



A Guide to Compressed Air Usage

Airguns using compressed air (CA) technology are currently the most popular equipment in 10-meter circles. For schools or other junior programs shooting 3-position air rifle, compressed air has become the only real competitive alternative, due to the difficulties of cocking other type of airguns during the kneeling and prone stages. Along with the purchase of the CA guns themselves, coaches must also purchase the means to fill the cylinders, something that is not often considered when pricing out a conversion to CA guns. There are a number of confusing options, and often it is difficult to get good advice due to the relatively obscure nature of our particular usage to the dive shop industry that we must deal with. Safety is also a big concern with CA usage. Too often it is taken for granted by shooters, primarily because they are not aware of the potential danger and the need for safe handling procedures. In today's lawsuit riddled society, it is imperative that coaches and match officials understand and enforce recommended SCUBA safety procedures. This brief is an attempt to make you aware of some of these issues. For brevity and clarity's sake, SCUBA tanks will be referred to as tanks and the small cylinders that remove from the airgun (rifle or pistol), as cylinders.

BASIC SCUBA KNOWLEDGE

CA seems to be most common acronym used in match airgun community for this technology. Others in the airgun community, such as the field target competitors and hunting airgun users, often use the British terms of PCP, standing for Pre-Charged Pneumatic or just PC, standing for Pre-Charged. All of these are different names for SCUBA air (which stands for Self Contained Underwater Breathing Apparatus); the fire department personnel use SCBA, which drops the underwater "U".

There are two methods in use for filling CA cylinders. One is a specialty-made hand pump and the other is to use a SCUBA tank to fill from. The pump gives the user ultimate independence but tanks are much more practical for most programs. The tanks most commonly seen in use by divers and at airgun matches are aluminum tanks that hold 80 cubic feet of air (80 cu). There are smaller tanks, made of either steel or aluminum, but for club usage you don't want to go below 80 cu. Larger tanks are also available, but their size and weight make them impractical to fill regularly. All of these tanks are designed to hold 3000 psi of as a working pressure.

Fortunately, this is same pressure that our airgun cylinders are designed to use. Unfortunately, our match airgun cylinders, with their European SCUBA fittings do not easily connect up to the American SCUBA tanks. Nearly all of the SCUBA tanks in the US will be a 3000 psi tank with a K-valve on top. This valve is the connection point to dispense air. The shape of a K-valve is a square block with a rubber o-ring on the side that allows a "D" shaped yoke to drop over the top and clamp on to the seals.

All systems that use a K-valve and a yoke are 3000-psi systems. The European airgun manufacturers such as Anschutz, FWB, Walther, Steyr etc, all use the European DIN valve system for their high-pressure SCUBA connections. Instead of using a clamp system, the DIN system uses male /female threads to attach to each other. Each manufacturer includes with its gun a small brass piece, called a fill adapter, that interfaces between the airguns cylinder and the SCUBA tank. These brass adapters will have a male thread on the SCUBA side designed for DIN connection, either 200 or



K-valve installed on tank

300 DIN. It is from this that a multitude of problems arise for the unsuspecting coach who walks into a dive shop and tries to purchase the correct fill mechanism.



Yoke with filling adaptor

The 200 DIN fitting is designed around a 200 bar pressure which is 2931 psi, or basically the same as our American K valve system that uses 3000 psi. Therefore, all of our airguns from Europe come with 200 DIN connector to go between the cylinder and the SCUBA tank to ensure that you don't over pressurize the cylinder. Because it is basically the same pressure, American dive shops have never sold or used this system. What they do use, in the rare shops that cater to specialty divers is a 300 DIN system which uses 300 bar of pressure or 4351 psi, substantially more than the American K valve system pressure. Many dive shop employees seem to be unaware that there is more than one kind of a DIN threaded fill adapter and only know about the 300 DIN and assume you want 300 DIN fittings. Unfortunately, this will not work. While the 200 DIN and 300 DIN connectors share the same thread size and pitch, you cannot make a 200 DIN male fitting seal to 300 DIN female because the lengths are different. This is done intentionally so that is impossible to fill a lower rated 200 DIN system from a higher pressured 300 DIN system. Anschutz and Walther both make 300 DIN length threads even though they use

only a 200 bar working pressure. Note: the current Walter LG300 and LP300 series are now rated for 300 bar, but they will still function fine beginning with only 200 bar pressures.

Having dealt with this issue on a weekly basis for a number of years with school programs throughout the United States, I can state unequivocally that the best, easiest and most practical way to set and fill match airguns is with a 3000 psi 80 cu aluminum tank with a k-valve installed on top, accompanied by a separate yoke that has a 200 DIN female opening on it. This gives you a number of advantages.

- 1) You can go to any dive shop anywhere in the US and get your tank filled.
- 2) You have a yoke that is pocket sized that allows you to go into any dive shop in the US and get your cylinders filled.
- 3) You can fill any brand of currently manufactured airgun cylinder. For teams that have different guns such as Anschutz or FWB and even the Daisy Valiant sporters, it makes life much simpler.
- 4) Many shooters already have their brass adaptor installed in their own private yoke, allowing them to fill off your tank quickly and easily without a possibility of your fill adapter getting set aside and lost.



Yoke-installed k valve

Conversely, If you try to install a DIN valve on your tank, you will encounter a problem if you ever try to get it filled at any location other than your local shop, say you have traveled to match out of town. From a price and availability standpoint, it is difficult to get 200 DIN fittings in the US. As stated before, if one does encounter a DIN valve in the US, it normally will be a 300 DIN valve, which is for 4300 psi tanks. (Yokes are not considered strong enough for this additional pressure). Because of the higher pressures involved, these are more expensive.

It is NOT recommended that any 300 bar/4300 psi tanks be used at airgun events due to the possibility of someone over pressurizing their 3000 psi rated cylinder. I know some colleges are exploring the possibility of using the 300 bar tank, to get longer service life between tank fills, but this requires extra equipment and extra vigilance to ensure that unsafe overfilling does not occur. From a practical viewpoint, I think the 300 bar tanks not needed, particular given their extra safety concerns.

200 DIN yokes are available with and without gauges to indicate fill pressure. I feel that for normal usage a gauge is unnecessary, because you should be starting with a 3000 psi tank, so no potential for overfilling exists.

GETTING YOUR TANK FILLED

Where to get your tank filled can sometimes be a difficult question. For most people I recommend that you buy your tank from a local dive shop where you are going to have it filled. This gives them an incentive to fill it for you if you do not have a dive card. Getting a tank filled at dive shops can be a problem if you don't have a diver certification card. This is because the dive shops don't want the liability of an untrained person drowning himself. In most cases, this obstacle can be overcome if you will go visit the shop personally, (a phone call will not do!), make arrangements to meet the owner or the manager, introduce yourself, explain who you are and what you wish to do, maybe have the fill adapter that go to the gun with you, (DON'T take the gun into the store unless you have specific permission to do so!), and ask if you bought a tank would they be willing to fill it for you, or if you have one already what would you have to do to get your tank filled. Some stores may want you to sign a liability waiver, stating that you will not use the tank for diving purposes. I also have stickers for the tank itself that states "NOT FOR BREATHING, Air in this tank is for competition airguns only" and this seems to help also.

It is essential that you speak to the owner or manager of the shop for this, a regular employee is not going to break the rules for you and risk getting fired. Once you have overcome the legal aspect of filling the tank, the cost of getting the tank filled is normally a \$3-4 dollar charge. Paintball shops also often have the ability to fill tanks. Another source for filling SCUBA tanks that may be available to you is the local fire department. Many departments have the same filling apparatus to fill their breathing systems as a dive shop so if you have any friends there, that is a possibility. Of course if you are a school or community group with a shooting team, the local fire department may be good source for some adult volunteers or support. As with any freebie, or favor, if you go this route, always be sure to leave a small donation for their coffee fund, or maybe bring some medals from one of your events to decorate their bulletin board.

SCUBA TANK SAFETY WARNINGS

The pressurized air normally used is at 3000 PSI (pounds per square inch) and has enormous energy potential. The kinetic energy potential contained within an average SCUBA tank is 1.3 MILLION foot-pounds. This is enough energy to lift a 100-ton diesel locomotive off its tracks and into the air. Because of the potential dangers of using these high-pressure vessels, manufacturers and other parties in the dive industry have set specific guidelines and recommendations for safe usage of these tanks. DOT and OSHA also have some regulations pertinent to SCUBA tank usage, but these are typically beyond the average user but do apply to commercial air fill stations and employees where compressed air is used. Tanks are required to be visually inspected at least once a year. The visual inspection consists of removing the valve and having a thorough look inside and outside the tank for evidence of corrosion, cracking or other damage that could lead to an explosion or other failure of the tank. After an inspection with no faults found, an Evidence of Inspection (EOI) sticker is attached to the tank by the inspector, with date and standards used to evaluate the cylinder noted. SCUBA tanks must also be hydro-tested every five years by a certified hydro-test facility and will bear stampings to this effect including the date on the shoulder of the tank leading up to the valve. Hydrostat testing is the method of determining the cylinder's expansion properties in an overfilled pressure state.

Safety needs to be stressed at all times. There have been cases of a tank being dropped, causing the valve to be broken off, and the resulting stream of air causing the tank to become a missile, and propelling itself through solid concrete walls. With that in mind, the following safety precautions should be adhered to when handling tanks:

- *SCUBA tanks should be secured tightly when being carried in vehicles to prevent damage to the valve or scraping, gouging or denting the tank walls in the event of sudden stopping or lane changes of the vehicle.
- *Tanks also should be securely attached at their permanent location to prevent tipping over, causing damage either to the tank itself or to the feet of the user or bystander.
- *There is an explosion danger possible from using typical firearm solvents or oils on CA guns. Airgun users should be cautioned against using petroleum-based solvents or lubricants anywhere near the airflow connections such as valves, cylinder connection points, or the breech of the gun. Silicon grease such as Dow 111™ is typically the only dive industry recommended lubricant to be used where exposure to high-pressure air is possible, and that should be applied sparingly.
- * Never carry SCUBA tank over your shoulder. Temporarily losing your balance due to tripping or avoiding someone could cause the tank to fall on the valve. If the valve shears off, that tank instantly becomes a huge projectile. Always carry the tank in a manner to protect the valve in the event of an unexpected droppage.
- *It is suggested by some folks that Dive shops should be asked to overfill your tank if you are not going to use it for diving. Do NOT ask someone to fill a tank over its prescribed fill pressure. To do so is both an illegal act and causes long-term damage to your tank.

FILLING AIRGUN CYLINDERS

When filling a cylinder (rifle or pistol) off a SCUBA tank you are basically equalizing the air pressure between the two containers. This means that if you have 3000 psi in the scuba tank and zero pressure in the cylinder the equalized pressure between the two when you open the valve will be approximately 2980 psi.

The next time after you have shot and emptied the cylinder and re-attached to the tank at 2980 psi then the equalized pressure will be say 2970 psi and you will consequently get a few shots less than the first time. And so on, each time you fill you will get slightly fewer shots. Quite likely you could probably have your scuba tank at half to a third its capacity and a filling of your cylinders still should be enough to go through a 60-shot match plus sighters. How many filled cylinders you get off of a 80 cu ft SCUBA tank will vary quite a bit depending on a number of factors such as the size of the airgun cylinders themselves or the amount of remaining pressure prior to filling.

Hand pumps are also an option but only if you have no possibility of getting SCUBA air. They look similar to a bicycle pump, but are capable of 3000 psi fills. They are a good aerobic workout. There are three pumps commonly used today, the Axsor, FX and Hill Pump. The first two are made in Sweden and were designed by the same engineer even though they are marketed under many different names. The Hill Pump is made in England, and seems to be the more robust of the three. For usage purposes they are basically the same. To use these you first screw the fill adapter directly into the base of the unit. There is a gauge at the base of the pump to show your progress. The gauge is in Bars and 200 Bar should be your stopping point. Normally its best to pump about 30 strokes and then let the pump (and you) cool down. The pumps are useful for traveling and to top cylinders not getting a full fill off a nearly depleted SCUBA tank.

The pumps do contain a moisture trap and a blow-off valve that **MUST** be used to prevent moisture from being introduced into airgun cylinders. The Hill pump also has a dry-pack system that lets remove all vestiges of moisture before it enters the pump. Moisture inside any pressure vessel will eventually lead to corrosion, which ultimately could lead to a failure of the cylinder. After pumping your cylinder to the desired pressure, the brass valve opening is opened slightly allowing a stream of moisture to remove itself from the pump itself.

AIRGUN FILL SAFETY PARTICULARS

Most airgun manufacturers use 200 BAR as the operating pressure in their airgun cylinders. Some manufactures, Walther in particular, allow the possibility of filling to 300 BAR, i.e.; their cylinders are rated for this. But a 200 BAR filling is more than sufficient to shoot any airgun match (twice over in most cases). Each airgun comes with its own fill adapter; usually a machined brass fitting that interconnects the DIN fitting with the detachable cylinder.

Dive industry recommendations for filling of SCUBA tanks is 300-600 psi per minute. This is on tanks that are much larger than our small airgun cylinders. This same guideline should be applied to the filling of airgun cylinders. This means that the shooter, having shot his full cylinder down to roughly 30% of its full fill pressure (1000 psi), should not screw his cylinder on to the tank, instantly open the valve wide open going from 1000 to 3000 psi in about 2 seconds. The sudden increase in pressure generates a lot of heat, which can be felt by touching the cylinder. This heat not only leads to premature failure of the rubber O-rings but also the long term expansion and contraction in the cylinder wall caused by this heating could cause metal fatigue.

*Cylinders when attached to the tank should be pointed in a safe direction (i.e., not at people standing nearby) in the event of thread failure on the tank, cylinder or adapter and the cylinder itself suddenly becoming a missile.

*Prior to each fill, shooters should inspect thread of both cylinders and adapter for evidence of dirt, foreign objects or signs of cross-threading or other abuse. Threads in either the adapter or cylinder showing ANY sign of wear or abuse should be considered dangerous and discarded.

*When filling the cylinders, shooters should be advised not to look directly at the manometer (gauge) present on the end of some brands of cylinders. There have been instances of gauges shearing their threads and the gauge itself becoming a projectile. All safety precautions should be adhered to at all times.

*Shooters should be made to understand the potential dangers of the individual cylinders, the potential energy of a fully charged cylinder is equal to a stick of dynamite and cylinders should not be dropped or abused in any way. Walking down a hallway and throwing a cylinder up end over end and catching it on its downward fall should be cause for a severe reprimand.

*Follow all of the manufacturer's current guidelines for filling, handling, and using their product.

*Some manufacturers such as Anschutz have a small blow off port that must be released prior to unscrewing the cylinders from the adapter/tank. Shooters should be cautioned not to place their thumb or fingers over this air outlet or embolism can result.

CONCLUSION

SCUBA air is safely used thousands of times around the world each day in a variety of applications. This brief is not intended to scare, but rather to encourage shooters and their coaches using this new technology to understand and follow proper safety measures. Just as firearms or the tank of gasoline within our vehicle can be safely handled within their respective guidelines, so must we also treat airguns using SCUBA air technology. Individuals wishing to learn more or receive training about SCUBA and other high-pressure vessels handling and inspection procedures are encouraged to contact:

PSI, Inc., 16932 Woodinville-Redmond Road, Suite A201 Woodinville, WA 98072, phone 425-398-4300,

www.pscopylinders.com

Definitions

bar = a “bar” is a unit of pressure. One bar equals 14.504 psi.

psi = pounds per square inch, a more common unit of pressure. Most car tires are inflated to about 32 psi

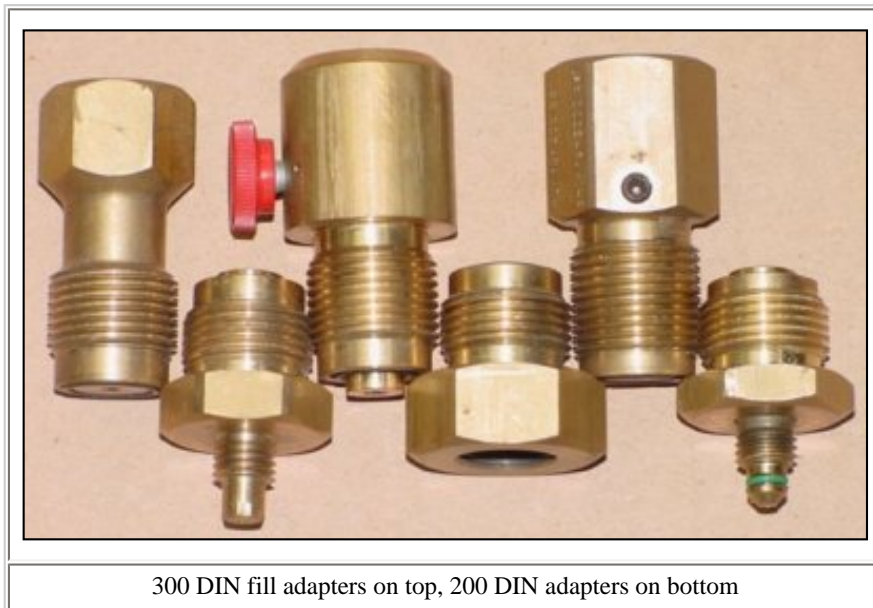
K-valve = this is the most common type of SCUBA valve in US, rated for 3000 psi, using a “D” shaped yoke to clamp over the valve head. Unfortunately, all the European airguns use a different type of fitting called DIN.

Yoke = a “D” shaped clamp that interfaces between a K-valve and airgun cylinder adapter.

DIN fitting = these are the European SCUBA fittings, as opposed to the American system referred to as yokes and K-valves. “DIN” is a German acronym for “Deutsches Institut fuer Normung”. This is the body that sets standards, similar to the CGA (Compressed Gas Association) in the United States.

200 DIN fitting = a SCUBA connection fitting rated for 200 bar (or 2900 psi). the most common type of DIN fitting used by airgun manufacturers, it is the LEAST common available in the US Dive shops.

300 DIN fitting = These are more common in the US Diving industry, although still not common in comparison to K-valves. These are rated for 300 bar of pressure, (4350 psi). Because of the higher pressures involved, the 300 DIN “fill side” (the female threads on the tank) will not seal to 200 DIN adapter.



300 DIN fill adapters on top, 200 DIN adapters on bottom

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