BUOYANCY CHANGE

While flexible buoyancy has many advantages, many of which you will be aware, it has one characteristic which must be considered carefully in every application. A unit inflated at the surface, or any given depth, will lose volume (buoyancy) as it descends through the water column and gain it when it *rises* through the water column.

Although this is obvious we find it is commonly misunderstood and please forgive us stating below the elementary principles that govern the behaviour of our products in their working environment.

The amount that flexible buoyancy changes its volume (lift) is proportional to the change in depth and is calculated using Boyle's Law, the formula for which is -

$$P_1 \times V_1 = P_2 \times V_2$$

From this it will be seen that to find the volume (buoyancy) at any given depth in relation to a 'starting' depth the formula is -

$$V_2 = \frac{P_1 \times V_1}{P_2}$$

Where:-

V_1 = Starting Volume
V_2 = New volume (buoyancy lift)
P_1 = Starting Pressure (depth)
P_2 = New Pressure (depth)

Sufficient accuracy can be achieved in shallow water applications for most practical purposes by taking:-

1bar = 1 atmosphere = 10m water head
$1m^3$ = 1MT buoyancy

Example:- A two ton buoyancy bag is fully inflated above the surface , attached to a pipe which descends to 15m. depth. What buoyancy is the 2t unit now developing?

$$\text{Buoyancy developed} = \frac{1\ (\text{bar}) \times 2\ (m^3)}{2.5(\text{bar})} = 0.8\ \text{MT}$$

In the above calculation the starting pressure has been assumed at 1 bar which does NOT take into account the overpressure in the bag created by the PRV. We normally disregard this as it is almost all absorbed by the initial immersion of the bag.

It will be readily appreciated that Boyle's Law does not provide a straight line graph and the closer to the surface the more dramatic the buoyancy change. For instance a bag descending the first ten metres from the surface looses 50% of it's buoyancy whereas a bag descending the same distance of 10m, but from 20m to 30m will only lose 25%.

Also, if bags are rising through the water column the volume is increasing as it gets shallower. Air Lift Bags (ALBs) simply vent this excess air out through the open bottom while Inflatable Buoyancy Units (IBUs) have Pressure Release Valves (PRVs) which vent when internal pressure exceeds 0.17bar (2.5psi) over ambient. As these PRVs have a finite flow capacity, excessive rates of ascent can create sufficient internal pressure to burst them. IBUs should therefore never be used in situations where this can occur such as vessel salvage and other 'underwater lifting' operations.