

Although it is technically quite challenging to do, if you have separately measured your drysuit’s exact surface buoyancy, you may enter it independent of all other calculations in cell D24. That entry will then override all other suit buoyancy results, so don’t forget to add hood, glove and bootie buoyancy to your measured suit amount.

If you only know your suit buoyancy but not your accessory buoyancies, you can let the spreadsheet estimate those buoyancies, and then add the “component buoyancy” for the desired items from Column G to your measured suit buoyancy, and enter that combined amount in Cell D24.

Even if you enter your own measured buoyancy in the gray cell, be sure to select the appropriate type of drysuit in Cell D10 (“Drysuit Material”). This will preserve buoyancy adjustments with depth, as the tool uses different formulas depending upon the environmental suit type, as described on page 10.

If you enter your own measured drysuit buoyancy, the spreadsheet will change Cell E20 to Red, to remind you that you are using your own measurement.

Approx Suit Buoyancy at Surface:	24.0 LB.
I WISH TO ENTER MY OWN MEASURED SUIT BUOYANCY:	
24	LB.

(For entry of Rig data, see next page)

The Rig Tab

The Rig tab is a small one with minimal, but critical data input.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Contributions to rig buoyancy (other than bcd bladder)														
Having determined the contribution of your environmental suit to buoyancy, we will next determine how much your rig subtracts from your net buoyancy:														
BCD/Backplate + fittings buoyancy:		0.0	LB.	<--- Enter <u>in-water</u> buoyancy, not dry weight. Start with "0" for most BCD's										
First Stage Weight:		-1.5	LB.	<--- For typical brass firsts, enter 0.7kg/1.5lb; for titanium use 0.4kg/0.8lb or actual mfr data										
Bands, manifold + second reg weight:		0.0	LB.	<--- For single-tank diving, leave this field blank or "0"										
Other Fixed Weight:		0.0	LB.	<--- Other fixed weight, e.g., light canisters, fixed B/P lead wedges										
Other Fixed BUOYANCY:		0.0	LB.	<--- Fixed BUOYANT items, such as a positive +0.5 to +2 for Full Face Mask or Double Hose Rig, or +0.2 to +1 for floaty fins										
(Ditchable Weight and Trim Weight will be entered later, on "Lift" tab)														
NOTE: Negative values sink; Positive values are buoyant														

Before continuing, again keep in mind the convention regarding data entry. When entering weights and other heavier-than-water items, a negative number is used. When entering positively buoyant items such as wetsuits and floaty fins, a positive number is used. This reminder is prominently found on the Rig tab:

NOTE: Negative values sink; Positive values are buoyant

BCD/backplate + fittings buoyancy:

First, we need to offset our environmental suit buoyancy with the buoyancy of our BCD. For most jacket-style BCD's, the in-water buoyancy is "0". Note that we enter in-water buoyancy, and not jacket weight. Some BCD's, with extensive hardware and D-rings may be 1-2lb / 0.5-1kg negative. Use manufacturer data if available, or hang your BCD from a luggage scale at the surface of a swimming pool.

Some BCD's with foam padding, may start positive, but finish the dive neutral after air is squeezed out of open-cell foam. A few BCD's are continuously positive.

Back plate and wing rigs start with a backplate of known weight per the manufacturer. Indeed, they may be chosen specifically for their weight or lack thereof. Don't forget to add the weight of additional fittings (as a negative number).

First Stage Weight:

If you do not know the weight of your first stage, you can generally enter -1.5lb/-0.7 kg for a standard brass first stage, and less for a titanium model. Second stages, once mated to their hoses, have insignificant buoyancy effects.

Bands, manifold + Second Reg Weight: Enter the total weight of the manifold and add 1 first stage.

This field is for doubles and sidemount divers. Here you enter the combined weight of the bands, manifold/isolator and the other first stage. Note that it will not affect the spreadsheet result if you put all the first stage weight in either D7 or D8, but using this field only for doubles simplifies going from singles to doubles when experimenting with buoyancy results. If you do not know your bands, manifold and additional first stage weight, enter -12lb/-5.5kg. Sidemount divers have no bands or manifold, but multiple additional 1st stage weights. The total weight of all first stages beyond the original should be entered in this field.

Other Fixed Weight: Enter the net buoyancy (neg) of other items in Cell D9.

While trim weights will await entry on another page, this field is intended for other items that can generally not be ditched. It includes lead weight permanently bolted to a backplate, attached light canister batteries, and similar negative items. Do not include trim weights here. If you are using this tool to decide how much lead to bolt to your back plate, do not enter a guess here, but let the tool assist you and later on, include it (temporarily) in the trim weight area in the Lift tab. That makes it easier to experiment.

The Rig Tab (cont'd)

Other Fixed BUOYANCY: Enter the net buoyancy (positive) of “floaty” items in Cell D10. When diving with a Full Face mask, for example, it may be necessary to add an additional 0.5-1lb buoyancy for the added air volume carried in the mask. Double-hose divers without ring weights on their hoses may need to add 1-2lb buoyancy for the large air filled double hoses. Even fins should be considered. Some divers choose positively buoyant fins either to aid in retrieval, or as a trim correction. That buoyancy should be accounted for, and commonly ranges from +0.2lb to +1.5lb.

Entering Tank data comes next

The Tanks Tab

The Tanks tab requires the most care of all the data entry sections of the tool. If you are a single tank diver, there is an easy default way to start. Simply find your tank, enter “1” in the appropriate row of Column B and move on to the QuikResults tab. Over 200 tanks of both U.S. and European specification are listed in the Tanks tab. Rows 15-126 are U.S./Imperial tanks, and European/Metric tanks are found in Rows 136-240. Each group has room for four “manual entry” tank types if you do not find your particular tank in the list. Tanks are generally sorted by size. Some identically sized tanks have different buoyancy due to varying wall thickness. Choose carefully! Differing open source data may prompt near-duplicate entries. Identically sized tanks with different buoyancies are in **TAN SHADED CELLS**.

There is the option of entering your actual starting pressure in Column D, and your Planned End-of-Dive Pressure in Column E. However, if you leave those columns blank, the spreadsheet presumes tank working pressure at the start of the dive and 500 psi/35 bar (for buoyancy purposes) at the end of the dive.

If you carry a pony, or are a multiple tank diver, or are diving with an overfilled or partially filled tank, some additional considerations are warranted. Let’s examine them.

As noted above, the tool presumes tank working pressure to start, and 500 psi/35 bar at dive end. Therefore, if you enter no data in Columns D & E, you will still get good results:

		Total # tanks:	1	Sum of Tank Buoyancies:	-0.6 LB.	<-- Empty, with valve					
		CHECK THIS NUMBER!!		Total Vol Gas Carried:	100 Cu Ft	Planned End Dive Gas Vol:		15 Cu Ft			
				Total Wt Gas Carried:	-7.7 LB.	Planned End Dive Gas Wt:		-1.1 LB.			
NOTE: Make sure that the total number of tanks carried makes sense. If not, check for missing or extra tanks.											
NOTE: Make sure that the total quantity of gas carried makes sense. If not, make sure you chose your intended tank(s).											
If actual start or end pressure (Col. D or E) is left blank, spreadsheet automatically calculates start pressure as Working Pressure (Col. K) and end as 500 psi											
Enter Quantity	Size (Cu Ft)	Actual Start Pressure (psi)	Planned End Pressure (psi)	Brand	Material	Tank Model	Capacity (Cu Ft)	@ Pressure (psi)	Buoyancy @ 0 psi w/valve lb. (Imperial)	Diam (in)	Height (in) w/o valve
	100			Faber	Steel	FX100	100	3442	-0.6	7.24	25.4
1	100			Faber	Steel	HP100	100	3442	-0.6	7.24	25.39

If you enter working pressure and 500 psi (for example), your carried gas weight doesn’t change. To confirm that you are using defaults, the cells in Columns D & E stay gray.

				Total # tanks:	1	Sum of Tank Buoyancies:		-0.6 LB.	<-- Empty, with valve			
				CHECK THIS NUMBER!!		Total Vol Gas Carried:		100 Cu Ft	Planned End Dive Gas Vol:		15 Cu Ft	
						Total Wt Gas Carried:		-7.7 LB.	Planned End Dive Gas Wt:		-1.1 LB.	
NOTE: Make sure that the total number of tanks carried makes sense. If not, check for missing or extra tanks.												
NOTE: Make sure that the total quantity of gas carried makes sense. If not, make sure you chose your intended tank(s).												
If actual start or end pressure (Col. D or E) is left blank, spreadsheet automatically calculates start pressure as Working Pressure (Col. K) and end as 500 psi												
Enter Quantity	Size (Cu Ft)	Actual Start Pressure (psi)	Planned End Pressure (psi)	Brand	Material	Tank Model	Capacity (Cu Ft)	@ Pressure (psi)	Buoyancy @ 0 psi w/valve lb. (Imperial)		Diam (in)	Height (in) w/o valve
	100			Faber	Steel	FX100	100	3442	-0.6		7.24	25.4
1	100	3442	500	Faber	Steel	HP100	100	3442	-0.6		7.24	25.39

If you are using an overfilled tank, for example, the starting pressure cell will turn yellow to remind you that you have deviated from default values. This weight change isn’t very large.

		Total # tanks: 1		Sum of Tank Buoyancies: -0.6 LB.		<-- Empty, with valve					
		CHECK THIS NUMBER!!		Total Vol Gas Carried: 105 Cu Ft		Planned End Dive Gas Vol:		15 Cu Ft			
				Total Wt Gas Carried: -8.0 LB.		Planned End Dive Gas Wt:		-1.1 LB.			
NOTE: Make sure that the total number of tanks carried makes sense. If not, check for missing or extra tanks.											
NOTE: Make sure that the total quantity of gas carried makes sense. If not, make sure you chose your intended tank(s).											
If actual start or end pressure (Col. D or E) is left blank, spreadsheet automatically calculates start pressure as Working Pressure (Col. K) and end as 500 psi											
Enter Quantity	Size (Cu Ft)	Actual Start Pressure (psi)	Planned End Pressure (psi)	Brand	Material	Tank Model	Capacity (Cu Ft)	@ Pressure (psi)	Buoyancy @ 0 psi w/valve lb. (Imperial)	Diam (in)	Height (in) w/o valve
	100			Faber	Steel	FX100	100	3442	-0.6	7.24	25.4
1	100	3600		Faber	Steel	HP100	100	3442	-0.6	7.24	25.39

However, if you are a doubles diver, planning on using “thirds” and returning with significant reserve gas, weight planning should take that into consideration. This diver is returning with 1150 psi in each tank, and will be carrying almost 3 lb. more gas than he would at 500 psi.

		Total # tanks: 2		Sum of Tank Buoyancies: -1.2 LB.		<-- Empty, with valve					
		CHECK THIS NUMBER!!		Total Vol Gas Carried: 200 Cu Ft		Planned End Dive Gas Vol:		67 Cu Ft			
				Total Wt Gas Carried: -15.3 LB.		Planned End Dive Gas Wt:		-5.1 LB.			
NOTE: Make sure that the total number of tanks carried makes sense. If not, check for missing or extra tanks.											
NOTE: Make sure that the total quantity of gas carried makes sense. If not, make sure you chose your intended tank(s).											
If actual start or end pressure (Col. D or E) is left blank, spreadsheet automatically calculates start pressure as Working Pressure (Col. K) and end as 500 psi											
Enter Quantity	Size (Cu Ft)	Actual Start Pressure (psi)	Planned End Pressure (psi)	Brand	Material	Tank Model	Capacity (Cu Ft)	@ Pressure (psi)	Buoyancy @ 0 psi w/valve lb. (Imperial)	Diam (in)	Height (in) w/o valve
	100			Faber	Steel	FX100	100	3442	-0.6	7.24	25.4
2	100		1150	Faber	Steel	HP100	100	3442	-0.6	7.24	25.39

This issue will be discussed further in the QuikResults and Lift chapters below.

To finish the data entry in the Tanks tab, enter the number of tanks of each type that you will dive, in Column B in the appropriate row. As noted above, for single tank divers, that will be a single quantity “1” in the row of the tank chosen. Doubles will show a quantity “2” in a row, while sidemount, pony and deco divers may have tank quantities in more than one row.

Leave Columns D & E blank if you are diving with your tanks’ standard working pressure and planning for a finishing pressure of 500 psi/35 bar. Enter a different value in each of Columns D & E if your tank is over/underfilled and/or you plan to return with other than 500 psi/35 bar. For example, here we see a pony listed that this diver plans to return full:

26		13		Luxfer	Alum	Luxfer 13	13.2	3000	-0.12	4.37	12.87
27		14		Luxfer	Alum	Luxfer 14	13.7	3000	1.7	4.4	16.5
28		19		Catalina	Alum	S19	19	3000	0	4.38	17.4
29	1	19	3000	Luxfer	Alum	Luxfer 19	19.9	3000	0.12	4.38	17.4
30		19		Worthington	Steel	X19	19	3130	-2.2	4	16.5
31		20		Faber	Steel	LP20	20	2640	-1.5	3.9	19.5

Note that repeatedly using the spreadsheet with changing configurations does NOT require that the non-standard tank pressures be deleted when you choose a different tank. The spreadsheet will ignore custom values as long as you have deleted the number(s) of tanks you are not using from Column B.

Total # tanks: 2		Sum of Tank Buoyancies: -1.2 LB.		<-- Empty, with valve							
CHECK THIS NUMBER!!		Total Vol Gas Carried: 200 Cu Ft		Planned End Dive Gas Vol: 67 Cu Ft							
		Total Wt Gas Carried: -15.3 LB.		Planned End Dive Gas Wt: -5.1 LB.							
NOTE: Make sure that the total number of tanks carried makes sense. If not, check for missing or extra tanks.											
NOTE: Make sure that the total quantity of gas carried makes sense. If not, make sure you chose your intended tank(s).											
If actual start or end pressure (Col. D or E) is left blank, spreadsheet automatically calculates start pressure as Working Pressure (Col. K) and end as 500 psi											
Enter Quantity	Size (Cu Ft)	Actual Start Pressure (psi)	Planned End Pressure (psi)	Brand	Material	Tank Model	Capacity (Cu Ft)	@ Pressure (psi)	Buoyancy @ 0 psi w/valve lb. (Imperial)	Diam (in)	Height (in) w/o valve
	100		3000	Faber	Steel	FX100	100	3442	-0.6	7.24	25.4
2	100		1150	Faber	Steel	HP100	100	3442	-0.6	7.24	25.39
	100	3500	2500	Catalina	Alum	C100	100	3300	2.2	8	26.5

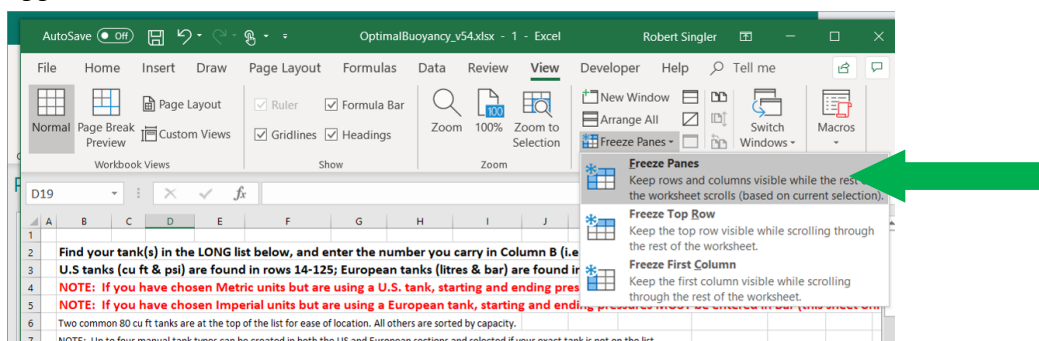
Emergency weight planning by the spreadsheet uses a tank pressure of 300 psi/20 bar to calculate buoyancy, should you need to use all available gas due to a delay, a first stage failure with gas loss, or sharing air to minimums with a buddy. The spreadsheet does not calculate buoyancy changes from handing off an entire pony bottle to another diver in an emergency, as the buoyancy increase from donating a full aluminum bottle is less than 2lb/1kg up to a tank size of 80 cu ft/11 liters.

Manufacturer data has been utilized wherever available. However, other open-source lists of tank data are included where actual manufacturer data was not found. Calculated buoyancies are used for European cylinders, as they do not commonly publish buoyancy, but instead supply tank weight and volume. If you do not know your own tank's exact data, keep in mind that buoyancy may be off by several pounds if the open source data listed here is, in fact, erroneous. Your corrections and additions are welcome! As noted above, identically sized tanks with different buoyancies are in **SHADED TAN CELLS**. Choose carefully based upon your mfr's data!

Rows 7 and 8 are your check rows. MAKE SURE that the total number of tanks equals what you are diving. The list is so long, that it is possible for a "1" to remain hidden out of sight from a previous iteration. Also make sure that the total quantity of gas (Cell J10) equals what you think you are diving.

Tank data taken from multiple open sources, not all of which are manufacturer's sources. Do not rely on the accuracy of this data!										briefly ch:
Total # tanks:	1	Sum of Tank Buoyancies:	-1.3 LB.							After corr:
CHECK THIS NUMBER!!		Total Cu Ft Air Carried:	102 Cu Ft							
NOTE: Make sure that the total quantity of gas carried makes sense. If not, check for missing or extra tanks.										
Quantity	Brand	Material	Type	Capacity	Capacity	@ Pressure	Buoyancy @	Buoyancy @	Diam (in)	Height (in)
* * * * *										

Navigation in the Tanks tab can be difficult because it is so long. However, using the Excel "Freeze Panes" feature allows you to retain the column headers as you choose your tank. First, scroll until the header for the section you are interested in is at the top of your screen. Then, click on the top row of tanks in either the Imperial or Metric section (Cell B15 or Cell B136). Next, click View | Freeze Panes, then click on "Freeze Panes" when the drop-down window appears.



This will lock the column header in place while you scroll down, and convert this:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
72			80			Worthington	Alum	AL80	77.4	2192	3000		1.9	7.25	26.1
73			80			Worthington	Alum	ALN80	77.4	2192	3300		0.4	7.25	25.4
74			80			Catalina	Alum	C80	77.4	2192	3300		0.0	7.25	25.5
75			80			Catalina	Alum	S80	77.4	2192	3000		1.9	7.25	25.9
76			80			Faber	Steel	LP80	78	2209	2640		-0.8	7.25	24

To this:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
135		If actual start or end pressure (Col. D or E) is left blank, default start pressure is Working Pressure (Col. O) and default end is 35 bar													
		Enter Quantity	Nom. Size (liter)	Actual Start Pressure (bar)	Planned End Pressure (bar)	Brand/ Diam (mm)	Material	Tank Size (measured liters)		Est. Capacity (liters)	@ Pressure (psi)		Calculated Buoyancy (lb) @ 0 psi w/ 0.7kg valve (Metric)	Tank Weight w/o valve (kg) (critical data)	Working Pressure (bar)
136						Eurocylinder/171	Steel	10.0		2319	3367		-1.2	12.4	232
172			10			Heiser	Steel	10.0		2319	3367		-1.2	12.4	232
173			10			Luxfer	Aluminum	10.0		2319	3367		2.1	12.1	232
174		2	10		80	Scubapro	Steel	10.0		2319	3367		-0.8	12	232
175			10.4			Luxfer	Aluminum	10.4		2412	3367		1.6	13.6	232
176			11.1			Faber/184	Steel	11.1		2319	3033		-1.5	14.1	209
177						Catalina/184	Aluminum	11.1		2307	3004		1.0	14.3	207

You have now entered the minimum required data and the spreadsheet is fully functional.

The QuikResults Tab

Once diver and equipment data has been entered into the first four tabs, the spreadsheet is fully functional. There are two modes to get results: simple, and complex.

Complex: the majority of the spreadsheet consists of tabs that allow evaluation of diving challenges, but require additional data entry and experimentation. Topics covered include:

- Buoyancy, including buoyancy at depth after wetsuit compression
- Rig Buoyancy
- Required lift
- Moving weight to the diver from the rig
- Balancing your rig
- Self-rescue by partial weight ditching

However, many divers have doubtless chosen this tool to answer just two simple questions:

- 1) “How much lead should I put in my weight pockets?”, and 2) “Is my BCD buoyant enough to carry my rig and support me at depth after wetsuit compression?”

With initial data entry complete, the QuikResults Tab immediately displays the answer to those two questions, as well as a bit more. There are no user data entry fields, and the results should be self-explanatory.

2		(Complete First Four Tabs FIRST)	Quick				5 lb lead	Not every diver is a numbers geek. This tab gives you quick access to two key numbers: Required lead, and Required BCD/Wing Lift					
3			Recommendations:				12					to	16 lb lift
4			Inspect cells below to determine if Quick Recommendation is right for you										
5													
6	Weight Requirement:		(for this Salt Water Dive)										
7	PLANNED GAS USE	Adding	4.3 lb.	leaves diver neutrally buoyant at the safety stop									
8		Diver is now	3.5 lb.	buoyant at surface with PLANNED ending pressure(s)									
9													
10													
11													
12	EMERGENCY GAS USE	Adding	4.7 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL tanks to 300 psi									
14		However, this now leaves diver	0 lb.	buoyant at 15 ft with PLANNED GAS USE									
15													
16	BCD/Wing Lift Requirement:		for dive to		80	feet		(chosen from the worst-case scenario below to be at least 2lb buoyant)					
17	Wing Size Needed for		4.7 lb.	carried lead:		16 lb. bladder		(with all weight on rig)					
18				or		12 lb. bladder		(with		4.2 lb.	transferred from rig to diver via belt/harness)		
19	Due To One of these Issues ↓		Fine tune this further on 'Wetsuit' tab										
20													
21													
22		Rig Buoyancy:	-13.9	lb.	surface buoyancy by itself (no diver)								
23		Alternate Rig Buoyancy:	-9.7	lb.	surface buoyancy with		4.2 lb.	transferred from rig to a weightbelt or harness,					
24													
25		Diver buoyancy at depth:	-9.7	lb.	buoyant with full tanks		(at 80 feet)						
26	*** Consult 'Lift' tab to further evaluate consequences of different carried weight on lift requirement ***												

But there are additional factors that can be considered on this tab.

First, the “recommended” weight in the top tan box is the heaviest of three possible recommendations. The heaviest weight is chosen as a “simple” recommendation, so that you will always be able to maintain a safety or decompression stop even if you have used up nearly all your gas. But choosing the heaviest weight flies in the face of the previous discussion that suggests that optimal is being neutral at safety stop depth. If you do not use up your reserve, you will be heavy at your safety stop. Clearly, you must make a choice.

However, for most warm-water single tank configurations, the differences are small enough to be inconsequential (see screenshot on previous page). But even in warm water, carrying added gas means making a decision regarding optimal weighting.

In this example, the diver is carrying an AL40 pony which he plans to bring back full. With the added gas weight carried, he only needs 10.7 pounds to be neutral at 15 feet coming back with a planned 750 psi in his main tank. Why not just carry 11 pounds of lead?

(Complete First Four Tabs FIRST)		Quick Recommendations:		14 lb lead	Not every diver is a numbers geek. This tab gives you quick access to two key numbers: Required lead, and Required BCD/Wing Lift
		20	to	27 lb lift	
Inspect cells below to determine if Quick Recommendation is right for you					
Weight Requirement:		(for this Salt Water Dive)			
PLANNED GAS USE	Adding	10.7 lb.	leaves diver neutrally buoyant at the safety stop		
	Diver is now	6.5 lb.	buoyant at surface with PLANNED ending pressure(s)		
	OR: Adding	12.2 lb.	yields -1.5 lb. buoyancy at safety stop with PLANNED ending tank pressure(s)		
	Diver is now	5.0 lb.	buoyant at the surface, reducing the risk of 'corking'		
Consult the "Lift" tab to investigate this further (Alt weighting allows a max of 5lb/2.5kg surface buoyancy)					
EMERGENCY GAS USE	Adding	14.5 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL tanks to 300 psi		
			However, this now leaves diver	-4 lb.	buoyant at 15 ft with PLANNED GAS USE
BCD/Wing Lift Requirement:		for dive to 80 feet (chosen from the worst-case scenario below to be at least 2lb buoyant)			
Wing Size Needed for		14.5 lb.	carried lead:	27 lb. bladder	(with all weight on rig)
			or	20 lb. bladder	(with 7.0 lb. transferred from rig to diver via belt/harness)
Due To One of these Issues ↓		Fine tune this further on 'Wetsuit' tab			
Rig Buoyancy:		-25.0 lb.	surface buoyancy by itself (no diver)		
Alternate Rig Buoyancy:		-17.9 lb.	surface buoyancy with 7.0 lb. transferred from rig to a weightbelt or harness,		
Diver buoyancy at depth:		-17.9 lb.	buoyant with full tanks (at 80 feet)		
*** Consult 'Lift' tab to further evaluate consequences of different carried weight on lift requirement ***					
WARNING! This is experimental data derived from physics formulas and modestly tested buoyancy data. Do not rely on this data alone for dive planning.					

In the event that this diver needed to use both his reserve gas and his pony's gas due to an emergency, unexpected delay or higher gas requirement, the spreadsheet computes that he will be 4 pounds buoyant at his safety stop. Being unable to maintain the stop might increase the risk of DCS. Therefore, the spreadsheet chooses to recommend the weight that will leave the diver neutral if he is forced to use nearly all his available gas (300 psi remaining in all tanks). In the area below the Quick Recommendation, it then points out the risk of that added weight:

EMERGENCY GAS USE	Adding	14.5 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL tanks to 300 psi
			However, this now leaves diver -4 lb. buoyant at 15 ft with PLANNED GAS USE

There is another consideration. In Row 9, (only visible when applicable) the tab points out that being neutrally buoyant at the safety stop in neoprene comes at the possible price of excessive positive buoyancy upon reaching the surface, increasing the risk of a rapid final ascent. It then provides a solution to the problem, suggesting a weight which will avoid the problem, at the cost of some negative buoyancy at the safety stop.

The tool suggests a weight that will leave the diver no more than 5lb/2.5kg buoyant at the surface, and gives the resulting negative buoyancy at 15'/5m. If this weight is heavier than the emergency gas weight requirement, it will be selected as the Recommended Weight to be carried.

But you, the diver, have to make a choice. The spreadsheet's recommendation comes at a price, and you may well choose one of the other options based upon your individual dive circumstances.

Finally, when considering the Lift Recommendation, if all weight is carried in integrated pockets, the required bcd lift may be greater than would otherwise be needed had weight been transferred from the rig to a weight belt or weight harness. This can occur when total carried lead exceeds the required buoyancy of the bcd when environmental suit buoyancy is included. In this case, the bcd must at least be able to float itself, and that becomes the driving consideration for bladder size.

BCD/Wing Lift Requirement:			for dive to 80 feet (chosen from the worst-case scenario below to be at least 2lb buoyant)	
Wing Size Needed for 14.5 lb.		carried lead:	27 lb. bladder	(with all weight on rig)
		or	20 lb. bladder	(with 7.0 lb. transferred from rig to diver via belt/harness)
Due To One of these Issues ↓		Fine tune this further on 'Wetsuit' tab		
Rig Buoyancy:		-25.0 lb.	surface buoyancy by itself (no diver)	
Alternate Rig Buoyancy:		-17.9 lb.	surface buoyancy with 7.0 lb. transferred from rig to a weightbelt or harness,	

The QuikResults tab suggests a weight transfer to a weight belt or harness that will minimize required bcd lift. Thus, a diver with a smaller bcd bladder will discover one way to dive safely with that configuration. Keep in mind that the spreadsheet always recommends a bladder size which will leave the rig at least 2 lb/1 kg buoyant.

If the information provided by the QuikResults tab is intriguing, the rest of the spreadsheet offers even more!

The Lift tab is discussed next.

This tab allows you to fine tune your choice of weight, evaluate the buoyancy of your rig, experiment with moving weight from integrated pockets to a weight belt or harness, and examine buoyancy if weights are ditched in an emergency at the surface.

The Lift Tab

The Lift tab computes

- 1) Starting Net Surface Buoyancy (with an empty bcd)

	Surface
NET Buoyancy with weights & full tank(s) without BCD lift:	-0.4

- 2) Rig Surface Buoyancy without the flotation provided by the diver's exposure suit or BCD air

Rig Buoyancy (not incl. diver)	-25.1
--------------------------------	-------

- 3) Buoyancy at the surface, at 15'/5m, Half Max Dive Depth, and Max Dive Depth
- 4) Buoyancy at Dive Start (full tank) and Dive End (based upon defaults of 500psi/40 bar tank pressure), **OR** the planned ending gas pressures you specified in the Tanks tab
- 5) Buoyancy at minimum possible remaining gas—300 psi/20 bar

	Surface	At 15 ft	50	100	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	-9.1	-12.6	-15.2	-16.9	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	-4.3	-7.7	-10.3	-12.1	<--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	-3.8	-7.3	-9.9	-11.6	

- 6) BCD bladder/wing lift requirement with and without the contribution of the diver's suit buoyancy

Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	50	100	feet
Rig Lift Requirement <u>without</u> Diver Buoyancy	14.8	14.8	14.8	14.8	
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	2.0		10.4	13.6	

- 7) Lift needed in case you happen to jump in with your gas off and no air in your BCD, **once you ditch your weight pockets**. You MUST be able to swim this up, or be able to get out of your rig quickly!

	Surface	At 15 ft	50	100	feet
Total Lift Required @ Dive Start if weights are dropped	None		5.4	8.6	

- 8) Adequacy of your BCD/wing for flooded drysuit (if applicable):

Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	50	100	feet
Rig Lift Requirement <u>without</u> Diver Buoyancy	25.1	25.1	25.1	25.1	
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	6.3		6.3	6.3	
Total Lift Req. @ Dive Start w/weights dropped	None		None	None	
Max Lift Requirement with Flooded Drysuit (full tanks)	31.1		31.1	31.1	
Max Lift Req with Flooded Drysuit if all weight dropped	13.1		13.1	13.1	
Is BCD/Wing adequate lift for flooded drysuit?	NO	← A "NO" here? Try a bigger wing or explore further on the Drysuit - Weight Ditching Page			
Is BCD/Wing adequate lift for flooded drysuit					
if ALL ditchable weight is dropped?	YES				

As noted in QuikResults, excess positive buoyancy at the surface may make you more prone to “corking” in the last 15ft/5m of ascent. Especially with thick neoprene, you may choose to accept slightly more negative buoyancy at your safety stop, in order to make a more controlled final ascent.

Consider adding weight similar to the alternative weighting in QuikResults Line 9, and re-evaluate your buoyancy. Here, we’ve added two more pounds of lead to reduce “corking” risk.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0				
ENTER Ditchable Integrated (Rig) Weight Here:	-12.0				
ENTER Ditchable Weightbelt Weight Here:	-2.0				
Number: Negative values sink; positive values float					
NET Buoyancy with weights & full tank(s) without BCD lift:	-1.5	-7.9	-12.8	-16.1	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	3.4	-3.1	-8.0	-11.3	<--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	3.8	-2.7	-7.5	-10.8	

EXAMPLE:

A complete lift analysis using **thick neoprene** (worst case for weighting) follows below:

With thick neoprene, while near-zero buoyancy can be obtained at the safety stop with an appropriate amount of added lead, neoprene expansion in the last 15’/5m makes the chance of rapid final ascent a real risk. This is of concern, because the last 15’/5m are a time of increased gradient for offgassing, when a rapid change in depth can be of concern with regard to DCS. Some instructors advise decreasing the rate of ascent during this final phase of ascent to the surface. This requires decreasing positive surface buoyancy. Here is an example of just this sort of problem—this diver has an increased buoyancy of **over 10lb** in 15ft!

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0				
ENTER Ditchable Integrated (Rig) Weight Here:	-20.0				
ENTER Ditchable Weightbelt Weight Here:	0.0				
	Surface	At 15 ft	40	80	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	5.3	-5.1	-13.0	-18.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	10.2	-0.3	-8.2	-13.5	<-
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	10.6	0.2	-7.7	-13.1	

But by adding 6lb lead, surface buoyancy is minimized, though requiring some bcd air at 15’/5m:

ABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight		
ENTER Ditchable Integrated (Rig) Weight Here:	-20.0	<-----	less at 15' at dive		
ENTER Ditchable Weightbelt Weight Here:	-6.0	<-----	your positive buoyancy		
Number: Negative values sink; positive values float	Surface	At 15 ft	40	80	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	-0.7	-11.1	-19.0	-24.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	4.2	-6.3	-14.2	-19.5	<-
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	4.6	-5.8	-13.7	-19.1	

The entire Lift tab requires just one entry and then a little experimentation.

1) In Cell B22, enter your current or planned bcd/wing lift (from the manufacturer).

Enter Wing/BCD bladder lift capacity:	13.0 lb
Rig Buoyancy (not incl. diver)	-7.5
Net weight from rig to weightbelts / quik	5.5

Next, inspect Cell C18 (red border):

"NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift (at 15ft/5m)"

	Surface	At 15 ft	50	100	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	1.5	-4.9	-9.8	-13.1	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	6.4	-0.1	-5.0	-8.3	<--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	6.8	0.3	-4.5	-7.8	


Optimally, this cell should be at or just below zero buoyancy. If neutral at your safety stop with no air in your bcd, you should be able to maintain stop depth with minimal effort.

Any negative buoyancy will require air in your bcd. Any positive buoyancy will require a fixed tether (a hold bar), temporary weights obtainable at the safety stop, or exhalation to a lower lung volume to hold depth.

If you start with no carried weight in cells B13-15, then you will likely be very positive at your safety stop. This makes sense - after all, that's why we carry lead weight:

	Surface	At 15 ft	50	100	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	12.5	6.1	1.2	-2.1	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	17.4	10.9	6.0	2.7	<--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	17.8	11.3	6.5	3.2	

At this point, the amount of additional weight attached to the rig can be manipulated to bring buoyancy at the safety stop to zero or just below, decreasing the need for any air in the bcd during this critical period.

It is easiest to start by placing the recommended lead from QuikResults  in Ditchable Integrated (Rig) Weight (Cell B14).

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight which will give you zero buoyancy or less at 15' at dive end in Cell C18 below. Then assess your positive buoyancy at the surface, and determine if you need more weight	QuikResults Recommendation 12 lb carried lead
ENTER Ditchable Integrated (Rig) Weight Here:	0.0	<-----		
ENTER Ditchable Weightbelt Weight Here:	0.0	<-----		

positive values float

ENTER Ditchable Integrated (Rig) Weight Here: -12.0

Amounts can then be adjusted from here.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0				
ENTER Ditchable Integrated (Rig) Weight Here:	-12.0				
ENTER Ditchable Weightbelt Weight Here:	0.0				
NET Buoyancy with weights & full tank(s) without BCD lift:	0.5	-5.9	-10.8	-14.1	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	5.4	-1.1	-6.0	-9.3	<--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	5.8	-0.7	-5.5	-8.8	

Note this warning placed to the right of the Buoyancy cells:

<----- While zero buoyancy at 15'/5m is the desired result, there is a significant buoyancy change as you rise to the surface with thick neoprene. You may need to accept some negative buoyancy at 15' to avoid "corking" as you rise the last 15'/5m.

Based on this consideration, add or remove weight from Cells B13, B14 and B15 until you have an acceptable negative buoyancy at your safety stop and acceptable positive buoyancy at the surface.

Next, make a check of your buoyancy vs lift at depth. Rows 17-19 contain this information. Compare that with your bcd lift in Cell B22.

17	NET Buoyancy with weights & full tank(s) without BCD lift:	-0.7	-11.1	-19.0	-24.4	lb
18	NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	4.2	-6.3	-14.2	-19.5	--
19	NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	4.6	-5.8	-13.7	-19.1	
20	BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17)					
21						
22	Enter Wing/BCD bladder lift capacity:	30.0	lb			
23	Rig Buoyancy with full tanks (not incl. diver)	-29.2				
24	?? Move weight from rig to weightbelt/suit??	YES	1.2	lb		
25	↑ Assumption: Rig should be at least 2 lb buoyant					

Finally, in Row 23 we see your rig's inherent buoyancy without you wearing it. This is an important last step in case you doff your rig. If your rig's negative buoyancy is greater than the lift in your bcd/wing, your rig will sink. In our example, since we added all 12lb to weight pockets, we brought rig negative buoyancy to within ~5lb of the BCD's lift capacity. Row 23 has a yes/no suggestion to transfer integrated weight from a pouch or trim pocket to a weight belt, which turns "Yes" if your rig is not at least 2lb/1kg buoyant by itself. Additionally, a warning will appear if the rig is too heavy for the BCD.

For Northern California cold water divers, splitting weight between integrated and weight belt is a frequent practice to help ensure neutral buoyancy without your rig, should you need to doff it underwater, perhaps after becoming entangled in kelp. Without weight belt lead, your positive buoyancy upon shedding your rig may make self-rescue significantly more difficult, not to mention creating excessive negative rig buoyancy, as discussed above.

If you are a cold water wetsuit diver aiming at neutral

	Surface	At 15 ft	40	80	feet
Suit Buoyancy in Salt Water	33.5	23.0	15.2	9.8	
Net Buoyancy not including BCD/Wing or ditchable lead	25.3	14.9	7.8	1.6	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:	-6.0				
ENTER Ditchable Integrated (Rig) Weight Here:	-5.0				
ENTER Ditchable Weightbelt Weight Here:	-15.0				
NET Buoyancy with weights & full tank(s) without BCD lift:	-0.7	-11.1	-19.0	-24.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	4.2	-6.3	-14.2	-19.5	--
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	4.6	-5.8	-13.7	-19.1	

buoyancy at depth in your suit when out of your rig, consider wearing weight belt lead roughly equal to the buoyancy in Lift tab Cell D11: **"Suit Buoyancy in Salt/Fresh Water"** at half maximum dive depth. As you can see, this addition has made this diver -6.3# at the safety stop, so some more weight needs to come out of the weight pockets to compensate.

Divers who carry more than one tank have an additional consideration: they often plan to return with significant reserve gas, with its attendant weight. A diver with an AL19 or AL40 pony may plan to never use it, and thus return with an extra 1.5 to 3 lb of gas weight. A doubles diver with additional decompression bottles of EAN50 and Oxygen may plan the dive to return with 1000 psi each in two doubles tanks, half of his EAN50, and 1/3 of his oxygen unused. This diver has more than 8 lb of unconsumed gas weight upon finishing a final deco stop. What are the weighting considerations with that weight, and how do they change if there is an emergency, and ALL available gas is consumed by an accompanying buddy, or by the diver himself due to surfacing delay? The next section discusses how the Lift tab addresses these issues.

Lift Tab: Diving with Multiple Tanks

As noted in the QuikResults discussion on page 16, the spreadsheet makes an initial recommendation of carried weight based upon the heavier of 1) weight required to counteract wetsuit expansion on ascent, leaving the diver <5lb buoyant at the surface, or 2) weight to keep diver neutral at 15'/5m after all gas is consumed in an emergency (down to 300 psi/20 bar).

A diver carrying an AL40 pony, or a decompression diver carrying doubles plus stage bottles, may plan to return with between 3 lb and 9 lb unused reserve gas weight. He or she may be tempted to dive with that much less lead, so as to be neutrally buoyant at the last deco stop. However, the QuikResults tab recommends a weight that is predicated on that gas all being used in an emergency, because for a deco diver, not being able to hold a stop due to underweighting is a greater problem than being forced to fin up against 3-9 lb. If you are a no-stop diver, that may not be necessary.

The Lift tab allows you to look at this in greater detail, so as to decide among your options. They include: 1) weighting for zero buoyancy at your last stop; 2) weighting for optimum surface buoyancy as your wetsuit expands in the last 10-15 feet; 3) weighting for zero buoyancy in the event that all tanks return near-empty and 4) weighting for optimal surface buoyancy with empty tanks.

What the spreadsheet **cannot** do is account simultaneously for one of the above options, as well as release of a buoyant stage bottle that is no longer necessary. For these types of scenarios, you will need to do two sequential runs of buoyancy data, with and without the tank in question. The reason that two runs are necessary is that 1) initial buoyancy requirements for your wing are predicated upon all full tanks, while 2) end-dive weighting requirements are predicated upon the tanks you retain and the gas within them. Two unneeded 80AL stage bottles with 8lb of lift can be released to allow you to hold a deco stop, but the spreadsheet is not yet programmed to specify releaseable tanks. Giving results based upon ALL possible options yields excessively complex results for the average user. The consequence is that multi-tank divers have to do a little extra work.

The Lift tab, unlike QuikResults, does not make any assumptions. Your weight is chosen manually (although the recommendation from QuikResults is presented on the Lift page for information only).

Here is the QuikResults page for a diver in a thick wetsuit, BP/W with 40lb bladder, steel doubles, carrying one each AL80 and AL40 decompression tanks. Use of a wetsuit with this configuration is often said to be ill advised. We'll also do a drysuit example next , but let's explore this further.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R						
1																								
2		(Complete First Four Tabs FIRST)	Quick Recommendations: 17 lb lead 38 to 49 lb lift										Not every diver is a numbers geek. This tab gives you quick access to two key numbers: Required lead, and Required BCD/Wing Lift											
3																								
4			Inspect cells below to determine if Quick Recommendation is right for you																					
5																								
6		Weight Requirement:			(for this Salt Water Dive)																			
7	PLANNED GAS USE	Adding	10.7 lb.	leaves diver neutrally buoyant at the safety stop																				
8		Warning:	Diver is now	10.5 lb.	buoyant at surface with PLANNED ending pressure(s)																			
9		OR: Adding	16.1 lb.	yields	-5.5 lb.	buoyancy at safety stop with PLANNED ending tank pressure(s)																		
10			Diver is now	5.0 lb.	buoyant at the surface, reducing the risk of 'corking'																			
11			Consult the "Lift" tab to investigate this further (Alt weighting allows a max of 5lb/2.5kg surface buoyancy)																					
12																								
13	EMERGENCY GAS USE	Adding	16.9 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL retained tanks to 300 psi																				
14			However,	this now leaves diver	-6 lb.	buoyant at 15 ft with PLANNED GAS USE																		
15	-----																							
16	BCD/Wing Lift Requirement:			for dive to		80 feet	(chosen from the worst-case scenario below to be at least 2lb buoyant)																	
17	Wing Size Needed for		16.9 lb.	carried lead:		49 lb. bladder	(with all weight on rig)																	
18				or		38 lb. bladder	(with 10.7 lb. transferred from rig to diver via belt/harness)																	
19	Due To One of these Issues ↓			Fine tune this further on 'Wetsuit' tab																				
20																								
21																								
22			Rig Buoyancy:	-46.1 lb.	surface buoyancy by itself (no diver)																			
23			Alternate Rig Buoyancy:	-35.4 lb.	surface buoyancy with 10.7 lb. transferred from rig to a weightbelt or harness,																			
24																								
25			Diver buoyancy at depth:	-35.3 lb.	buoyant with full tanks (at 80 feet)																			
26	*** Consult 'Lift' tab to further evaluate consequences of different carried weight on lift requirement ***																							

Here, for comparison is the Lift page, with the first weight possibility entered. QuikResults prescribed 10.7 lb lead to render the diver neutral at the end of the last "10'-20' deco stop" (15' used for computations), after using all planned gas.

DIRECTIONS IN ROW 35		IMPERIAL UNITS! (LB and FEET)				
Data from "Diver&Dive" tab		Surface	At 15 ft	40	80	feet
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)		-10.5	-10.5	-10.5	-10.5	lb
Weight of Air Carried		-24.3	-24.3	-24.3	-24.3	
EMPTY tank buoyancy		5.6	5.6	5.6	5.6	
Personal Buoyancy		1.0	1.0	1.0	1.0	
Suit Buoyancy in Salt Water		33.5	23.0	15.2	9.8	
Net Buoyancy not including BCD/Wing or ditchable lead		5.3	-5.2	-13.1	-18.4	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:		0.0	<-----			Choose a total weight
ENTER Ditchable Integrated (Rig) Weight Here:		-11.0	<-----			less at 15' at dive
ENTER Ditchable Weightbelt Weight Here:		0.0	<-----			your positive buoyancy
number: Negative values sink; positive values float						
NET Buoyancy with weights & full tank(s) without BCD lift:		-5.7	16.2	-24.1	-29.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:		10.1	-0.3	-8.2	-13.6	<---
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:		16.3	5.9	-2.0	-7.4	
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑						
Enter Wing/BCD bladder lift capacity:		40.0 lb				
Rig Buoyancy with full tanks (not incl. diver)		-40.2				RIG TOO HEAVY FOR BCD!
?? Move weight from rig to weightbelt/suit??		YES	2.2 lb			

As predicted by QuikResults, the diver is indeed neutral at 15' with 1000 psi left in each of his doubles tanks, 1500 psi left in his EAN50 AL80, and 1000 psi left in his AL40 oxygen deco bottle. However, Quik Results also notes that the bladder lift requirement can be reduced by transferring up to 10.7 lb from the rig to a weightbelt or harness. Here, the Lift tab specifies that moving 2.2 lb will make the rig at least 2lb buoyant should it need to be doffed. Lets move 4 lb.

	Surface	At 15 ft	40	80	feet
Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0		<-----		Choose a total weight
ENTER Ditchable Integrated (Rig) Weight Here:	-7.0		<-----		less at 15' at dive
ENTER Ditchable Weightbelt Weight Here:	-4.0		<-----		your positive buoyancy
number: Negative values sink; positive values float					
NET Buoyancy with weights & full tank(s) without BCD lift:	-5.7	-16.2	-24.1	-29.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	10.1	-0.3	-8.2	-13.6	<---
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	16.3	5.9	-2.0	-7.4	
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑					
Enter Wing/BCD bladder lift capacity:	40.0 lb				
Rig Buoyancy with full tanks (not incl. diver)	-36.2				
?? Move weight from rig to weightbelt/suit??	No	0.0 lb			

The next issue that needs to be addressed is the buoyancy change from 15' to the surface due to wetsuit re-expansion. With planned gas usage, a shift to +10 lb buoyancy is significant, but controllable during final ascent from the last deco stop by exhaling fully (which can result in a buoyancy change of -3 to -7 lb). But what if all gas is used due to an unexpected emergency or delayed ascent? Can this diver hold the last stop when +5.9 lb buoyant? Can he control his final ascent if he is ending up with +16 lb buoyancy?

	Surface	At 15 ft
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	10.1	-0.3
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	16.3	5.9

In order to control this, let's add an additional 6 lb, for a total of 17 lb carried lead.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight less at 15' at dive your positive buoyancy
ENTER Ditchable Integrated (Rig) Weight Here:	-7.0	<-----	
ENTER Ditchable Weightbelt Weight Here:	-10.0	<-----	
number: Negative values sink; positive values float			
NET Buoyancy with weights & full tank(s) without BCD lift:	-11.7	-22.2	-30.1
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	4.1	-6.3	-14.2
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	10.3	-0.1	-8.0
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑			
	↓		
Enter Wing/BCD bladder lift capacity:	40.0 lb	MARGINAL BCD LIFT AT DEPTH	
Rig Buoyancy with full tanks (not incl. diver)	-36.2		
?? Move weight from rig to weightbelt/suit??	No	0.0 lb	

We have now rendered this diver neutral at 15' in the event that all tanks are breathed down to 300 psi, at the cost of leaving the diver -6.3 lb negatively buoyant at that depth if the dive goes as planned, and 6 lb of reserve gas is still on board.

Finally, we need to evaluate redundant buoyancy requirements. While this is more easily done on the Balanced Rig tab, suffice it to say that in the event of bladder rupture, this diver might need as much as 35 lb of redundant lift at depth at the beginning of a dive.

On the basis of this analysis, one can say that with some form of redundant lift available, this dive can be safely accomplished in thick neoprene with steel doubles.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight less at 15' at dive your positive buoyancy
ENTER Ditchable Integrated (Rig) Weight Here:	-7.0	<-----	
ENTER Ditchable Weightbelt Weight Here:	-10.0	<-----	
number: Negative values sink; positive values float			
NET Buoyancy with weights & full tank(s) without BCD lift:	-11.7	-22.2	-30.1
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	4.1	-6.3	-14.2
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	10.3	-0.1	-8.0
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑			
	↓		
Enter Wing/BCD bladder lift capacity:	40.0 lb	MARGINAL BCD LIFT AT DEPTH	
Rig Buoyancy with full tanks (not incl. diver)	-36.2		
?? Move weight from rig to weightbelt/suit??	No	0.0 lb	

But what if the emergency did occur right at the beginning of the dive? With full doubles, and no significant decompression obligation, both deco bottles could theoretically be jettisoned, and the diver could return to the surface on back gas alone. With a ruptured bcd, how much redundant lift is really necessary? To determine that, without changing any other variables, go back to Tanks and delete the two deco bottles and then return to the Lift tab:

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight less at 15' at dive your positive buoyancy
ENTER Ditchable Integrated (Rig) Weight Here:	-7.0	<-----	
ENTER Ditchable Weightbelt Weight Here:	-10.0	<-----	
number: Negative values sink; positive values float			
NET Buoyancy with weights & full tank(s) without BCD lift:	-9.5	-20.0	-27.8
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	1.4	-9.1	-17.0
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	4.5	-6.0	-13.9

As is not surprising to experienced tec divers, the net improvement from jettisoning full tanks is insignificant, because the aluminum tanks in question are minimally negative when full.

Let us do the same dive in a drysuit, which provides its own redundant buoyancy...

Same diver, same rig, but now in a trilam drysuit with 4mm liner that yields approximately the same surface buoyancy as his previous thick neoprene wetsuit. The first thing that QuikResults tells us is that his previous 40 lb wing is no longer sufficient, in case of drysuit flood:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1																			
2		(Complete First Four Tabs FIRST)	Quick Recommendations:										26 lb lead	Not every diver is a numbers geek. This tab gives you quick access to two key numbers: Required lead, and Required BCD/Wing Lift					
3			Recommendations:										51 to 58 lb lift						
4			Inspect cells below to determine if Quick Recommendation is right for you																
5																			
6		Weight Requirement:		(for this Salt Water Dive)															
7	PLANNED GAS USE	Adding	19.9 lb.	leaves diver neutrally buoyant at the safety stop															
8		Diver is now	1.6 lb.	buoyant at surface with PLANNED ending pressure(s)															
9																			
10																			
11																			
12																			
13	EMERGENCY GAS USE	Adding	26.1 lb.	leaves diver neutrally buoyant (able to hold 10-20 ft. deco/safety stop) after breathing ALL retained tanks to 300 psi															
14			However, this now leaves diver	-6 lb.	buoyant at 15 ft with PLANNED GAS USE														
15																			
16	BCD/Wing Lift Requirement:			for dive to 80 feet (chosen from the worst-case scenario below to be at least 2lb buoyant)															
17		Wing Size Needed for	26.1 lb.	carried lead:	58 lb. bladder		(with all weight on rig)												
18				or	51 lb. bladder		(with 7.2 lb. transferred from rig to diver via belt/harness)												
19		Due To One of these Issues			Fine tune this further on 'Drysuit' tab														
20		Drysuit Flood:	-48.2 lb.	negatively buoyant															
21																			
22		Rig Buoyancy:	-55.4 lb.	surface buoyancy by itself (no diver)															
23		Alternate Rig Buoyancy:	-35.4 lb.	surface buoyancy with 19.9 lb. transferred from rig to a weightbelt or harness,															
24																			
25		Diver buoyancy at depth:	-24.1 lb.	buoyant with full tanks (at 80 feet)															
26	*** Consult 'Lift' tab to further evaluate consequences of different carried weight on lift requirement ***																		

That is a simple fix on the Lift tab. At the same time, we can compare the 19.9 and 26.1 lb weight recommendations in the details of QuikResults. Increasing from 20 lb to 26 lb carried lead will reduce surface buoyancy with empty tanks. Alternatively, using only 20 lb can probably be dived safely by accepting slight drysuit squeeze on ascent from 15'.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----	Choose a total weight less at 15' at dive your positive buoyancy	
ENTER Ditchable Integrated (Rig) Weight Here:	-10.0	<-----		
ENTER Ditchable Weightbelt Weight Here:	-10.0	<-----		
Number: Negative values sink; positive values float				
NET Buoyancy with weights & full tank(s) without BCD lift:	-14.3	-15.9	-17.1	-18.0 lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	1.6	-0.1	-1.2	-2.1
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	7.8	6.1	5.0	4.1
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑				
Enter Wing/BCD bladder lift capacity:	50.0 lb			
Rig Buoyancy with full tanks (not incl. diver)	-39.2			
?? Move weight from rig to weightbelt/suit??	NO	0.0 lb		
↑ Assumption: Rig should be at least				
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	40	80 feet
Rig Lift Requirement without Diver Buoyancy	39.2	39.2	39.2	39.2 lb
Total Lift Requirement at Dive Start including Diver Buoyancy	14.3		17.1	18.0 lb
Total Lift Required @ Dive Start if weights are dropped	None		None	None lb
Max Lift Requirement with Flooded Drysuit (full tanks)	48.2		48.2	48.2 lb
Max Lift Req with Flooded Drysuit if all weight dropped	28.2		28.2	28.2 lb
Is BCD/Wing adequate lift for flooded drysuit?	YES	← A "NO" here? Try a bigger wing or explore further on the Drysuit - Weight Ditching Page		
Is BCD/Wing adequate lift for flooded drysuit if some or all ditchable weight is dropped?	YES			

Note finally (for the data geeks among you), that if a more precise buoyancy prediction at the 10 ft final deco stop is desired, compared with the 15' average chosen for divers whose final stops may be between 10 and 20 feet, it is only necessary to go back to the Diver&Dive tab, and **temporarily** change the maximum depth of the dive to 20 feet or 6 meters:

Units:	Imperial ← Choose from dropdown	
Enter your Height and Weight, and three dive spe		
Diver:		
Height:	70	IN.
Weight:	165	LB.
Salt Water Personal Buoyancy:	1.0	LB.
Correction for Fresh Water:	0.0	LB.
Maximum Dive Depth:		
	20	feet

This will then change the “mid-depth” of this “dive” to 10 feet, and the buoyancy difference between 10 ft and 15 ft (or 3m and 5m) can be directly compared:

	Surface	At 15 ft	10	20	feet
Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0		<-----		
ENTER Ditchable Integrated (Rig) Weight Here:	-10.0		<-----		
ENTER Ditchable Weightbelt Weight Here:	-10.0		<-----		
number: Negative values sink; positive values float					
NET Buoyancy with weights & full tank(s) without BCD lift:	-14.3	-15.9	15.5	-16.3	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	1.6	-0.1	0.4	-0.4	
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	7.8	6.1	6.6	5.8	

As can be seen, the buoyancy increases over the 5 ft are not significant, either after using planned gas, or in an emergency. What is significant is that in the event of a need to use all available gas, buoyancy at the last stop is very positive, and an additional 6 lb lead should probably be added.

Indeed, going to 26 lb is exactly what is recommended in QuikResults,

Quick	26 lb lead
Recommendations:	51 to 58 lb lift

and the reasons are now apparent.

This is the main purpose behind the Lift tab: to enable a diver with complex requirements to see for himself what is behind the QuikResults weight recommendation.

(As a final note for those intent upon the data, the reason that 51 lb of buoyancy is recommended, when we have seen that 50 lb is sufficient for a -48.2 lb buoyancy in the event of drysuit flood, is that the spreadsheet rounds UP to the next integer and adds 2 lb in determining required buoyancy. Thus, a +48.2 offset for drysuit flooding becomes +49 lb, and adding 2 lb yields a recommended 51. It must be emphasized that despite mathematical formula results in tenths of a pound, we do not expect accuracy across the range of divers and rigs closer than 2 to 5 lb, and even that is heavily dependent upon very soft factors such as estimates of personal buoyancy, neoprene age or drysuit liner thickness.)

Fine Tuning the Lift Tab

The Lift tab has several features designed to improve your safety, in addition to determining the weight required for zero buoyancy at a 15'/5m safety stop.

Lift Warning:

In this case, due to wetsuit compression at depth, the diver will be -19lb buoyant at 100 feet with a full tank. With only a 20lb wing, his excess lift is marginal. While he could easily swim up, the spreadsheet still warns re: lift at depth which is less than 5lb/2kg.

	Surface	At 15 ft	50	100	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	-1.3	-8.3	-14.4	-19.3	
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	3.6	-3.4	-9.5	-14.4	<-----
BCD/Wing lift (cell B21) should be more than diver's negative Buoyancy at Depth ↑					
↓					
Enter Wing/BCD bladder lift capacity:	20.0 lb	MARGINAL BCD LIFT AT DEPTH			

Overweight, and Weight Distribution Warnings:

If your rig is adequate to float you, but not big enough to float itself without your exposure suit, another warning will pop up:

Enter Wing/BCD bladder lift capacity:	20.0 lb	MARGINAL BCD LIFT AT DEPTH
Rig Buoyancy (not incl. diver)	-24.0	RIG TOO HEAVY FOR BCD!
?? Move weight from rig to weightbelt/suit??	YES 6.0 lb	You have insufficient movable weight to add to belt

The spreadsheet's convention is that the bcd/wing must have at least 2lb/1kg additional buoyancy beyond the negative buoyancy of the rig. In this case, with a 4lb shortfall in rig buoyancy, the spreadsheet suggests moving 6lb. to a weight belt from the rig, so the rig will reliably float itself if doffed at the surface or underwater in an entanglement. However, the spreadsheet notes that this diver does not have 6lb in integrated pockets to shift to a weight belt, and so gives an additional warning that "You have insufficient movable weight to add to belt." Some shifting between fixed and ditchable weight is in order for this diver, and perhaps a larger bcd bladder.

Wetsuit Expansion Warning:

As discussed above, thick neoprene poses a special risk between the safety stop and the surface, due to the marked buoyancy change in just a few feet. At a time of maximum offgassing when a diver should be ascending especially carefully, large buoyancy changes increase the likelihood of "corking", increasing DCS risk.

Here, a diver in thick neoprene has weighted himself for an optimal safety stop with no air in the bcd, but has very large buoyancy at the surface:

This diver is at risk for an uncontrolled ascent in the final 15 feet, and the spreadsheet warns him with a red surface cell buoyancy.

Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0				
ENTER Ditchable Integrated (Rig) Weight Here:	-20.0				
ENTER Ditchable Weightbelt Weight Here:	0.0				
	Surface	At 15 ft	40	80	feet
NET Buoyancy with weights & full tank(s) without BCD lift:	5.3	-5.1	-13.0	-18.4	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	10.2	-0.3	-8.2	-13.5	<-
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	10.6	0.2	-7.7	-13.1	

Note: Use of the .xls spreadsheet version of this tool (Excel 2003) may result in some conditional formatting warnings being omitted due to spreadsheet limitations.

Fine Tuning the Lift Tab (cont'd)

Drysuit Flood Warning:

In this case, a cold-water drysuit diver has chosen a wing which easily floats his rig. And with his drysuit lift, buoyancy is not a problem. So far so good. However, with heavy steel tanks at the beginning of a dive, his buoyancy is -37lb not including his drysuit, and in the event of an early drysuit flood, his wing does not have sufficient lift to bring him to the surface. This is warned of in the red cell noting insufficient lift.

Enter Wing/BCD bladder lift capacity:	30.0 lb		
Rig Buoyancy (not incl. diver)	-27.1		
?? Move weight from rig to weightbelt/suit??	No	0.0 lb	
Assumption: Rig should be at least			
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	50
Rig Lift Requirement <u>without</u> Diver Buoyancy	27.1	27.1	27.1
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	7.2		7.2
Total Lift Req. @ Dive Start w/weights dropped	None		None
Max Lift Requirement with Flooded Drysuit (full tanks)	37.1		37.1
Max Lift Req with Flooded Drysuit if all weight dropped	21.1		21.1
Is BCD/Wing adequate lift for flooded drysuit?	NO	← A "NO" here? Try a bigger wing or explore further on the Drysuit - Weight Ditching Page	
Is BCD/Wing adequate lift for flooded drysuit if ALL ditchable weight is dropped?	YES		

Note that ditching some weight underwater would be a life-saver, but that is a controversial topic. That topic is discussed further in the weight ditching tabs in the next section.

However, this diver could create a more balanced rig by simply having a larger wing:

Enter Wing/BCD bladder lift capacity:	40.0 lb		
Rig Buoyancy (not incl. diver)	-27.1		
?? Move weight from rig to weightbelt/suit??	No		
Assumption:			
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	50
Rig Lift Requirement <u>without</u> Diver Buoyancy	27.1	27.1	27.1
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	7.2		7.2
Total Lift Req. @ Dive Start w/weights dropped	None		None
Max Lift Requirement with Flooded Drysuit (full tanks)	37.1		37.1
Max Lift Req with Flooded Drysuit if all weight dropped	21.1		21.1
Is BCD/Wing adequate lift for flooded drysuit?	YES	←	
Is BCD/Wing adequate lift for flooded drysuit if ALL ditchable weight is dropped?	YES	big fur	

Wetsuit Buoyancy Controversies: **Evaluating Weight Ditching in the Wetsuit Tab**

Much discussion is devoted to “balanced rigs” and the need to have redundant buoyancy such as a drysuit, in the event of bcd failure. Yet for many divers, wetsuit diving is the local “norm”, or a drysuit is beyond their financial means. How best to ensure safety in the event of a catastrophic bcd failure? Options include using your buddy’s spare lift capability or using an SMB or lift bag, or perhaps a redundant bladder in your wing.

But there is one more option which might be considered: partial weight ditching. If your balanced rig has no ditchable weight, then this is not possible. But the spreadsheet allows you to examine this issue in more detail, to determine why a small amount of ditchable weight might be considered for self-rescue, if your buddy is not near, or if hanging off a lift bag is not desirable as your only other choice. **NOTE: for decompression diving, the risk of being unable to maintain a mandatory decompression stop due to inadvertent loss of weight makes consideration of ditchable weight almost unacceptable. Therefore, this discussion is primarily oriented toward no-stop divers.**

Let us consider an average-sized diver in thick neoprene with a 100 cu ft tank at 80 feet: With a steel backplate and a steel tank, she is carrying a modest 12lb of weight to be near-neutral at dive end at 15’ (-2.2lb), while having a modest +6lb surface buoyancy, allowing for a controlled final ascent.

Her wing lift of 30lb is enough to float her -22lb rig, and more than offsets her -18lb buoyancy at 80 feet at the beginning of a dive with full tanks. Here is her Lift Tab:

Data from "Diver&Dive" tab	Surface	At 15 ft	40	80	feet
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)	-5.5	-5.5	-5.5	-5.5	lb
Weight of Air Carried	-7.7	-7.7	-7.7	-7.7	
EMPTY tank buoyancy	-0.6	-0.6	-0.6	-0.6	
Personal Buoyancy	0.0	0.0	0.0	0.0	
Suit Buoyancy in Salt Water	24.7	17.0	11.2	7.2	
Net Buoyancy not including BCD/Wing or ditchable lead	10.9	3.2	-2.6	-6.5	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0		<-----		Choose a total weigh
ENTER Ditchable Integrated (Rig) Weight Here:	-8.0		<-----		less at 15' at dive en
ENTER Ditchable Weightbelt Weight Here:	-4.0		<-----		your positive buoyan
member: Negative values sink; positive values float					
NET Buoyancy with weights & full tank(s) without BCD lift:	1.1	8.8	-14.6	-18.5	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:	5.5	-2.2	-8.1	-12.0	<-----
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:	5.9	-1.8	-7.6	-11.6	
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell B17) ↑					
Enter Wing/BCD bladder lift capacity:	30.0 lb				
Rig Buoyancy with full tanks (not incl. diver)	-21.8				
?? Move weight from rig to weightbelt/suit??	No	0.0 lb			

But what if her bcd failed at depth? Does she have the strength to swim up against 18lb negative buoyancy? With an absent buddy, does she want to hang off a lift bag, when losing hold might result in a precipitous descent? What if the failure occurs where there is no hard bottom and her buddy is above her? Does she have time to deploy her lift bag before her depth becomes excessive?

Remember, a wetsuit will expand on ascent, so if she can only start up, the trip will get progressively easier. How might one address this problem?

The Wetsuit Tab for this diver might look like this:

As you can see, the spreadsheet asks if the diver feels able to swim up against -18lb with a full tank. It then shows that after ditching 8 of her 12lb, she is now facing only -10lb negative buoyancy. If she can start swimming that up, wetsuit expansion will begin to assist her.

	A	B	C	D	E	F
1	WETSUIT Buoyancy After Partial Weight Ditching					
2	Maximum Dive Depth from "Diver&Dive" tab:	80.0	IMPERIAL UNITS! (PSI, LB & FT)			
3	NON-Ditchable Trim Weight from "Lift" tab:	0.0				
4	Ditchable Integrated (Rig) Weight from "Lift" tab:	-8.0				
5	Ditchable Weightbelt Weight from "Lift" tab:	-4.0				
6	AFTER TOTAL BCD/WING FAILURE:	NOTE: BUOYANCY F				
7	Buoyancy at Depth with Full Tank(s) BEFORE Ditching:	-18.5	< CAN YOU SWIM			
8	Buoyancy at Depth with Half Tank(s) BEFORE Ditching:	-14.7	< THESE WEIGHTS			
9	Buoyancy at Depth with 300psi Tank(s) BEFORE Ditching:	-11.6	< OFF THE BOTTOM?			
10			Ditched Weight:			
11	Total Amount of Weight DITCHED:	8.0				
12	Buoyancy at Depth with Full Tank(s) AFTER Partial Ditching:	-10.5				
13	Buoyancy at Depth with Half Tank(s) AFTER Partial Ditching:					
14	Buoyancy at Depth with 300psi Tank(s) AFTER Partial Ditching:					
15						
16						
17	Change Depth Here to Find Buoyancy At That Depth:	15				
18	Buoyancy with Full Tank(s):	-0.8				

Upon reaching 15ft with a full tank, her buoyancy is now only -0.8lb. She can rest there, and offgas normally, until making a final ascent to the surface. Thus, partial weight ditching allows self-rescue despite a triple failure: NO bcd, NO buddy, NO redundant lift. While the likelihood of such a triple failure is vanishingly small, a solo diver might decide that having this option instead of having to hang off a lift bag might be preferable in the event of a catastrophic failure.

In any case, once she reaches the surface, she is now positively buoyant without having to hang on to redundant buoyancy while awaiting pickup:

Surface Buoyancy with Full Tank(s) after partial ditching:	6.9
--	-----

The following pages detail how to make use of the gray user-entry cells to determine a safe partial weight ditching amount for a wetsuit dive.

But despite the attractiveness of the theory, bear in mind the warning on each weight-ditching page:

WARNING! This is experimental data derived from physics formulas and minimally tested buoyancy data. Do not rely on this data alone for dive planning.

Because buoyancy increases as tank air is breathed off, *any partial weight ditching calculations will change with tank contents*. Nonetheless, it is still feasible to calculate buoyancy at beginning, middle and end of dive to determine self-rescue options by partial ditching. Thus, the spreadsheet is visually arranged to separate each of those three milestones.

It starts by reminding you of your ditchable vs. non-ditchable weight:

	A	B	C	D	E	F
1	WETSUIT Buoyancy After Partial Weight Ditching					
2	Maximum Dive Depth from "Diver&Dive" tab:	80.0	IMPERIAL UNITS! (PSI, LB & FT)			
3	NON-Ditchable Trim Weight from "Lift" tab:	0.0				
4	Ditchable Integrated (Rig) Weight from "Lift" tab:	-8.0				
5	Ditchable Weightbelt Weight from "Lift" tab:	-4.0				

Thus, if no satisfactory solution can be found, you can return to the Lift tab to change how your weight is distributed between ditchable and non-ditchable components.

Next, your status immediately upon wing/bcd failure is displayed for each of three tank levels:

AFTER TOTAL BCD/WING FAILURE:		
Buoyancy at Depth with Full Tank(s) BEFORE Ditching:	-18.5	< CAN YOU SWIM
Buoyancy at Depth with Half Tank(s) BEFORE Ditching:	-14.7	< THESE WEIGHTS
Buoyancy at Depth with 300psi Tank(s) BEFORE Ditching:	-11.6	< OFF THE BOTTOM?

At this point we have the first cells which accept user input. In the gray cells in Row 11, enter a weight ditching amount (as a positive number, since you are increasing buoyancy) which reduces your negative buoyancy to a level which you believe you are able to swim up. This requires, of course, that you test your ability in a pool. Try swimming up various weights in just a bathing suit and fins, until you know your capability. Alternatively, make yourself neutrally buoyant at the bottom in full gear, and try swimming up additional lead weight placed on the bottom for your experiment.

	Ditched Weight:			
Total Amount of Weight DITCHED:	8.0	4.0	12.0	--Enter up to the total ditchable weight from B4 & B5 above.
Buoyancy at Depth with Full Tank(s) AFTER Partial Ditching:	-10.5			--THIS BOX SHOWS THE MAX WEIGHT YOU MIGHT
Buoyancy at Depth with Half Tank(s) AFTER Partial Ditching:		-10.7		HAVE TO SWIM UP AFTER PARTIAL DITCHING
Buoyancy at Depth with 300psi Tank(s) AFTER Partial Ditching:			0.4	ANY RED CELLS MIGHT BE A RUNAWAY ASCENT RISK!

Note that with a Full and Half Tank, this diver has ditched enough weight to reduce her buoyancy to around -10lb; an amount she thinks she can swim up. Remember that as her wetsuit expands, that negative buoyancy will improve, and things will get easier. However, with a near-empty tank (300psi), if this diver ditches so much weight that she is positively buoyant at depth, wetsuit re-expansion on ascent will only make things worse, and she risks the runaway ascent that we are all taught is a consequence of ditching weight at depth. As you can see here, runaway ascents are only occasionally true. Ditching all 12lb with either a half or full tank will still leave this diver negative, with no runaway ascent. But the red cell and warning indicates that ditching 12lb at 300 psi is a safety risk. Less weight should be ditched at this tank setting, and to check this, the gray cell should be changed.

Next, it is necessary to determine the point at which the wetsuit expands just enough to make the diver neutral, and how buoyant she will be upon reaching the surface.

Here are three examples of experimenting with the Full Tank row:
Eight pounds are ditched by entering “8” in Cell D11, and buoyancy can be checked at each of 55, 25 and 15 feet, by sequentially entering those depths in Cell D17:

	1	2	3
Total Amount of Weight DITCHED:	8.0	8.0	8.0
Buoyancy at Depth with Full Tank(s) AFTER Partial Ditching:	-10.5	-10.5	-10.5
Buoyancy at Depth with Half Tank(s) AFTER Partial Ditching:			
Buoyancy at Depth with 300psi Tank(s) AFTER Partial Ditching:			
	If you ditch	you ditch	you ditch
	where you	here you	here you
Change Depth Here to Find Buoyancy At That Depth:	55	25	15
Buoyancy with Full Tank(s):	-8.5	-3.7	-0.8

Buoyancy improves from -8.5lb at 55 feet, to -3.7lb at 25 feet, to -0.8lb at 15 feet, *due solely to wetsuit re-expansion*. Experiment with different amounts of weight ditched and different depths, to find a reasonably shallow depth where you are close to neutral. *In this case, to be neutral at your usual 15’ safety stop, ditch 8lb if your emergency occurs with a full tank.*

The same thing applies to the rest of Row 11 and Row 17.

In this example, by entering different values in the Weight Ditched and Buoyancy rows:
this... becomes this:

	Ditched Weight:			Ditched Weight:		
Total Amount of Weight DITCHED:	8.0	8.0	8.0	8.0	5.0	4.0
Buoyancy at Depth with Full Tank(s) AFTER Partial Ditching:	-10.5			-10.5		
Buoyancy at Depth with Half Tank(s) AFTER Partial Ditching:		-6.7			-9.7	
Buoyancy at Depth with 300psi Tank(s) AFTER Partial Ditching:			-3.6			-7.6
	If you ditch the amount			you ditch the amount		
	where your buoyancy is			here your buoyancy is		
Change Depth Here to Find Buoyancy At That Depth:	13	26	40	13	15	20
Buoyancy with Full Tank(s):	0.0			0.0		
Buoyancy with Half Tank(s):		-0.1			0.0	
Buoyancy with 300 psi (EMERGENCY):			-0.2			0.0

Thus, this no-stop diver might have a slate tucked away with the following data on it:

FULL: 8lb/13ft
HALF: 5lb/15ft
500: 4lb/20ft

In the event of catastrophic failure, ditching the weight on the slate will allow an initially strenuous, but nonetheless lifesaving ascent to neutral buoyancy at the listed depths. Having this sort of advance plan also requires that ditchable lead be arranged to facilitate it.

Equally important, the bottom of the Weight Ditching tab will show the resulting surface buoyancy after ditching, as a final check against a runaway ascent from the neutral depth:

Then after a safety stop at the neutral depth chosen, ascend to surface and arrive with this buoyancy:		
Surface Buoyancy with Full Tank(s) after partial ditching:	6.9	
Surface Buoyancy with Half Tank(s) after partial ditching:		7.8
Surface Buoyancy with 300 psi after partial ditching:		9.3

As we can see, with a final buoyancy of +9.2lb, the 4lb ditch with a near-empty tank is probably excessive, and that row should be recalculated with a smaller amount of ditched weight and a new neutral buoyancy depth, to avoid an excessive final rate of ascent.

Drysuit Buoyancy Controversies: **Evaluating Weight Ditching in the Drysuit Tab**

Diving a balanced rig with heavy steel tanks is most commonly associated with using a drysuit, as the drysuit provides redundant buoyancy in the event of wing/bcd failure. Yet, examining the numbers behind your choice of gear may enable you to identify the limits of using a drysuit for redundant buoyancy. In no-stop diving at least, there is a place for having a small amount of ditchable weight to facilitate self-rescue. In this author's opinion, a small amount of ditchable weight does not make the rig unbalanced. **NOTE: for decompression diving, the risk of being unable to maintain a mandatory decompression stop due to inadvertent loss of weight makes consideration of ditchable weight almost unacceptable. Therefore, this discussion is primarily oriented toward no-stop divers.**

Let's examine a fairly typical scenario. This diver is wearing a trilam suit with a moderately thick liner for a winter fresh water quarry dive. He's diving a steel backplate with a steel 80 cylinder, and is carrying a total of 22# of additional lead. With a near-empty tank, he seems perfectly weighted. Here is the Lift tab:

Lift Calculator: Weight and Lift Requirement vs. Depth						Note:
Experiment with varying weight to obtain zero buoyancy at dive end						
SEE DIRECTIONS IN ROW 35		IMPERIAL UNITS! (LB and FEET)				
Data from "Diver&Dive" tab		Surface	At 15 ft	50	100	feet
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)		-5.5	-5.5	-5.5	-5.5	lb
Weight of Air Carried		-6.2	-6.2	-6.2	-6.2	
EMPTY tank buoyancy		-1.0	-1.0	-1.0	-1.0	
Personal Buoyancy		-4.2	-4.2	-4.2	-4.2	
Suit Buoyancy in Fresh Water		35.1	33.5	32.3	31.2	
Net Buoyancy not including BCD/Wing or ditchable lead		18.2	16.7	15.4	14.3	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:		0.0	<-----		Choose a total weight	
ENTER Ditchable Integrated (Rig) Weight Here:		-12.0	<-----		less at 15' at dive end	
ENTER Ditchable Weightbelt Weight Here:		-10.0	<-----		your positive buoyancy	
Remember: Negative values sink; positive values float						
NET Buoyancy with weights & full tank(s) without BCD lift:		-3.8	-5.3	-6.6	-7.7	lb
NET Buoyancy w/weights and PLANNED GAS AT DIVE END, but without BCD lift:		1.2	-0.3	-1.6	-2.7	
NET Buoyancy w/weights and MINIMUM GAS, but without BCD lift:		1.6	0.1	-1.2	-2.2	
BCD/Wing lift (Cell B22) should be more than diver's negative Buoyancy at Depth (Cell F17) ↑						
		↓				
Enter Wing/BCD bladder lift capacity:		30.0	lb			
Rig Buoyancy with full tanks (not incl. diver)		-24.7				
?? Move weight from rig to weightbelt/suit??		No	0.0	lb		
		↑ Assumption: Rig should be at least				
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:		Surface	At 15 ft	50	100	feet
Rig Lift Requirement without Diver Buoyancy		24.7	24.7	24.7	24.7	lb
Total Lift Requirement at Dive Start including Diver Buoyancy		3.8		6.6	7.7	lb
Total Lift Required @ Dive Start if weights are dropped		None		None	None	lb
Max Lift Requirement with Flooded Drysuit (full tanks)		33.0		35.8	36.8	lb
Max Lift Req with Flooded Drysuit if all weight dropped		11.0		13.8	14.8	lb
Is BCD/Wing adequate lift for flooded drysuit?		NO	← A "NO" here? Try a bigger wing or explore further on the Drysuit - Weight Ditching Page			
Is BCD/Wing adequate lift for flooded drysuit if some or all ditchable weight is dropped?		YES				

His wing has 30lb of lift; more than enough to offset the -25lb buoyancy of his rig. And yet, the spreadsheet tells us that he does not have sufficient buoyancy to compensate for a flooded drysuit at the beginning of a dive with full tanks. He will be 33lb negative with a 30lb wing.

The simple solution is to use a larger wing. But if you can't just go out and buy a bigger wing, there is still a straightforward way to increase safety for no-stop diving. Looking at the Drysuit tab suggests an answer.

The Drysuit - Weight Ditching Tab

The Drysuit tab dissects the data from the Lift tab with a specific eye on two problems: Wing/BCD failure, and Drysuit Flooding. Considering our cold water diver on the preceding page, let's examine BCD failure.

With regard to BCD failure, the redundant buoyancy of a drysuit generally makes a torn wing a non-issue. With 16lb of supplemental lift in this drysuit, and a maximum of -7.7lb negative buoyancy with a full tank, it is a simple matter to add enough air to the suit to be able to surface. The Drysuit tab examines buoyancy at four points in a dive: Full Tank, Half Tank, Planned Ending Pressure, and after a potential emergency requiring use of all gas down to 300 psi.

DRYSUIT Buoyancy And Partial Weight Ditching		IMPERIAL UNITS! (LB & P			
Complete "Lift" tab first. See DIRECTIONS In Row 43.					
Ditchable Integrated (Rig) Wt from "Lift" tab:		-12.0			
Ditchable Weightbelt Wt from "Lift" tab:		-10.0			
Excel Freeze Panes Feature Operating. Scroll up or down to see full spreadsheet while still viewing total ditchable weight					
BCD FAILURE					
Supplemental lift available from drysuit:		16.3 lb.	<--See User's Manual fo		
		Full Tank	Half Tank	Dive End	Emergency
Buoyancy at depth with Full Tank BEFORE using drysuit supplemental lift:		-7.7			
Buoyancy added from drysuit supplemental lift:		7.7			
Buoyancy at depth with Half Tank BEFORE using drysuit supplemental lift:		-4.6			
Buoyancy added from drysuit supplemental lift:		4.6			
Buoyancy at depth with PLANNED RESIDUAL GAS, BEFORE using drysuit supplemental lift:		-2.7			
Buoyancy added from drysuit supplemental lift:		2.7			
Buoyancy at depth with 300 psi in all tanks, BEFORE using drysuit supplemental lift:		-2.2			
Buoyancy added from drysuit supplemental lift:		2.2			
NET BUOYANCY AT DEPTH BEFORE DITCHING:		0.0	0.0	0.0	0.0
In the event of bcd/wing failure, can your drysuit provide sufficient lift?		YES	YES	YES	YES
From Lift Tab - Ditchable Weight Carried:		-22.0			

One time a torn wing might be an issue is when wearing a steel tank in cold water with a thick drysuit liner. Since the suit is already fairly full from the liner, there is much less suit expansion left before the suit begins to leak from a seal, or you have significant limitation in mobility *a la* "Michelin Man." In this situation, it is possible with a failed wing and full tanks at the beginning of a dive, to need more buoyancy than your drysuit can provide with added air, especially in the head-up position. This position places the greatest strain on the neck seal. Here is an example:

Now it is a relatively small matter to (in this case) swim up against -2.4lb negative buoyancy and jettison weight at the surface. It is even simpler to, as the spreadsheet suggests, jettison 3lb of your ditchable weight and be neutral, dumping the rest at the surface for safety.

BCD FAILURE					
Supplemental lift available from drysuit:		6.9 lb.	<--See User's Manual for		
		Full Tank	Half Tank	Dive End	Emergency
Buoyancy at depth with Full Tank BEFORE using drysuit supplemental lift:		-9.3			
Buoyancy added from drysuit supplemental lift:		6.9			
Buoyancy at depth with Half Tank BEFORE using drysuit supplemental lift:		-6.2			
Buoyancy added from drysuit supplemental lift:		6.2			
Buoyancy at depth with PLANNED RESIDUAL GAS, BEFORE using drysuit supplemental lift:		-4.3			
Buoyancy added from drysuit supplemental lift:		4.3			
Buoyancy at depth with 300 psi in all tanks, BEFORE using drysuit supplemental lift:		-3.8			
Buoyancy added from drysuit supplemental lift:		3.8			
NET BUOYANCY AT DEPTH BEFORE DITCHING:		-2.4	0.0	0.0	0.0
In the event of bcd/wing failure, can your drysuit provide sufficient lift?		NO	YES	YES	YES
From Lift Tab - Ditchable Weight Carried:		-20.0			
Weight Ditched:		3.0	0.0	0.0	0.0
Buoyancy at depth with Full Tank AFTER Ditching Weight Above:		0.6			
Buoyancy at depth with Half Tank AFTER Ditching Weight Above:			0.0		
Buoyancy at depth with PLANNED RESIDUAL GAS, AFTER Ditching Weight Above:				0.0	
Buoyancy at depth with 300 psi in all tanks, AFTER Ditching Weight Above:					0.0
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:		0.0	0.0	0.0	0.0
With bcd/wing failure, can ditching weight plus drysuit provide sufficient lift?		YES	YES	YES	YES

But it is simple only if you know in advance. *And that is the point of these ditching tabs.* With preplanning and a little data, a partial weight ditch can be a reasonable alternative for self-rescue for a no-stop diver.

However, a drysuit flood is a more serious issue. The spreadsheet assumes a 100% loss of drysuit buoyancy upon flooding. We know this is seldom the case, as some buoyancy can be retained with trapped air in an arm or leg. Nonetheless, assuming 100% loss of buoyancy means a loss of 52lb of drysuit lift, in the example of a thick drysuit with heavy doubles above!

1	DRYSUIT Buoyancy And Partial Weight Ditching	IMPERIAL UNITS! (LB & PSI)			
2	Complete "Lift" tab first. See DIRECTIONS In Row 43.				
3	Ditchable Integrated (Rig) Wt from "Lift" tab:	-20.0			
4	Ditchable Weightbelt Wt from "Lift" tab:	-20.0			
5	Excel Freeze Panes Feature Operating. Scroll up or down to see full spreadsheet while still viewing total ditchable weight				
30	FLOODED DRYSUIT				
31		Full Tank	Half Tank	Dive End	Emergency
32	Buoyancy at depth before drysuit flooding not including wing lift	-9.3	-6.2	-4.3	-3.8
33	Lost Drysuit Lift with Flooding	-51.5	-51.5	-51.5	-51.5
34	Buoyancy at depth with Flooded Drysuit not including wing lift	-60.8	-57.7	-55.8	-55.4
35	From Lift Tab - BCD/Wing Lift Capacity:	50	50	50	50
36	Net Buoyancy at depth with Flooded Drysuit and Full BCD/Wing:	-10.8	-7.7	-5.8	-5.4
37	In the event of drysuit flooding, can filling your wing provide sufficient lift?	NO	NO	NO	NO
38	REDUNDANT BUOYANCY NEEDED BEFORE DITCHING WEIGHT	11	8	6	6
39	From Lift Tab - Ditchable Weight Carried:	-40.0			
40	Weight Ditched:	11.0	8.0	6.0	6.0
41	Buoyancy at depth with Flooded Drysuit and Full BCD/Wing AFTER Ditching Weight Above:	0.2	0.3	0.2	0.6
42	In case of drysuit flood, can ditching weight plus filling wing provide sufficient lift?	YES	YES	YES	YES
43	REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:	0	0	0	0
44	Surface Buoyancy after ditching weight above:	15.0	12.1	10.0	10.5
45					

How does the spreadsheet evaluate that scenario?

Carrying a 50lb wing with steel tanks, we see that this diver with a thick flooded drysuit is now more than 60lb negatively buoyant due to a drysuit flood with full tanks at the beginning of a dive. In retrospect, he should have chosen a larger wing. Yet, this would not be the first time a diver with a drysuit flood has been surprised by the extent of his negative buoyancy.

Even so, once he fills his wing, he is only -10.8lb negative and *might* ascend with effort, jettisoning his weights at the surface. At less than full tanks, he is still negative, but things become easier.

Alternatively however, *by jettisoning weight at depth*, this diver becomes neutrally buoyant at depth, and can swim up with ease, venting from his bcd as needed, and then either fully inflate his bcd or jettison the rest of the weight at the surface.

Proponents of “balanced rigs” do not agree whether having ditchable weight is consistent with the definition of “balanced.” Nonetheless, ditching weight in this instance will clearly turn a potentially fatal equipment failure into a survivable scenario.

Thus, having preplanned his response to the two scenarios above, this no-stop diver *might* carry an emergency weight ditching slate like one of these:

BCD FAIL:

Full: 3#

Half: 0

DRYSUIT FAIL:

Full: 11#

Half: 8#

Empty: 6#

or

BCD: 3/0/0

SUIT: 11/8/6

Having this sort of advance plan also requires that ditchable lead be arranged to facilitate these drops.

The Balanced Rig Tab

A 42-page thread from 2018 on <https://www.scubaboard.com> entitled “Question about ‘balanced rigs’ and having all ballast unditchable” was a comprehensive discussion of balanced rigs from both proponents and naysayers. Courtesy of @PfcAJ, @boulderjohn, @Dan_P and others, I have pieced together this tentative definition of a “balanced rig.” A Balanced Rig is one that:

- a) is weighted so that the diver is neutral at the last stop/safety stop with an empty BCD and near-empty tanks; and,
- b) can be weighted to allow a swim to the surface in the event of BCD/wing failure or drysuit flood with full tanks; or,
- c) is designed with redundant buoyancy if both a) and b) cannot be satisfied at the same time; and ideally,
- d) is designed so that positive buoyancy can be established for a extended period after reaching the surface.”

The discussion dispelled one myth: that balanced rigs cannot incorporate any ditchable weight.

Occasionally, there are configurations where incorporating ditchable weight is impossible. Consider a warm water dive to the Spiegel Grove off Key Largo, with minimum deco time, by a muscular heavy-boned guy in steel doubles. With warmer water necessitating a drysuit with only a thin liner, and a rig with doubles tanks plus backplate plus manifold which is significantly negative by itself, this diver may not require any added lead at all:

IMPERIAL UNITS! (LB & PSI)				
DRYSUIT Buoyancy And Partial Weight Ditching				
Complete "Lift" tab first. See DIRECTIONS In Row 43.				
Ditchable Integrated (Rig) Wt from "Lift" tab:	0.0			
Ditchable Weightbelt Wt from "Lift" tab:	0.0			
Excel Freeze Panes Feature Operating. Scroll up or down to see full spreadsheet while still viewing total ditchable weight				
BCD FAILURE				
Supplemental lift available from drysuit:	26.1 lb.			<--See User's Manual for how this is calculated
	Full Tank	Half Tank	Dive End	Emergency
Buoyancy at depth with Full Tank BEFORE using drysuit supplemental lift:	-24.9			
Buoyancy added from drysuit supplemental lift:	24.9			
Buoyancy at depth with Half Tank BEFORE using drysuit supplemental lift:		-15.8		
Buoyancy added from drysuit supplemental lift:		15.8		
Buoyancy at depth with PLANNED RESIDUAL GAS, BEFORE using drysuit supplemental lift:			-9.3	
Buoyancy added from drysuit supplemental lift:			9.3	
Buoyancy at depth with 300 psi in all tanks, BEFORE using drysuit supplemental lift:				-8.3
Buoyancy added from drysuit supplemental lift:				8.3
NET BUOYANCY AT DEPTH BEFORE DITCHING:	0.0	0.0	0.0	0.0
In the event of bcd/wing failure, can your drysuit provide sufficient lift?	YES	YES	YES	YES
From Lift Tab - Ditchable Weight Carried:	0.0			
	Full Tank	Half Tank	Dive End	Emergency
Weight Ditched:	0.0	0.0	0.0	0.0
Buoyancy at depth with Full Tank AFTER Ditching Weight Above:	0.0			
Buoyancy at depth with Half Tank AFTER Ditching Weight Above:		0.0		
Buoyancy at depth with PLANNED RESIDUAL GAS, AFTER Ditching Weight Above:			0.0	
Buoyancy at depth with 300 psi in all tanks, AFTER Ditching Weight Above:				0.0
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:	0.0	0.0	0.0	0.0
With bcd/wing failure, can ditching weight plus drysuit provide sufficient lift?	YES	YES	YES	YES
FLOODED DRYSUIT				
	Full Tank	Half Tank	Dive End	Emergency
Buoyancy at depth before drysuit flooding not including wing lift	-24.9	-15.8	-9.3	-8.3
Lost Drysuit Lift with Flooding	-15.7	-15.7	-15.7	-15.7
Buoyancy at depth with Flooded Drysuit not including wing lift:	-40.6	-31.5	-25.0	-24.0
From Lift Tab - BCD/Wing Lift Capacity:	40	40	40	40
Net Buoyancy at depth with Flooded Drysuit and Full BCD/Wing:	-0.6	8.5	15.0	16.0
In the event of drysuit flooding, can filling your wing provide sufficient lift?	NO	YES	YES	YES
REDUNDANT BUOYANCY NEEDED BEFORE DITCHING WEIGHT:	1	0	0	0
From Lift Tab - Ditchable Weight Carried:	0.0			
	Full Tank	Half Tank	Dive End	Emergency
Weight Ditched:	0.0	0.0	0.0	0.0
Buoyancy at depth with Flooded Drysuit and Full BCD/Wing AFTER Ditching Weight Above:	-0.6	8.5	15.0	16.0
In case of drysuit flood, can ditching weight plus filling wing provide sufficient lift?	NO	YES	YES	YES
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:	1	0	0	0
Surface Buoyancy after ditching weight above:	-0.4	8.7	15.2	16.2
				<-- Air release

This diver can almost satisfy condition a): while he is -9lb at the end of the dive, he has plenty of reserve drysuit lift to make him neutral with an empty BCD.

He's okay on condition b): he is -24.9lb negative at the beginning of his dive, and has 26lb of reserve buoyancy in his drysuit. By adding air to his drysuit, he can easily swim to the surface in the event of a wing failure.

Condition c) also is satisfied if he carries an SMB for a drysuit flood. With full tanks, and zero drysuit buoyancy, he is -40.6lb negative, and has only 40lb of lift in his wing. Thus, even without an SMB he needs to swim up against only -1lb, which is clearly not a problem. And after breathing off very little air, he becomes positively buoyant with a full wing.

Finally, he meets condition d) by hanging off an SMB: establish extended positive buoyancy at the surface with a flooded drysuit and full tanks.

Some might argue whether this is truly a balanced rig, without a better source of redundant buoyancy than an SMB. But knowing the data provides for an intelligent choice of equipment by showing just how close to the edge one might be.

The Drysuit tab can be used for these sorts of evaluations, but forces you to move back and forth between it and the Lift tab to adjust weighting and lift. By contrast, the Balanced Rig tab allows you to manipulate both at once.

What the Balanced Rig Tab does, is examine both buoyancy and failure conditions on a single page of the spreadsheet. Optimal buoyancy is initially determined by entering wing lift and then choosing weight on the Lift tab as desired. A drysuit flood problem is warned of, but is better evaluated in the Lift tab.

But to balance a rig requires flexibility in both chosen buoyancy and chosen weight. This tab will allow you to see whether with a given equipment configuration, there is a reasonable set of **both** buoyancy and weight choices available.

In the example from the preceding page, the Balanced Rig tab makes it clear that the only solution to the problem is redundant lift:

(NOT From Lift tab)	BCD/Wing Lift Capacity (Cell F19 above):	40.0	40.0
Is BCD/Wing adequate lift for flooded drysuit WITHOUT ditching weight? A "NO" here? Then s			
		NO	
FLOODED DRYSUIT			
		Full Tank	Half Tank
Buoyancy at depth before drysuit flooding not including wing lift		-36.9	-27.8
Lost Drysuit Lift with Flooding		-15.7	-15.7
Net Buoyancy at depth with Flooded Drysuit not including wing lift:		-52.6	-43.5
(NOT From Lift tab)	BCD/Wing Lift Capacity (Cell F19 above):	40.0	40.0
Net Buoyancy at depth with Flooded Drysuit and Full BCD/Wing:		-12.6	3.0
In the event of drysuit flooding, can filling your wing provide sufficient lift?		NO	YES
REDUNDANT BUOYANCY NEEDED BEFORE DITCHING WEIGHT			
		13	4
(NOT From Lift tab)	Ditchable Weight Carried (Cells B16,17):	-12.0	0.0
	Weight Ditched:	12.0	4.0
Buoyancy at depth with Flooded Drysuit and Full BCD/Wing AFTER Ditching Weight Above:		-0.6	3.0
nt of drysuit flooding, can ditching weight plus filling your wing provide sufficient lift?		NO	YES
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:			
		1	0

Increasing this wing to 55 lb buoyancy would eliminate the -12.6 lb buoyancy deficit in the event of a flooded drysuit with full tanks.

Let's examine a commonly voiced prohibition in diving: thick wetsuits and heavy doubles. Why are wetsuits so frowned upon in this scenario?

In this case we have an average-sized diver in a thick wetsuit with heavy steel doubles. Using the Lift tab, this diver has chosen neutral buoyancy at the safety stop to minimize the amount of weight carried, and accepted a marked positive shift in buoyancy in the last 15 feet. Carrying a heavy rig, this diver has chosen a 50lb wing.

Lift Calculator: Weight and Lift Requirement vs. Depth					Not
Experiment with varying weight to obtain zero buoyancy at 15'/5m at dive end. Experiment with varying lift					
SEE DIRECTIONS IN ROW 34		IMPERIAL UNITS! (LB and FEET)			
Data from "Diver&Dive" tab	Surface	At 15 ft	40	80	fee
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)	-12.5	-12.5	-12.5	-12.5	lb
Weight of Air Carried	-16.2	-16.2	-16.2	-16.2	
EMPTY tank buoyancy	-6.6	-6.6	-6.6	-6.6	
Personal Buoyancy	0.0	0.0	0.0	0.0	
Suit Buoyancy in Salt Water	34.8	24.0	15.8	10.2	
Net Buoyancy not including BCD/Wing or ditchable lead	-0.5	-11.4	-19.6	-25.2	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:	-2.0				
ENTER Ditchable Integrated (Rig) Weight Here:	0.0				
ENTER Ditchable Weightbelt Weight Here:	0.0				
Remember: Negative values sink; positive values float					
NET Buoyancy with weights & full tank without BCD:	-2.5	-13.4	-21.6	-27.2	lb
NET Buoyancy with weights and 500 psi without BCD:	11.0	0.1	-8.1	-13.7	<--
BCD/Wing lift (cell B21) should be more than diver's negative Buoyancy at Depth ↑					
Enter Wing/BCD bladder lift capacity:	50.0	lb			
Rig Buoyancy with full tanks (not incl. diver)	-37.3				
?? Move weight from rig to weightbelt/suit??	No	0.0	lb		

What does the Balanced Rig tab show us?

There is sufficient wing lift to manage the rig's weight. There is neutral buoyancy at the safety stop. There is sufficient wing lift to handle this diver's -25lb negative buoyancy at 100 feet. But as the Balanced Rig tab makes clear, there is inadequate buoyancy to handle a wing failure, even with weight ditching.

In the event of wing failure at depth with full tanks, this diver will be unable to swim up against -27lb buoyancy. There is only 2lb ditchable weight, and ditching all 2lb would still leave the diver -25lb buoyant. With an inability to swim up a failed rig, between 14lb and 27lb redundant buoyancy is required. Thus, diving this rig with a wetsuit requires redundant buoyancy that would not be required with a drysuit.

Creating a Balanced Rig (with or without some ditchable weight)					Note: Password to unlock spreadsheets	
SEE DIRECTIONS IN ROW 49					IMPERIAL UNITS! (LB and FEET)	
Max Dive Depth from "Diver&Dive" tab					Surface	At 15 ft
Rig Tab: Backplate, 1st stages, manifold					-12.5	-12.5
Tanks Tab: Weight of Air Carried					-16.2	-16.2
Tanks Tab: EMPTY tank buoyancy					-6.6	-6.6
Dive_Diver Tab: Personal Buoyancy					0.0	0.0
Lift Tab: Suit Buoyancy in Salt Water					34.8	24.0
Buoyancy with full tank, not including BCD/Wing, lead or other fixed weight					-0.5	-11.4
Fixed Weight from "Rig" Tab:					0.0	
NOTE: THIS ADDED LEAD IS NOT FROM LIFT TAB - MAKE SEPARATE WEIGHT ENTRIES HERE ↓					From Lift tab	
Enter New Additional NON-DITCHABLE Weight Here:					0.0	-2.0
ENTER New Ditchable Integrated (Rig) Weight Here:					-2.0	0.0
ENTER New Ditchable Weightbelt Weight Here:					0.0	0.0
					Surface	At 15 ft
Buoyancy with empty BCD and full tank (Dive START):					-2.5	-13.4
Buoyancy with empty BCD with near-empty tank (500 psi in 3000 psi tank):					11.0	0.1
If your bcd fails, can you hold a safety stop at these buoyancies? ↑					↑ If your bcd fails, can you swim up these buoyancies?	
Rig Lift Requirement without Diver Buoyancy →					37.3	lb
Total Lift Requirement at Dive Start including Diver Buoyancy					2.5	27.2
Total Lift Req. @ Dive Start if ditchable weights dropped					0.5	25.2
					80	feet
					45.0	lb
					50.0	
					With bcd/wing failure, redundant buoyancy between 13.7 and 27.2 pounds may be needed	

Between the extremes of these last two examples lies the true utility of the Balanced Rig tab. Once a rig is designed for adequate buoyancy at the surface and depth, review of the failure modes quickly shows any necessary changes. Let us look at one last pair of examples.

Imagine a temperate water drysuit diver who dives with a large mildly negative steel tank. A 2mm drysuit liner is managed with a standard 40lb wing and commensurate lead. As the Lift tab for this diver shows, the backplate plus 9lb of lead yields neutral buoyancy at 15' with near-empty tanks, just as intended. The rig's -25lb negative buoyancy is easily managed with the 40lb wing.

SEE DIRECTIONS IN ROW 34			IMPERIAL UNITS! (LB and FEET)			
Data from "Diver&Dive" tab			Surface	At 15 ft	40	80 feet
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)			-6.5	-6.5	-6.5	-6.5 lb
Weight of Air Carried			-8.1	-8.1	-8.1	-8.1
EMPTY tank buoyancy			-3.3	-3.3	-3.3	-3.3
Personal Buoyancy			-3.0	-3.0	-3.0	-3.0
Suit Buoyancy in Salt Water			21.7	21.0	20.5	20.1
Net Buoyancy not including BCD/Wing or ditchable lead			0.8	0.1	-0.4	-0.8 lb
Enter NON-DITCHABLE Trim Pocket Weight Here:			0.0			
ENTER Ditchable Integrated (Rig) Weight Here:			-7.0			
ENTER Ditchable Weightbelt Weight Here:			0.0			
Remember: Negative values sink; positive values float						
NET Buoyancy with weights & full tank without BCD:			-6.2	-6.9	-7.4	-7.8 lb
NET Buoyancy with weights and 500 psi without BCD:			0.6	-0.2	-0.7	-1.1 lb
BCD/Wing lift (cell B21) should be more than diver's negative Buoyancy at Depth ↑						
Enter Wing/BCD bladder lift capacity:			40.0 lb			
Rig Buoyancy with full tanks (not incl. diver)			-24.9			
?? Move weight from rig to weightbelt/suit??			No	0.0 lb		

The Balanced Rig tab confirms that the rig can handle a drysuit flood:

	Surface	At 15 ft	80	feet
Buoyancy with empty BCD and full tank (Dive START):	-6.2	-6.9	-7.8	←-----→
Buoyancy with empty BCD with near-empty tank (500 psi in 3000 psi tank):	0.6	-0.2	-1.1	lb
				↑ If your bcd f
Rig Lift Requirement without Diver Buoyancy →				
	Surface		80	feet
Total Lift Requirement at Dive Start including Diver Buoyancy	6.2		7.8	lb
Total Lift Req. @ Dive Start if ditchable weights dropped	None		0.8	lb
Max Lift Requirement with Flooded Drysuit (full tanks)	25.0		26.7	
Max Lift Req with Flooded Drysuit if all ditchable weight dropped	20.9		20.9	
(NOT From Lift tab) BCD/Wing Lift Capacity (Cell F19 above):	40.0		40.0	Pounds
Is BCD/Wing adequate lift for flooded drysuit WITHOUT ditching weight:	YES			A "NO" here? Then some might

The same tab also confirms that a bcd failure can be easily managed with supplemental drysuit lift:

0.0	Enter new				
80 feet	BCD Lift:		BCD Lift from 'Lift' tab		
-7.8	40.0 lb		40.0 lb		
-1.1 lb	21.3 lb				
← Supplemental lift available from drysuit					
↑ If your bcd fails, your drysuit supplemental lift must be sufficient to help you swim this up					

In fact, this excess lift is so significant (21lb for an 8lb requirement), that this diver gradually forgets about limitations.

Consider the consequences then, when this diver takes his trusty rig to a slightly colder climate. Instead of a 2mm liner, he moves to a 6.5mm liner for the 50 degree water. Nothing else has changed, except for the added lead required for the buoyancy of the thicker liner.

Once again, the diver is neutral at 15' with near-empty tanks, and there is still plenty of wing buoyancy to float the rig:

Enter NON-DITCHABLE Trim Pocket Weight Here:	-9.0	
ENTER Ditchable Integrated (Rig) Weight Here:	-7.0	
ENTER Ditchable Weightbelt Weight Here:	-10.0	
Negative values sink; positive values float		
NET Buoyancy with weights & full tank without BCD:	-6.3	-7.1
NET Buoyancy with weights and 500 psi without BCD:	0.4	-0.3
BCD/Wing lift (cell B21) should be more than diver's negative E		
Enter Wing/BCD bladder lift capacity:	40.0 lb	
Rig Buoyancy with full tanks (not incl. diver)	-33.9	

What has insidiously happened however, is that the added lead required to balance the thicker liner now means that there is insufficient lift in the event of drysuit flooding:

Enter Wing/BCD bladder lift capacity:	40.0 lb
Rig Buoyancy with full tanks (not incl. diver)	-33.9
?? Move weight from rig to weightbelt/suit??	No
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	
Rig Lift Requirement <u>without</u> Diver Buoyancy	Surface At 15 ft
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	33.9 33.9
Total Lift Required @ Dive Start if weights are dropped	6.3
Max Lift Requirement with Flooded Drysuit (full tanks)	None
Max Lift Req with Flooded Drysuit if all weight dropped	46.9
Is BCD/Wing adequate lift for flooded drysuit?	29.9
	NO

Turning to the Balanced Rig page helps us determine if there is an easy solution, short of buying an expensive new wing.

Upon inspection, we can quickly see that the inadequate lift is only really present in the event of a drysuit flood with full tanks. At half tank buoyancy, the deficit is less than 2lb. With this reassurance, this diver has multiple options, all of which are within the bounds of what can still be termed a "balanced rig."

FLOODED DRYSUIT		Full Tank	Half Tank	500 Tank	
Buoyancy at depth before drysuit flooding not including wing lift		-8.0	-3.9	-1.3	
Lost Drysuit Lift with Flooding		-37.7	-37.7	-37.7	
Net Buoyancy at depth with Flooded Drysuit not including wing lift:		-45.7	-41.6	-39.0	
(NOT From Lift tab) BCD/Wing Lift Capacity (Cell F19 above):		40.0	40.0	40.0	Pounds
Net Buoyancy at depth with Flooded Drysuit and Full BCD/Wing:		-5.7	-1.6	1.0	Pounds
In the event of drysuit flooding, can filling your wing provide sufficient lift?		NO	NO	YES	Redundant
REDUNDANT BUOYANCY NEEDED BEFORE DITCHING WEIGHT		6	2	0	Pounds
(NOT From Lift tab) Ditchable Weight Carried (Cells B16,17):		-17.0			
Weight Ditched:		6.0	2.0	0.0	
Buoyancy at depth with Flooded Drysuit and Full BCD/Wing AFTER Ditching Weight Above:		0.3	0.4	1.0	
vent of drysuit flooding, can ditching weight plus filling your wing provide sufficient lift?		YES	YES	YES	Redundant
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:		0	0	0	Pounds

- 1) In the event of drysuit failure, the diver can swim up a maximum of -5.7lb and ditch weight at the surface;
- 2) The diver can use a small SMB to provide added lift;
- 3) The diver can ditch between 2 and 6 lb at depth to become neutral with a full wing and then surface without the effort of option 1;
- 4) The diver can go buy a 50lb wing.

To use the Balanced Rig Tab, experiment with the four gray cells open for user input. Comparing fixed and ditchable weight with the cells in column D (which are the amounts from the Lift tab, decide if you wish to change either the distribution or total weight to influence buoyancy. Enter your data in column B gray cells:

	B	C	D	E	F
NOTE: THIS ADDED LEAD IS NOT FROM LIFT TAB - MAKE SEPARATE WEIGHT ENTRIES HERE ↓					From Lift tab
Enter New Additional NON-DITCHABLE Weight Here:	-4.0		-4.0		
ENTER New Ditchable Integrated (Rig) Weight Here:	-8.0		-8.0		
ENTER New Ditchable Weightbelt Weight Here:	-4.0		-4.0		
	Surface	At 15 ft	100	feet	
Buoyancy with empty BCD and full tank (Dive START):	-0.4	-7.0	-16.2	←	
NET Buoyancy at DIVE END w/weights and PLANNED RESIDUAL GAS, but without BCD:	4.1	-2.4	-11.7	lb	
NET Buoyancy in emergency w/weights and MINIMUM GAS, but without BCD:	6.3	-0.3	-9.5		

Inspecting the lift capacity of the wing/bcd in column I (from the Lift tab), helps you determine whether you need to change carried lift in Column F:

D	E	F	G	H	I	J	K	L	M
-4.0		Enter new							
100	feet	BCD Lift:			BCD Lift from 'Lift' tab				
-5.0	←	35.0	lb		35.0	lb			
-0.4	lb	25.3	lb		← Supplemental lift available from drysuit				
1.7									
↑ If your bcd fails, your drysuit supplemental lift must be sufficient to help you swim this up									

Comparing your BCD lift with the rig lift requirement just below it will help you determine whether you need to shift lead bolted to your backplate (Non-Ditchable Cell B15) onto a weight harness (Cell B17), to allow your rig to float by itself at the surface (or at depth should you doff it in an entanglement).

	Enter new			
	BCD Lift:		BCD lift from 'Lift' tab	
	33.0	lb	33.0	lb
Rig Lift Requirement without Diver Buoyancy →	37.9		← WARNING: BCD cannot float your rig	

Increasing wing lift from 40lb to 50lb might have the following effect:

40.0		40.0	
NO	← A "NO" here? Then s		
Full Tank	Half Tank	500 Tank	
-8.0	-3.9	-1.3	
-37.7	-37.7	-37.7	
-45.7	-41.6	-39.0	
40.0	40.0	40.0	
-5.7	-1.6	1.0	
NO	NO	YES	

becomes:

50.0		50.0	
YES	← A "NO" here? Then s		
Full Tank	Half Tank	500 Tank	
-8.0	-3.9	-1.3	
-37.7	-37.7	-37.7	
-45.7	-41.6	-39.0	
50.0	50.0	50.0	
4.3	8.4	11.0	
YES	YES	YES	

Or, ditching between 2 and 6lb of weight at depth might have the following effect:

	Full Tank	Half Tank	500 Tank
FLOODED DRYSUIT			
Buoyancy at depth before drysuit flooding not including wing lift	-8.0	-3.9	-1.3
Lost Drysuit Lift with Flooding	-37.7	-37.7	-37.7
Net Buoyancy at depth with Flooded Drysuit not including wing lift:	-45.7	-41.6	-39.0
(NOT From Lift tab) BCD/Wing Lift Capacity (Cell F19 above):	40.0	40.0	40.0
Net Buoyancy at depth with Flooded Drysuit and Full BCD/Wing:	-5.7	-1.6	1.0
In the event of drysuit flooding, can filling your wing provide sufficient lift?	NO	NO	YES
REDUNDANT BUOYANCY NEEDED BEFORE DITCHING WEIGHT	6	2	0
(NOT From Lift tab) Ditchable Weight Carried (Cells B16,17):	-17.0		
Weight Ditched:	6.0	2.0	
Buoyancy at depth with Flooded Drysuit and Full BCD/Wing AFTER Ditching Weight Above:	0.3	8.4	0
In the event of drysuit flooding, can ditching weight plus filling your wing provide sufficient lift?	YES	YES	YES
REDUNDANT BUOYANCY NEEDED AFTER DITCHING WEIGHT ABOVE:	0	0	0
Surface Buoyancy after ditching weight above:	8.0	4.0	2.7

The Calcs Tab

The final tab in the spreadsheet is for inspection purposes. No user input cells are located here. The buoyancy calculations used by some tabs in the spreadsheet are computed here. Simultaneous computations for wetsuit and drysuit buoyancy are made, whether or not those areas are visible in the various tabs. A brief summary of the rules used by this tab is located in Rows 24-39.

File Home Insert Draw Page Layout Formulas Data Review View Developer Help Tell me Share Comments																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
1	To approximate the buoyancy of your exposure suit in the Buoyancy Computer,																
2	data is taken from first two tabs (Diver&Dive and Suit).																
3	Results are automatically transferred to all other spreadsheet pages										To edit spreadsheet, unlock protection with password: scuba						
4																	
5	Height:	69	IN														
6	Weight:	154.3	LB														
7	BSA:	1.85	Sq m.														
8	EBV:	66	Liter														
9	Wetsuit Thickness:		8.5	mm			Wetsuit Surface				Drysuit Surface						
10	Vest Thickness:		0	mm			Component Buoyancy				Component Buoyancy						
11	Glove Thickness:		5	mm			27.7 LB.	Suit			26.5 LB.						
12	Bootie Thickness:		6	mm			1.3 LB.	Glove			1.3 LB.						
13	Hood Thickness:		7	mm			1.8 LB.	Bootie			1.8 LB.						
14	Density of Salt Water:		0.002257	lb/cm3			2.8 LB.	Hood			2.8 LB.						
15	BSA:		1.85				↑ Item present if Suit Tab ↑										
16	Component Buoyancy at Surface:						indicates "Yes" for component in question.										
17	Wetsuit:	27.7 lb	78% BSA (60% shorty)				Drysuit Liner Thickness 4.5 mm Reserve Drysuit Lift										
18	Add'l Vest:	0.0 lb	31% BSA (hood below)				Drysuit Type: Crushed Neoprene 34.4 lb										
19	Gloves:	1.3 lb	6% BSA				For BSA: 1.85 sq meter (See User's Manual)										
20	Booties:	1.8 lb	7% BSA				Surface Buoyancy 32.3 lb										
21	Hood:	2.8 lb	9.5% BSA (overlaps suit)				Liner Component of Buoyancy: 28.5 lb										
22	Total:	33.5 lb					(NOTE: may include hood/gloves/booties from left, if "Yes" in										
23							Suit Tab, but does NOT recognize an "Additional Vest" entry)										
24	Use sock thickness for drysuit "bootie" thickness																
25	Exposure suit buoyancy at the surface is approximated by a determination of total body surface area times thickness of suit times weight of water displaced.																
26	The buoyancy of this volume is reduced by suit compression as you descend, which is approximated in a formula in the Lift vs Depth page.																
27	For a standard neoprene wetsuit, in the Wing Calculator sheet, buoyancy is estimated to decrease in a non-linear amount as a function of depth in atmospheres.																
28	The 4th order polynomial formulae that approximate this change are contained in sheet "Lift vs Depth", Row #11 and elsewhere. Their accuracy has been MINIMALLY tested!																
29	NOTE: That 4th order polynomial equation loses accuracy below 230ft/70m. Suit buoyancies begin to acquire fanciful values that prohibit the tool's accurate use.																
30	For a trilaminate drysuit, buoyancy is reduced by compression, but returned by inflation of the drysuit. Therefore, lift calculations will not change with depth,																
31	unless the suit floods. On the Lift vs. Depth sheet, buoyancy loss from drysuit flooding is assumed to be complete (100% loss).																
32	Any retained buoyancy is wholly dependent upon diver technique and the location of the leak, and is not quantified in this spreadsheet.																
33	For drysuits of other designs, there may or may not be an outer neoprene shell susceptible to compression at depth, with loss of buoyancy.																
34	The formulas account for the buoyancy and compressibility of four different drysuit designs.																
35	...	Suit	Rig	Tanks	QuikResults	Lift	Wetsuit	Drysuit	Balanced Rig	Calcs							

The various contributions of individual components of buoyancy are listed adjacent to the wetsuit and drysuit areas, respectively.

Reserve drysuit lift, and lift attributable only to the buoyancy of the liner are also calculated and listed in the drysuit box.

The user is cautioned that unlocking the spreadsheet and manipulating formulas in this area can have effects throughout the tool. Any changes should be made only after backing up the spreadsheet.

Advanced Excel Techniques to Optimize Your Display

This spreadsheet is a large tool, and it is impossible to keep data entry and results all on one screen. Thus, once you get used to entering data, there may be some frustration referring back and forth between multiple tabs as you attempt to compare differing equipment configurations or scenarios.

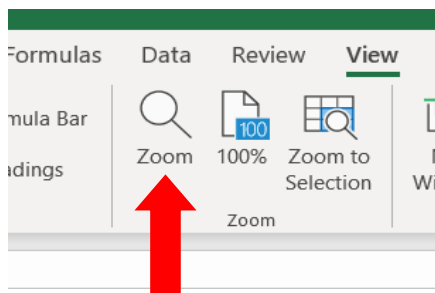
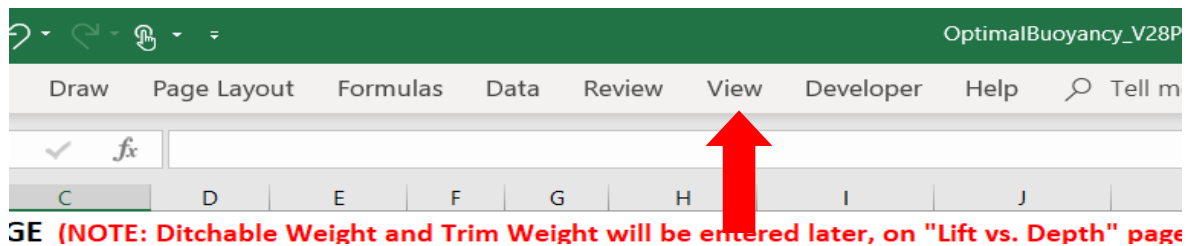
Excel provides a way to display several parts of the spreadsheet simultaneously, so that the results of changes in input will immediately be reflected in another tab also on your screen.

Depending upon your screen resolution, you may also find it helpful to decrease the display magnification so as to see more columns at one time. Finally, eliminating some menu bars will also increase your screen real estate.

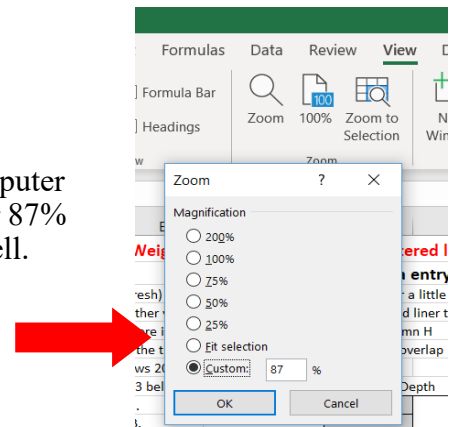
Display Magnification:

There are three ways to change magnification:

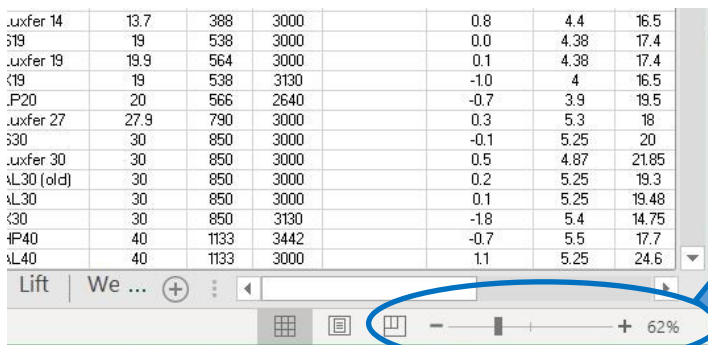
- 1) Fastest is to use your mouse, scrolling the wheel while pressing the Ctrl key. One direction with the wheel enlarges, the other shrinks. This only works if you have a wheel mouse
- 2) To change the magnification using your keyboard, click View | Zoom and choose your mag.



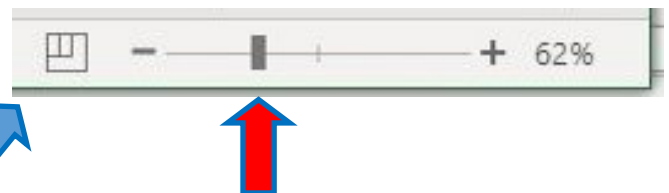
For modern computer displays, 75% or 87% seem to work well.



- 3) The third method is to use a slider bar in the bottom right corner of your screen:



Grab the little slider highlighted below and move it left for smaller, right for larger.



Note that some text boxes may be cut off at some magnifications. If a cell displays “###” instead of an expected number, try a different magnification.

Lift Calculator: Weight and Lift Requirement vs. Depth

Note: Password to unlock spreadsheets is "scuba"

Experiment with varying weight to obtain zero buoyancy at 15'/5m at dive end. Experiment with varying lift capacity to manage wetsuit compression

SEE DIRECTIONS IN ROW 34

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1																						
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35																						

IMPERIAL UNITS (LB AND FEET)

	Surface	At 15 ft	50	99	feet
Fixed weight [BCD/Wing, plate, regs, manifold, other fixed weight]	-6.5	-6.5	-6.5	-6.5	
Weight of Air Carried	-5.9	-5.9	-5.9	-5.9	
EMPTY tank buoyancy	4.4	4.4	4.4	4.4	
Personal Buoyancy	1.0	1.0	1.0	1.0	
Suit Buoyancy in Salt Water	18.8	12.9	7.5	4.7	
Net Buoyancy not including BCD/Wing or ditchable lead	11.8	5.9	0.5	-2.3	lb
Enter NON-DITCHABLE Trim Pocket Weight Here:	0.0	<-----			
ENTER Ditchable Integrated (Rig) Weight Here:	0.0	<-----			
ENTER Ditchable Weightbelt Weight Here:	-10.0	<-----			
Remember: Negative values sink; positive values float					
NET Buoyancy with weights & full tank without BCD:	1.8	-4.1	-9.5	-12.3	lb
NET Buoyancy with weights & 500 pb without BCD:	6.7	0.8	-4.6	-7.4	lb
BCD/Wing lift (cell B21) should be more than diver's negative Buoyancy at Depth ↑					
Enter WING/BCD bladder lift capacity:	18.0	lb			
Rig Buoyancy with full tanks (not incl. diver)	-8.0				
? Move weight from rig to weightbelt/suit??	No	0.0 lb			
↑ Assumption: Rig should be at least 2 lb buoyant at max wing inflation, by itself					
Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:	Surface	At 15 ft	50	99	feet
Rig Lift Requirement <u>without</u> Diver Buoyancy	8.0	8.0	8.0	8.0	lb
Total Lift Requirement at Dive Start <u>including</u> Diver Buoyancy	None		9.5	12.3	lb
Total Lift Required @ Dive Start if weights are dropped	None		None	2.3	lb
					lb
					lb
WARNING! This is experimental data derived from physics formulas and minimally tested buoyancy data. Do not rely on these figures alone for dive planning!					

DIRECTIONS FOR USE:

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Lift Calculator: Weight and Lift Requirement vs. Depth

Note: Password to unlock spreadsheets is "Scuba"

SEE DIRECTIONS IN ROW 34

Experiment with varying weight to obtain zero buoyancy at 15'/m at dive end.

Experiment with varying lift capacity to manage wetsuit compression

	Surface	At 15 ft	50'	99'	feet
Data from "Diver/Dive" tab					
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)	-6.5	-6.5	-6.5	-6.5	lb
Weight of Air Carried	-5.9	-5.9	-5.9	-5.9	"
EMPTY tank Buoyancy	4.4	4.4	4.4	4.4	"
Personal Buoyancy	1.0	1.0	1.0	1.0	"
Suit Buoyancy in Salt Water	18.8	12.9	7.5	4.7	"
Net Buoyancy not including BCD/Wing or ditchable lead	11.8	5.9	0.5	-2.9	lb
ENTER NON-DITCHABLE Trim Pocket Weight Here	0.0	<	<	<	"
ENTER Ditchable Integrated (Rig) Weight Here	0.0	<	<	<	"
ENTER Ditchable Weightbelt Weight Here	-10.0	<	<	<	"
Remember: Negative values sink; positive values float					
NET Buoyancy with weights & full tank without BCD	1.8	-4.1	-9.5	-12.1	lb
NET Buoyancy with weights and 500 psi without BCD:	6.7	0.4	-4.6	-7.4	lb
BCD/Wing lift (cell B21) should be more than diver's negative Buoyancy at Depth ↑					
Enter Wing/BCD bladder lift capacity ↓	18.0	lb			
Rig buoyancy with full tanks (not incl. diver)	8.0	O.O	lb		
? Move weight from rig to weightbelt/suit?	No	0.0	lb		
↑ Assumption: Rig should be at least 2 lb buoyant at max wing inflation, by itself					

How big a Wing/BCD do you need?
Will your rig (Cell B22) float by itself?
With your weight, are you 0 @ 15/m?
How buoyant will you be at the surface?
How negatively buoyant are you at max depth due to wetsuit compression?
Can your wing/bcd handle that?

Choose a total weight which will give you zero buoyancy or less at 15' at dive end in Cell C18 below.
Then assess your positive buoyancy at the surface, and determine if you need more weight

While zero buoyancy at 15'/m is the desired result, there is a significant buoyancy change as you rise to the surface with thick neoprene.
You may need to accept some negative buoyancy at 15' to avoid "cooking" as you rise the last 15'/m.

Choosing a BCD/Wing: calculated TOTAL Lift Req'mt:

Rig Lift Requirement without Diver Buoyancy

Total Lift Requirement at Dive Start including Diver Buoyancy

Total Lift Required @ Dive Start If weights are dropped

DIRECTIONS FOR USE:

This spreadsheet presumes you have entered your equipment configuration in first four tabs (not including ditchable weight)

Enter your BCD/Wing flotation (lift capacity) in Cell B21, as a POSITIVE number.

Enter your Trim Weight or other Fixed Weight (less bolted to B/P?) in Cell B13, as a NEGATIVE number.

Enter your ditchable weight in Cells B14 and B15, as a NEGATIVE number.

NOTE: This may generate a warning in Rows 21-23 if the distribution of weight makes your rig less than 2 lb. buoyant floating by itself.

Rig Tanks QuikResults Lift Wetsuit Drysuit Balanced Rig Calcs

WARNING! This is experimental data derived from physics formulas and minimally tested buoyancy data. Do not rely on these figures alone for dive planning!

Lift Calculator: Weight and Lift Requirement w/ Depth

Note: Password to unlock spreadsheets is "scuba"

Experiment with varying weight to obtain zero buoyancy at 15'/m at dive end.

SEE DIRECTIONS IN ROW 34

		IMPERIAL UNITS (lb and FEET)		
	At 15'ft	50	99	feet
Data from "Dive & Dive" tab:	-4.5	-4.5	-4.5	lb
Fixed weight (BCD/Wing, plate, regs, manifold, other fixed weight)	-5.9	-5.9	-5.9	lb
Weight of Air Carried	-4.4	-4.4	-4.4	lb
EMPTY tank buoyancy	1.0	1.0	1.0	lb
Personal Buoyancy	18.8	12.9	2.5	lb
Suit Buoyancy in Salt Water	11.8	5.9	0.5	lb
Net Buoyancy not including BCD/Wing or ditchable lead	0.0	0.0	0.0	lb
Enter NON-DITCHABLE Trim Pocket Weight Here	1.8	4.1	0.5	lb
ENTER Ditchable Integrated Rig Weight Here:	10.0	0.0	0.0	lb
ENTER Ditchable Weightbelt Weight Here:	10.0	0.0	0.0	lb

Remember: Negative values sink; positive values float

		METRIC UNITS (kg and METERS)		
	At 15'm	50	99	meters
NET Buoyancy with weights & full tank without BCD:	-2.0	-2.0	-2.0	kg
NET Buoyancy with weights & 50% without BCD:	-2.0	-2.0	-2.0	kg
RCD/Wing lift [Cell B21] should be more than diver's negative buoyancy at Depth. If	18.8	12.9	2.5	kg
Enter Wing/BCD bladder Rlt capacity:	18.8	12.9	2.5	kg
Rig buoyancy with full tanks (not incl. diver)	-8.0	0.0	0.0	kg
?? Move weight from rig to weightbelt/suit?	No	Yes	Yes	kg

Assumption: Rig should be at least 2 lb buoyant at max wing inflation, by itself

Choosing a BCD/Wing: calculated TOTAL LIFT Req't:

	Surface	At 15'ft	50	99	feet
Rig Lift requirement without Diver Buoyancy	8.0	8.0	8.0	8.0	lb
Total Lift Requirement at Dive Start including Diver Buoyancy	None	9.5	12.3	12.3	lb
Total Lift Required @ Dive Start if weights are dropped	None	None	2.3	2.3	lb
					lb

DIRECTIONS FOR USE:

- This spreadsheet assumes you have entered your equipment configuration in first four tabs (not including ditchable weights).
- Enter your BCD/Wing flotation (lift capacity) in Cell B21, as a POSITIVE number.
- Enter your Trim Weight or other Fixed Weight (lead loaded to 0/PT) in Cell B23, as a NEGATIVE number.
- Enter your ditchable weight in Cells B18 & B19, as a NEGATIVE number.

NOTE: This may generate a warning in Rows 21-23 if the distribution of weight makes your rig less than 2 lb. buoyant floating by itself.

In that case it may be suggested to transfer weight from integrated pockets to a weightbelt worn on your exposure suit, in case you need to ditch your rig.

You can redistribute weight between your rig and worn weightbelt until the warnings disappear.

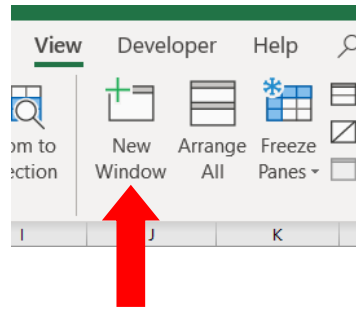
Adjust your carter load for near neutral buoyancy at your safety stop depth with near-empty tanks.

Examine your surface buoyancy with that weight, and adjust if excessive positive buoyancy due to wet suit expansion places you at risk of "cooking". See User's Manual for discussion.

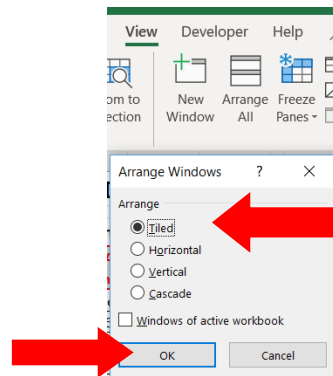
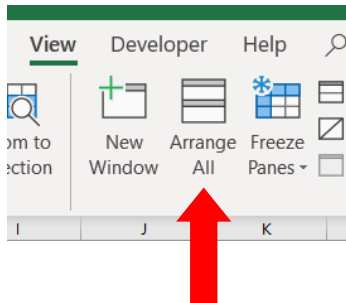
WARNING! This is experimental data derived from physics formulas and minimally tested buoyancy data. Do not rely on these figures alone for dive planning!

Opening Multiple Windows

To open multiple copies of the spreadsheet at the same time, click View | New Window:



At that point, the windows will overlap, and you may not be able to see the second window behind the first. To correct this, click View | Arrange All, and then choose Tiled, and then OK.



Your computer screen should look something like this:

Two side-by-side screenshots of the 'Lift Calculator: Weight and Lift Requirement vs. Depth' spreadsheet. The left window is at 100% magnification, and the right window is at 87% magnification. Both windows show the same spreadsheet content, which includes various input fields for diver weight, buoyancy, and lift requirements, along with calculated results and directions for use. The right window also has a pink warning box visible in the bottom right corner.

Note that the window you previously had open on the right is at 87% magnification, where you set it. But every new window that is opened starts at 100%. Once you choose the tabs you wish to view simultaneously, you will need to adjust the magnification of each new window with View | Zoom | %, or with your mouse using CTRL-Scroll.

As in the example below, you can also drag the edges or corners of an active window to resize it to show exactly what you want.

At this point you need to decide what to view simultaneously. To start, I would recommend 1) QuikResults, and 2) Lift. This will allow you look more carefully at your lift data, using the weights recommended in QuikResults to start. Then fine tuning your choice will set you up to examine equipment failure scenarios.

The image shows two Excel spreadsheets side-by-side. The left spreadsheet is titled 'Quik' and the right is 'Lift Calculator: Weight and Lift Requirement vs. Depth'. Both spreadsheets contain various input fields and formulas for calculating buoyancy and lift requirements. The 'Quik' spreadsheet has tabs for 'Rig', 'Tanks', 'QuikResults', and 'Lift'. The 'Lift Calculator' spreadsheet has tabs for 'Lift', 'Wetsuit', 'Drysuit', 'Balanced Rig', and 'Calcs'. A red arrow points to the 'Lift' tab in the 'Lift Calculator' spreadsheet.

Once Lift is optimized, perhaps change QuikResults to Wetsuit, and then maximize that window by clicking on the small overlapping squares in the upper right-hand corner of that window:

Wetsuit, Drysuit and Balanced Rig will help you evaluate failure scenarios for your existing equipment configuration. Spending some time with one of those three tabs will allow you to really understand your buoyancy during equipment failure.

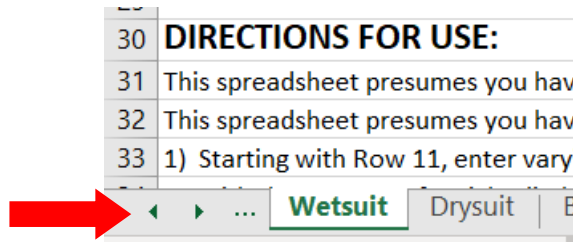
But what about just getting started with choosing equipment and/or an environmental suit? Having multiple initial data entry tabs open simultaneously allows you to immediately see the results of, say, a thicker wetsuit or a different tank. This can be facilitated by opening *four or more* windows at a time.

Using the same techniques described above, use View | New Window, View | New Window, View | New Window and then View | Arrange All | Tiled | OK to get a screen like this:

All that remains is to switch to the desired view in each window, and reduce magnification. Don't forget CTRL-Scroll Wheel for quick magnification changes using your mouse!

The image shows four Excel spreadsheets arranged in a tiled view. The first three are 'WETSUIT Buoyancy After Partial Weight Di' and the fourth is 'Lift Calculator: Weight and Lift Requirement vs. Depth'. Each spreadsheet shows buoyancy calculations for a diver at 99 feet depth. The 'Lift Calculator' spreadsheet is the same as the one in the previous image.

Start by switching each window to the desired tab of the spreadsheet. In the lower left corner of each sub-window is a small left and right arrowhead that scrolls through the tabs when a window is small.



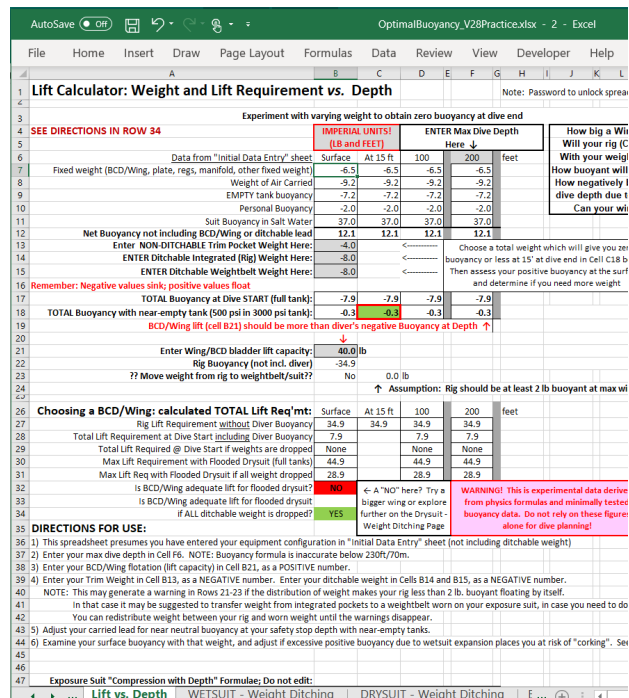
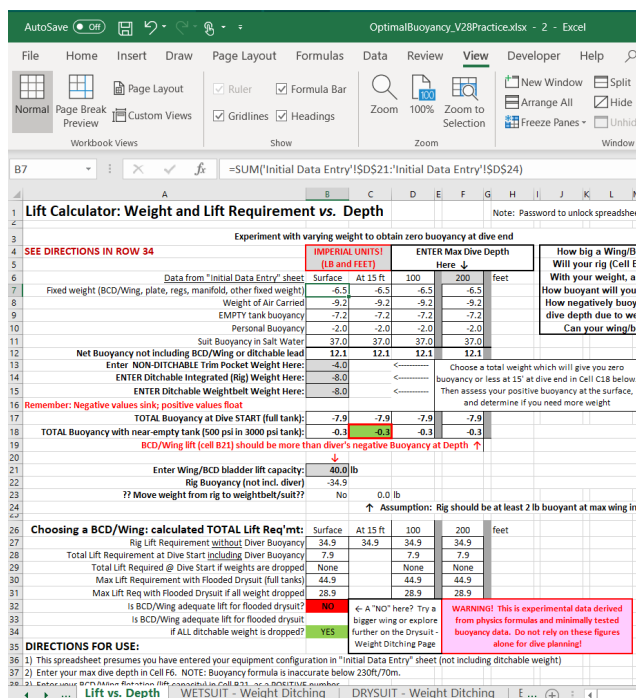
The open window is highlighted in green on white, and adjacent tabs will appear as you click left or right. Click on the desired tab name, and the window will switch to it. Drag a corner of the window to the correct size and change magnification, and move on to the next.

Alternatively, just use CTRL-Page Up and CTRL-Page Down to quickly move to a new window.

NOTE: When you do a File|Save and then close Excel with multiple windows open, the next time you open it, it will retain the same multi-window layout, so you don't have to go to a lot of work recreating a complex layout to evaluate equipment.

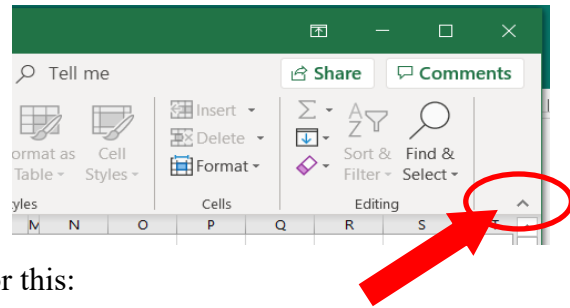
Don't forget, any time you wish to see an entire window, click on the little overlapping squares in the top right corner, and the subwindow you have open will fill the screen. When you wish to return to the multiple display, click the square in the same place, and the window will return to its small size.

Before you try the multi-window display on page 41, there's one last trick to maximizing screen real estate: getting rid of thick menu bars and the formula bar. Menus can be a significant obstacle with small windows. Getting rid of menu bars will convert the display at left, to the one on the right, where you can see much more:

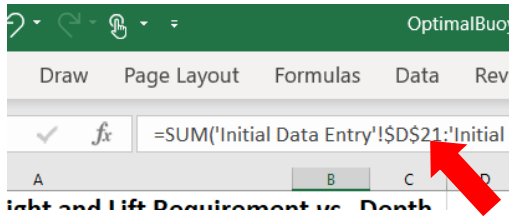


Follow the steps on the next page to learn how to remove menu bars and formula bars that take up valuable space.

In order to remove a permanent thick menu bar, look in the upper right-hand corner of the screen and click on the little up-arrow here:



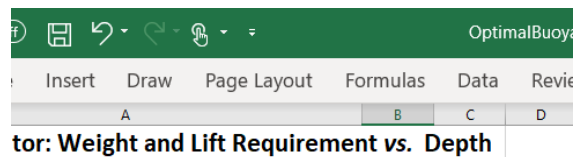
That turns the thick menu into this:



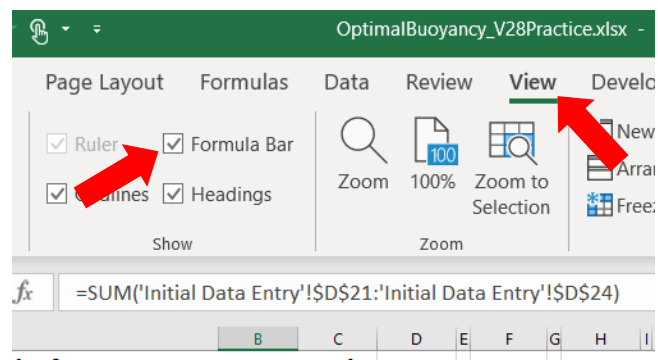
But if your display still has this formula bar, you can get rid of that too.

Click View, and when the thick menu bar drops down, uncheck the “Formula Bar” box.

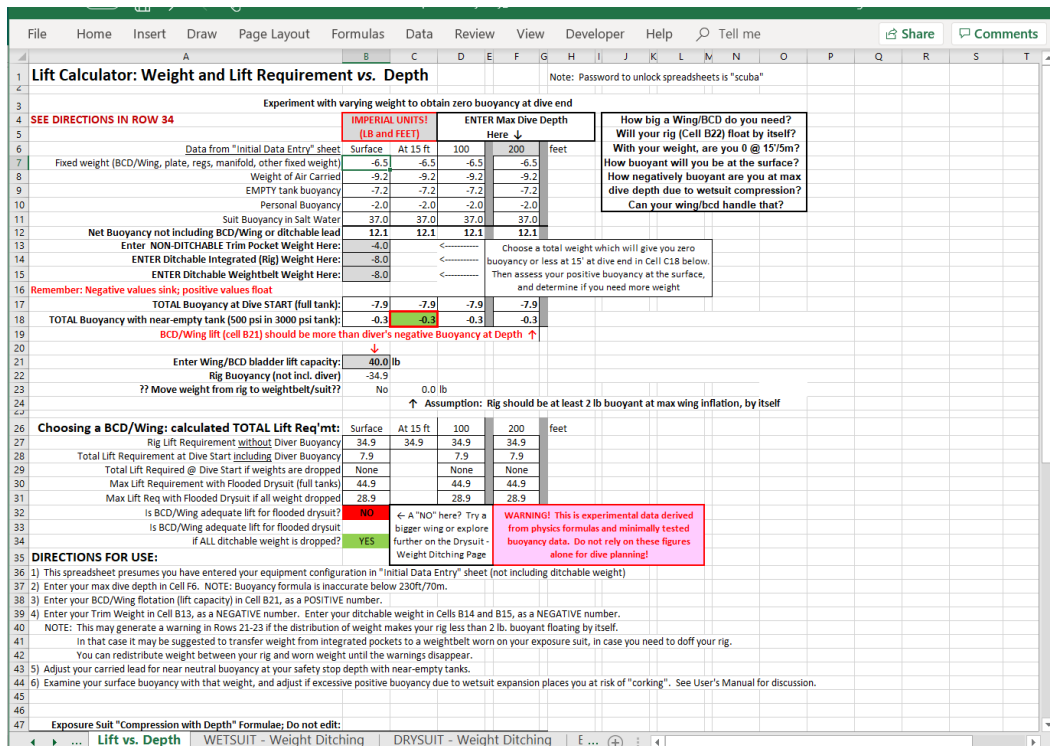
or this:



If your display is like this, you’re all set!



You’ll now have maximum screen area for inputting data and viewing results.



Now lets take the multi-window display one last step to have a layout for comparing wetsuit and drysuit, or changing tanks, or examining the effect of personal buoyancy on your lift requirements. Using View | New Window repeatedly, open five total windows and perhaps drag them to the configuration on the next page:

Below we see the following layout (top to bottom, left to right):

- Diver&Dive @ 75% magnification
- Suit @ 75% mag
- QuikResults @ 62% mag
- Rig @ 75% mag
- Lift @ 87% mag

The image displays five Excel spreadsheets from the OptimalBuoyancy V37 software, arranged in a collage. The top row shows three smaller spreadsheets: 'Diver', 'Suit', and 'QuikResults'. The bottom row shows two larger spreadsheets: 'Rig' and 'Lift'. The 'Lift' spreadsheet is the most detailed, showing a 'Lift Calculator: Weight and Lift Requirement vs. Depth' with various input fields for equipment weight, buoyancy, and depth. It includes a table for 'Choosing a BCD/Wing' and a 'DIRECTIONS FOR USE' section. The 'Rig' spreadsheet shows 'Contributions to rig buoyancy' and 'Weight Requirement'. The 'Suit' spreadsheet shows 'Environmental Suit' details. The 'Diver' spreadsheet shows 'Diver&Dive' information. The 'QuikResults' spreadsheet shows 'Quick Recommendations' for lift and weight.

This layout is ideal for quickly changing diver characteristics or dive depth, environmental suit thickness and rig characteristics and immediately seeing the effect on recommended weighting. Then, using the Lift tab at right, you can fine tune your choices.

Then, converting one of the center windows to Wetsuit, Drysuit or Balanced Rig and dragging it larger, you can quickly evaluate failure scenarios in greater detail, while changing carried weight.

The image displays two Excel spreadsheets from the OptimalBuoyancy V37 software. The left spreadsheet is titled 'DRYSUIT Buoyancy And Partial Weight Ditching' and shows detailed calculations for drysuit buoyancy and weight ditching. It includes a table for 'Buoyancy at depth with Full Tank BEFORE using drysuit supplemental lift' and a 'FLOODED DRYsuit' section. The right spreadsheet is titled 'Lift Calculator: Weight and Lift Requirement vs. Depth' and shows a detailed calculation of lift requirements for various equipment and depth. It includes a table for 'Choosing a BCD/Wing' and a 'DIRECTIONS FOR USE' section. Both spreadsheets include warnings and instructions for use.

Assumptions and Conventions

The following assumptions have been made by the spreadsheet author.

They are listed in no particular order. Some listed values may have changed in the version of the spreadsheet currently in use based upon new data.

- DRYsuit buoyancy does not change at depth unless flooded.
- The spreadsheet presumes that air is added to the drysuit to preserve lift, as descent compresses the liner.
- Buoyancy figures for drysuit flooding are based upon ZERO retained buoyancy; an unlikely worst-case scenario.
- Reserve lift capacity in a drysuit is a function of the room remaining inside the shell before a ballooning shape results in an air leak from a neck or wrist seal. This reserve lift is calculated in the spreadsheet by subtracting the buoyancy of the current loft of the liner from a 9mm one, or using 12% of current liner buoyancy, whichever is greater. This may be conservative. However, the presumption is that expansion more than 12% past 9mm begins to approach unmanageable "Michelin Man" shape, or may result in a leak at one or more seals.
- Note that reserve lift presumes a horizontal position, to minimize stress on the neck seal, which may not be the optimum rescue position for emergency ascent.
- A drysuit shell must be chosen from one of four types: trilaminate, neoprene, compressed neoprene, crushed neoprene
 - * Trilaminate is assumed to be neutrally buoyant. Drysuit lift is calculated by the volume of water displaced by the liner. Estimation of liner loft is critical.
 - * Neoprene is assumed for buoyancy purposes to be a 3mm wetsuit shell around the liner. The liner loft is maintained constant by gas addition on descent. The neoprene shell undergoes compression at depth and loses buoyancy like a New Standard wetsuit. Buoyancy is maintained by the addition of additional liner gas, which decreases reserve buoyancy somewhat.
 - * Compressed neoprene is assumed for buoyancy purposes to be a 1mm wetsuit shell around the liner. Liner loft is maintained constant by gas addition on descent. The neoprene shell undergoes compression at depth and loses buoyancy like a New Standard wetsuit. Buoyancy is maintained by the addition of additional liner gas, which decreases reserve buoyancy somewhat.
 - * Crushed neoprene is negatively bouyant, and does not further compress with depth. It is treated as a 2lb negative thick shell which traps slightly more air in fabric folds with a thin liner. This effect is assumed to disappear above liner thicknesses >2mm.

(cont'd)

WARNING: These spreadsheets are experimental tools using formulas created by amateur divers for educational use only. Numerous assumptions regarding buoyancy have been made based upon only partially tested equipment configurations. The information herein is for your personal educational use and should not be relied upon to determine the adequacy of a given equipment configuration. Consultation with a dive professional regarding equipment, weighting and performing a neutral buoyancy check should all be strongly considered before diving a new equipment configuration. Note specifically that the practice of ditching weight at depth is a controversial one, and the theoretical data in this spreadsheet should not be considered a recommendation of that practice.

Assumptions and Conventions (cont'd)

-
- ◇ WETSUIT buoyancy is decreased by compression from ambient pressure at depth, adjusted in this spreadsheet by the factors below:
 - ◇ With a new soft neoprene wetsuit, the formula assumes slightly more compression with depth (less buoyancy) than with standard neoprene.
 - ◇ With an old wetsuit, the formula assumes 20% less buoyancy overall than with a new standard suit due to neoprene cell decomposition (arbitrary).
 - ◇ Wetsuit buoyancy computations are made using body surface area and the "Rule of Nines" from hospital burn units, for various body parts.
 - ◇ A Shorty wetsuit is assumed to have 60% of the buoyancy of a Full suit
 - ◇ A Farmer John suit is assumed to have 130% of Full Suit buoyancy due to overlap
 - ◇ A fourth order polynomial equation is used to determine buoyancy for Standard and Old neoprene, on the basis of incomplete experimental data. The fourth order component of this equation produces nonsensical answers below 230 ft/70 m and the spreadsheet should not be used below those depths.
 - ◇ New Soft neoprene is assumed to lose buoyancy inversely proportional to atmospheres of depth, without further correction. This may overestimate buoyancy loss at depth by a small amount, but data collection is continuing and formulas may be changed in future versions of the tool
 - ◇ Old neoprene is treated as a standard neoprene suit with an assumed 20% loss of buoyancy due to cell deterioration. This may be more or less than your current suit, and may produce errors of as much as 5lb/2.5kg with thick neoprene.
-
- * Carried Air is assumed to weigh 0.08 lb/cu ft; or 1.225 kg/m³, though this may presume a temperature greater or less than that of your dive. Temp errors in air weight are <0.5 lb.
 - * Salt water density is set at 63.911 lb/cu ft; or 1023.7 kg/m³. This is a compromise value among known sea water densities.
 - * Buoyancy at Dive End includes weight of 500 psi/35bar in your chosen tank, unless you have selected different ending tank pressure
 - * Buoyancy after an emergency that required "all" available gas presumes gas loss or consumption to a tank minimum of 300 psi/20 bar in all tanks.
-
- ⇒ The "Correction for Fresh Water" is based upon estimated body volume calculated from Body Surface Area using a formula developed for males
 - ⇒ The error for females or for substantial deviations from average density due to lean body mass or excess body fat is generally less than 1/2 pound.
 - ⇒ The Correction for Fresh Water is listed separately ONLY for calculated body volume. There is an additional fresh water change in buoyancy due to the volume of the exposure suit and accessory neoprene which is calculated separately
 - ⇒ BCD lift is considered marginal without at least 5lb/2kg reserve lift for a diver at depth
 - ⇒ Nominal Wing Requirement might be decreased by adding air to a drysuit instead, but this cuts into BCD failure drysuit reserve lift

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This spreadsheet is not copyrighted, and there are no restrictions on its distribution or modification for your own personal use. The password to control access to formulas is annotated in multiple locations.

The author does not guarantee the accuracy of any calculations made by this spreadsheet, and the user is advised to make a buoyancy check prior to diving any new configuration.

Discussion and/or a dive with a dive professional is recommended before implementing a new technique suggested by the data in this tool.

This tool is offered as an educational aid for a sport that, by its very nature, is fraught with risk. It is hoped that the information provided, when properly confirmed by testing in advance with adequate provision for safety, will enhance your diving enjoyment.

*Robert Singler
August, 2019*