

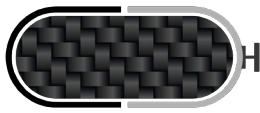
INTALLATION, USE, AND MAINTENANCE MANUAL

COMPOSITE CYLINDERS – BREATHING AIR

- **2.0L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **3.0L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **4.0L 300 BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **6.8L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **9.0L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **13.0L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**
- **20.0L 300BAR (EN 12245:2009+A1:2011) / 310BAR (ISO 11119-3:2013)**

INDEX

1) IDENTIFICATION DATA	3
2) GENERAL INFORMATION	3
3) TECHNICAL CHARACTERISTICS	4
4) CYLINDERS USE	6
5) CYLINDER HANDLING	9
6) MAINTENANCE	9
7) STORAGE	12
8) SPECIFIC CHECKS	13
9) SHIPPING	14
10) SCRAPPING AND DISPOSAL	15



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1) IDENTIFICATION DATA

1.1) MANUFACTURER CONTACT INFORMATION

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2) GENERAL INFORMATION

This use and maintenance manual can be requested via email by each client at the following email address: info@carboncylinder.com

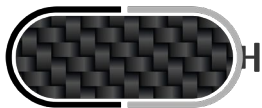
This manual is intended to provide the customer, and especially the staff working directly with the cylinder, all the information necessary for its proper use, as well as instructions for the maintenance in operational conditions, ensuring that is carried out in full respect of all safety conditions.

The instructions in this manual are a supplement to of the health and safety standards in force, not a replacement.

High-pressure composite cylinders, with a plastic non-structural liner (in PET) wrapped in carbon fibre, are designed to resist in difficult conditions of use. However, like any other vessel containing pressurised gas, also Type 4 cylinders need to be handled with caution and properly maintained. **Specifically, they should not be, in any case, rolled, dragged, thrown to the ground, or hit with any kind of object. Do not move or store the cylinders without the protective caps.**

Carbon Cylinder Srl declines any responsibility in case of:

- any use different from the provisions of the current health and safety legislation;
- disregarded or incorrect application of the manual instructions;
- non-compliant uses;
- unauthorised changes or changes not carried out by Carbon Cylinder Srl technicians or personnel authorised by Carbon Cylinder Srl.



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3) TECHNICAL CHARACTERISTICS

Carbon Cylinder Srl composite pressure tanks for breathing air are designed and produced for high pressure compressed gases. Their main features such as light weight, ease of handling and durability make them innovative cylinders. All Carbon Cylinders Srl cylinders are marked CE or UN, in compliance with PED directive (2014/68/EU) and have passed all the tests dictated by EN 12245:2009+A1:2011 and ISO 11119-3:2013.

Carbon Cylinder Srl composite pressure tanks are made of an internal PET liner, fully wrapped with a composite material layer made of carbon fibres and epoxy resin.

The cylinder comes with rubber protective caps (upper and bottom) which have the purpose of cushioning the impacts.

These caps may also have holes for water drainage.

The service life of Composite Cylinder Srl cylinders can be extended thanks to these two features:

- the internal boss (to which the valve is screwed) and its O-rings can all be changed (this procedure must be performed on an empty cylinder by competent personnel)
- the label, the protective sleeves and caps can be easily changed without losing the cylinder data and, so, the possibility of using it. In fact, the sleeves protect the main label, which is integral with the composite material.

For the replacement of the sleeves, label, and caps, ALWAYS turn to Carbon Cylinder Srl authorised personnel.

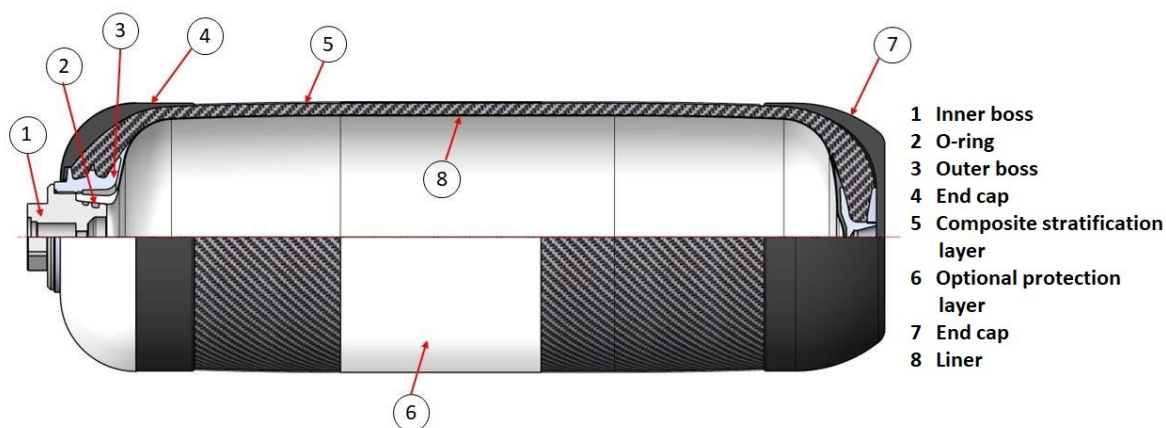


Figure 1. CARBON CYLINDER tank composition

3.1) CYLINDER MARKING AND LABELLING

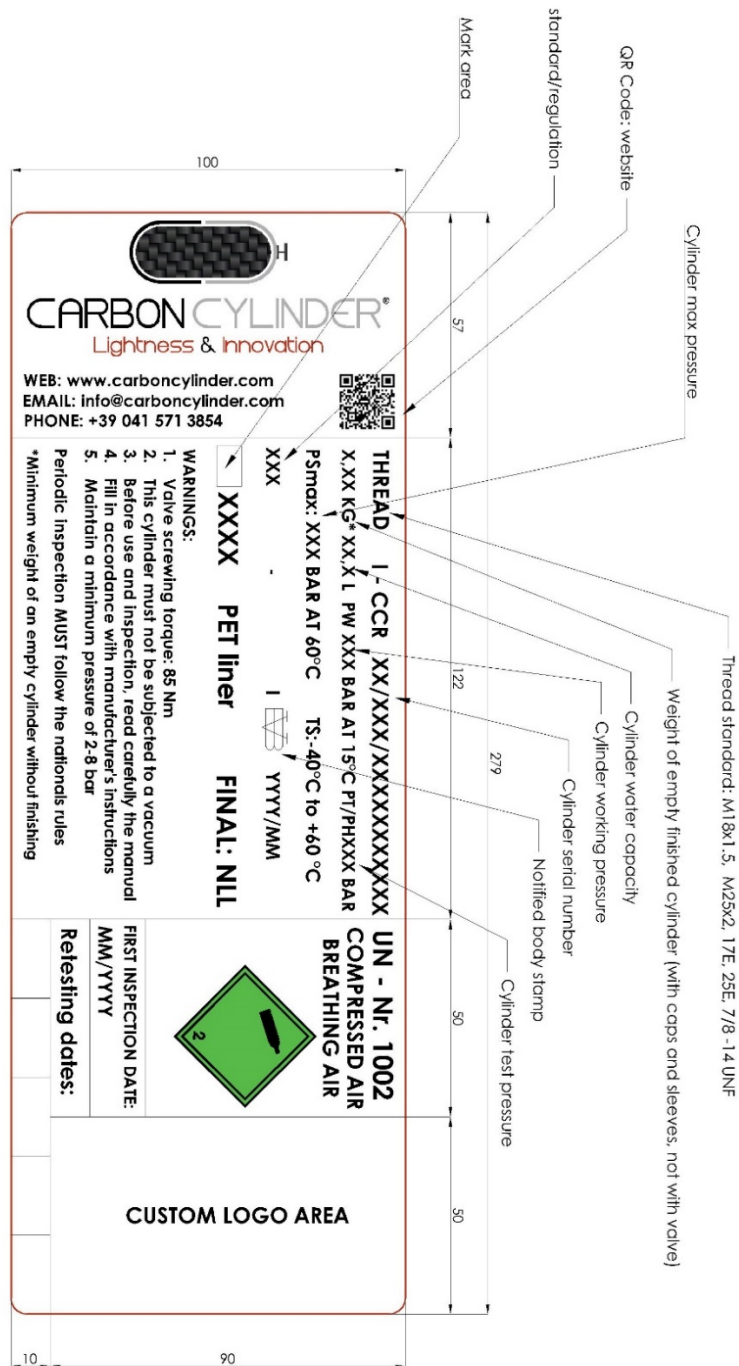
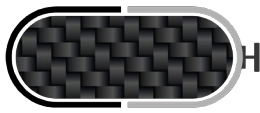


Figure 2. Label Example

Both the main label (applied on the composite layer) and the secondary label (visible) show all the data required by the standard.

The instructions on the label must be meticulously followed.



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4) CYLINDER USE

Carbon Cylinder Srl pressure tanks are designed to be used in the same way as any other pressurised gas cylinders, with all the appropriate precautions.

However, there are some major differences to consider, as explained in the following paragraphs.

4.1) NOTES ON CYLINDER USE

It is recommended to:

- Keep the threads and the cylinder interior dry, without grease, dirt or other contaminants
- Only fill the cylinder with breathable air complying with UNI EN 12021:2014
- Follow the installation procedures and the recommendations provided by the valve manufacturer, when installing the valve
The cylinder should stay empty the least possible
- Recharge the cylinder and keep it at a minimum pressure between 20÷50 bar

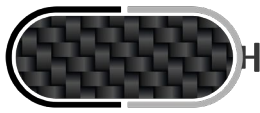
It is forbidden to:

- Fill the cylinder with a pressure higher than 110% of the working pressure (PW)
- Use the cylinder with a pressure higher than the working pressure (PW)
- Expose the cylinder to vacuum
- Fill the cylinder, completely or partially, with gases other than breathing air, or with enriched mix of oxygen
- Fill the cylinder if it is past the re-testing date
- Screw a valve with a tightening torque not complying with the provided values
- Tamper with the surface protections (end caps, protective sleeves), over-paint, modify the labels identifying the manufacturer, unless authorised by Carbon Cylinder Srl
- **Use valves with sintered filter**
- Move or store the cylinder without end caps

It is advised not to:

- Fill the cylinder if it presents a leak
- Fill the cylinder if it shows defects
- Fully discharge a cylinder, unless the valve needs to be removed (see paragraph 6.1)
- Artificially heat the cylinder, above all if exceeding 60 ÷ 70 °C
- Use a cylinder that has been exposed to a highly corrosive atmosphere or environment, without prior proper and thorough inspection and testing
- Use a cylinder showing signs of shocks, hits, abrasions or falls of considerable entity

In the above-mentioned cases it is recommended to have the cylinder examined by personnel authorised by Carbon Cylinder Srl.



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4.2) FILLING

The cylinder must be filled using a breathable air compressor, properly serviced and maintained and equipped with an appropriate filtering system, in order to ensure that the provided breathing air humidity is lower than 25 mg/m³, according to UNI EN 12021:2014.

GENERAL CAUTIONS:

When charging the cylinder, its temperature rises due to the increase of the pressure. Therefore, it is advised to pay attention to the following topics:

- THE TEMPERATURE OF THE CYLINDER BODY TEMPERATURE MUST NEVER EXCEED 60 ÷ 70 °C
- THE CYLINDER MUST BE CHARGED TO THE MAXIMUM PRESSURE SPECIFIED ON THE LABEL, AT A TEMPERATURE OF 15 °C
- Compression is an exothermal process; for this reason, it is recommended that the cylinder is charged at no more than 20 ÷ 30 bar/min
DO NOT immerse the cylinder in water (or other coolants), in order to dissipate the heat generated during the filling process.
For composite cylinders this process is useless and counterproductive
- The sealing O-RING between the inner and the outer boss sometimes requires a few cylinders pressurisation cycles to settle and operate properly

TO PROPERLY CHECK THE SEALING, OBSERVE THE FOLLOWING PROCEDURE:

- 1) Charge the cylinder at the working pressure
- 2) Let the cylinder and the O-Ring settle at room temperature for 2 ÷ 4 hours
- 3) Immerse the cylinder in water to check for leaks. Air bubbles coming from any area that is not the boss in the 2÷4 hours following the cylinder charge, DO NOT CONSTITUTE a leak.
These bubbles can be just trapped air among the different layers of the cylinder, pushed outwards during filling

During filling and discharging, the cylinder may emit some noises, often described as a creaking, which is not cause for concern.

Carbon Cylinder Srl pressure tanks can be filled with a higher pressure, up to a maximum of 10% above the operating pressure, provided that the pressure at rest corresponds to the operating pressure.

The following chart can be used as a reference to know the filling pressure for a complete charge, in relation to the gas temperature and according to a certain operating pressure (referred to 15 °C).

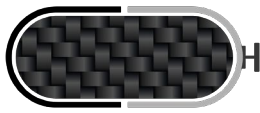


Table 1. Filling pressure at different room temperatures

Gas: Breathing Air		
Room Temperature [°C]	Max filling pressure for cylinders homologated for 300 [bar]	Max filling pressure for cylinders homologated for 310 [bar]
15	300	310
20	308	318
25	317	326
30	325	334
35	333	342

4.2.1) SLOW FILLING

Filling the cylinders slowly reduces the heat generated by the filling process.

If opting for slow filling (which is the advised method) the filling rate is equal or lower than 30 bar/minute.

4.2.2) FAST FILLING

It is possible to execute the procedure known as "quick/fast filling" on Carbon Cylinder Srl composite cylinders, provided that the tank has been properly handled and maintained and is in perfect conditions. This procedure shall anyway be performed by specialised technical staff duly trained, which shall make sure never to exceed the maximum working temperature. The maximum suggested flow speed is around 100 bar/min.

4.3) LEAK TEST

To verify the proper sealing of the cylinder, Carbon Cylinder Srl advises against the use of foamy leak detector, as they can be often misleading.

Therefore, the best solution is to immerge the cylinder in water for 30 seconds, possibly rich of surfactants (i.e. liquid soap, detergent, etc.). Before performing the test, it is necessary to fill the cylinder up to the working pressure and wait for it to settle. The settling period should last between 2 ÷ 4 hours.

The settling period is necessary for the following reasons:

- It allows the cylinder to reach room temperature
- It ensures the proper settling of the sealing O-RING
- It allows the trapped air between the various layers that make up the cylinder's coating (sleeves and end caps) to escape

If the cylinder is not allowed the settling period after filling, the described phenomena may simulate leaks. It is underlined once again that these are not actual leaks.

4.4) MOISTURE CONTENT OF THE AIR INSIDE THE CYLINDER

To reduce the moisture level of the gas inside a Carbon Cylinder Srl cylinder, observe the following procedure:

1. Use a compressor able to supply breathing air in compliance with EN12021:2014



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2. Fill the cylinder up to 50 bar with breathing with a moisture level in compliance with EN12021:2014
3. Empty the cylinder with a **discharge rate lower than 12 l/min**
4. Repeat steps 2 and 3 at least two more times
5. Fill the cylinder with at least 200 bar of breathing air with a moisture in compliance with EN12021:2014 before carrying out the moisture level test

NOTE: Carbon Cylinder Srl assures that, when leaving the production, the humidity level in the cylinder falls within EN12021:2014 parameters. If different values are recorder, follow the humidity level decrease procedure, as explained above.

When performing the humidity test Carbon Cylinder Srl does not recommend using salt vial-based instruments, as they are too sensitive to environmental conditions. Instead, it is recommended to use digital electronic devices, as they provide better precision, along with ease and quickness of use.

5) CYLINDER HANDLING

Any type of cylinder must not, under any circumstances, be dragged, dropped, manipulated, left without custody, or roughly handled. Moreover, during transport, make sure that they cannot roll, swing or fall. The cylinders must be moved in safe position, and it is necessary to use all the necessary precautions to avoid that the rest of the load may hit or damage them.

6) MAINTENANCE

After using a cylinder in an emergency situation or in a rescue operation, verify its conditions then proceed to the cleaning of the cylinder and its components. When using water for cleaning, allow the necessary time for the components to dry and do not reinstall the cylinder until they are all completely dry.

If the cleaning is done in a decontamination washer, it is possible that some water remains inside the end caps. To remove it, hold the cylinder in a vertical position, oriented according to the side where the water will exit.

Do not expose the wet cylinder to heat sources or steam jet to dry it. For a quick drying, it is possible to use a clean air jet with a temperature up to 60°C.

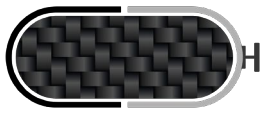
6.1) VALVE INSTALLATION/REMOVAL

TO BE CONSIDERED WHEN REMOVING THE VALVE:

The cylinder must be emptied of any gas, to allow an internal visual inspection.

The cylinder must be emptied, using the valve fitted, at a maximum rate of 40 litres/minute. Moreover, follow the recommendations provided by the valve manufacturer.

Once the cylinder is emptied, remove the valve following the instructions below, blocking the cylinder so as to prevent damage to the boss thread and the valve.



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To check if the valve is working correctly, simply fill the cylinder with a small amount of air, so as to be able to check that the valve is not blocked. Then release the pressure again. If this is successful, the valve works as expected.

It is now possible to completely depressurise the cylinder and remove the valve.

For any requests, or in the event of problems with the valve, also contact the valve manufacturer.

If, for any reason, the valve is difficult to remove, do not insist. In case of suspected valve defects, it is advisable to avoid removing the valve and instead to contact the manufacturer and/or dealers authorised by the manufacturer.

If during the check it is found a defect that leads to the non-acceptance of the cylinder, do not continue the check and contact Carbon Cylinder Srl or an authorised centre.

TO INSTALL THE VALVE:

Before installing the valve, verify that the valve designed service pressure is compatible with the cylinder designed service pressure. The valve thread and the boss thread should be carefully inspected and repaired, if necessary, in accordance with the valve manufacturer or cylinder manufacturer recommendations, to ensure satisfactory performance during use.

Do not install any valve that has not passed inspection. The valve threads must be free from damage and checked for compliance according to the thread specification, by using the appropriate thread plug gauges. The surface of contact with the valve must be smooth and in good condition.

Damaged or distorted valve threads can damage the cylinder boss threads. Damage to the contact surface can prevent sealing and damage the cylinder boss.

Use valves that allow tightening torques which are corresponding or higher than those indicated by the cylinder manufacturer.

To install/remove the valve always follow these steps:

- **PLACE THE CYLINDER:** place and secure the cylinder in a horizontal or vertical position. If using clamps or forks, first cover them with a rubbery material in order to prevent any damage to the surface of the cylinder. The force exercised on the cylinder must not compromise the mechanical characteristics of the composite; the maximum force applied to the jaws must not exceed $5\div 7 \text{ Kg/cm}^2$
- **USE A COUNTERWRENCH:** place a wrench complying with Table 2 on the boss hexagon, as shown in Figure 3. For the valve installation, use a calibrated torque wrench according to EN ISO 13341 (Table 3) values. **Carbon Cylinders recommends using 85Nm.**

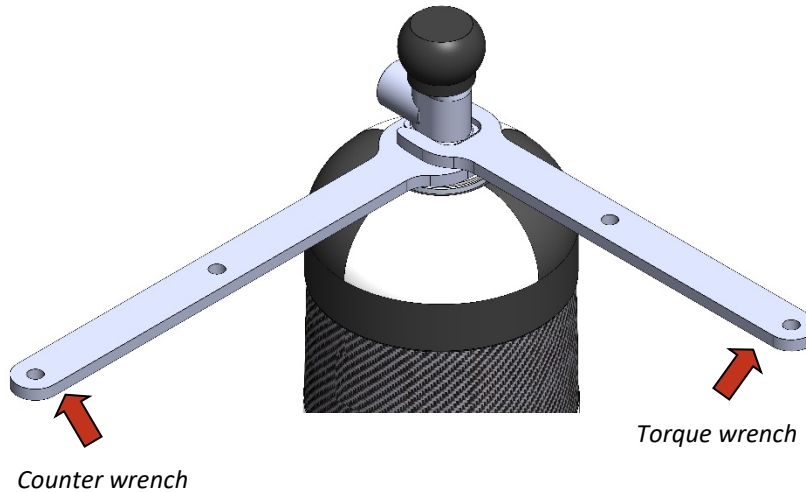
Table 2. Counter wrench size

Cylinder Size	Wrench
2L; 3L; 4L; 6.8L; 9L	36
13L; 20L	46

Table 3. Torque values EN ISO 13341

Thread	Torque [Nm]
M18	85 – 100
M25	95 – 130
17E	75 – 95
25E	95 – 110

Figure 3. Counter wrench use for installation/removal of the valve.
The figure shows the removal of the valve



In case of valve removal, FIRST MAKE SURE THAT THE CYLINDER IS COMPLETELY EMPTY

WARNING:

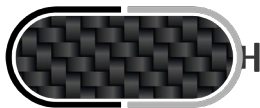
Installation/removal of the valve must be performed only by trained personnel or by authorised centres, following instructions at point 6.1 and following of this manual, along with the instructions given by the valve manufacturer.

6.2) AVAILABLE THREADS

The boss of a Carbon Cylinder Srl Type 4 cylinder can have the following threads:

Table 4. Thread types

Cylinder volume	Available threads				
	M18 x 1.5 EN ISO 15245-1	M25 x 2 EN ISO 15245-1	17E EN ISO11363-2	25E EN ISO11363-2	7/8" – 14 UNF
2L	X	-	X	-	-
3L	X	-	X	-	-
4L	X	-	X	-	-
6.8L	X	X	X	X	X
9L	X	X	X	X	X
13L	X	X	X	X	X
20L	X	X	X	X	X



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If necessary, refer to the valve manufacturer manual to change the valve components.

6.3) DRYING AND CLEANING

To clean composite cylinders with plastic liner, it is recommended following these procedures:

- *Moisture and light dirt:* Wash with a water solution containing a non-aggressive detergent, then thoroughly rinse with clean water. Remove any possible solid contaminants inside the cylinder by rinsing. The interior of the cylinder must be cleaned and dried before reinstalling the valve

To dry the cylinder turn it upside down and wait for the water to flow out of it. Do not expose it to heat sources to speed up the drying time. It is possible to use a clean air jet (max temperature 65°C). Avoid using organic solvents or acid/caustic substances that might corrode the inner plastic liner

- *Oil and grease:* Degrease with soap and water. Then follow the above-mentioned procedure
- *Odour:* Rinse with a solution of baking soda, then rinse with a highly diluted solution of vinegar, then follow the light dirt procedure above
- *Boss corrosion:* contact Customer Service. The inner collar of the boss can be removed to reach the areas exposed to corrosion. Ensure that this operation is done only by qualified personnel who will also be responsible for replacing the sealing O-rings

For any other kind of dirt, please contact Carbon Cylinder Srl.

Under no circumstances shall the cylinder interior be cleaned by rolling inside chips, balls or other solid materials mixed with water.

Never use liquids, gases or steams which have a temperature above 60°C (80°C if outside) or are high-pressured.

Whenever the cylinder boss is removed, it is recommended to change the sealing O-rings.

7) STORAGE

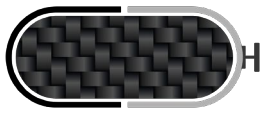
To avoid that the anti-aesthetic phenomenon of blistering occurs – which may happen in case of cylinders stored for 10 or more days with an internal pressure of 100÷200 bar – Carbon Cylinder Srl suggests to first discharge the cylinder until an internal pressure of 40÷50 bar. Then, leave the cylinder set for at least 48 hours before completely discharging it.

After use, it is advisable to charge and store the cylinder at a minimum pressure of 20÷50 bar.

Carbon Cylinder Srl underlines once more that blistering is merely an anti-aesthetical phenomenon which DO NOT AFFECT the efficiency and functionality of the cylinder.

Store the cylinder with at room temperature in a dry place, away from chemical products, heat sources, and corrosive environments. The cylinder must be secured in a vertical or horizontal position to prevent rolling, swaying or tipping. Properly protect the valve to avoid damage.

Make sure that the cylinder is not stored without any internal pressure.



8) SPECIFIC CHECKS

8.1) EXPOSURE TO CHEMICAL AGENTS

Composite materials can be attacked by chemicals and in some cases, by treated water. In this case the external composite layer must be inspected for clear signs of damage.

Chemicals may dissolve, corrode, soften, make sticky to touch, remove or damage the cylinder materials.

They may also cause bubbles, wholes, extreme discoloration or deterioration of the resin or protective layer (i.e. the protective sleeves) or, once the external protections are damaged, create multiple fractures to the structure.

Cylinders with evidence of such damage shall be REJECTED.

If a carbon cylinder has been damaged by chemicals, it must be REJECTED.

In case a cylinder has been exposed to a chemical not listed below, and of which it is uncertain the effect on the composite material, SET IT ASIDE and contact Carbon Cylinder Srl for further information.

The following is a list including, but not limited to, chemicals which are proven to damage or attack composite surfaces.

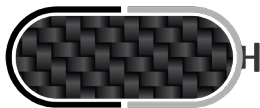
It is reminded that any cylinder coming into prolonged contact (e.g. soaking) with these types of chemicals and materials must be REJECTED:

- *Strong bases*: materials that contain medium-to-high concentrations of soda (i.e. sodium hydroxide, potassium hydroxide), substances containing strong soapy solutions and substances containing surfactants used in removing stubborn dirt, etc.
- *Acids*: materials that are, or contain, any concentration of acids such as hydrochloric, sulphuric, nitric, phosphoric acid, etc.
- *Corrosive agents*: corrosive materials or those containing corrosive components such as agents for glass cleaning, metal cleaning, detergent/abrasive agents for surfaces cleaning, sink plungers, pipe detergents, gluing products with a solvent base, chemical cements, as well as atmospheres containing corrosive gases
- *Solvents that can make the structure or the liner swell*: acetone, benzene, chlorinated solvents, mineral turpentine solvent, etc.

8.2) EXPOSURE TO HIGH TEMPERATURES

All cylinders exposed to high temperatures for a time long enough to make the internal gas reach and surpass 150°C must be REJECTED. In fact, at that temperature, air develops a pressure of about 520 bar, which is higher than the test pressure. Moreover, at these temperatures, the thermoplastic liner properties are altered.

A short exposure (not more than 15 seconds) to high temperatures – even above 300°C – is not sufficient to alter the external composite layer, nor to make the internal liner reach a temperature that degrades its chemical-physical properties. In these cases, it is suggested to have the cylinder analysed by an authorised centre or by Carbon Cylinder Srl.



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In case of exposure to high temperatures, if abandoned during a fire, it is necessary to have the cylinder(s) analysed by an authorised centre or by Carbon Cylinder Srl.

9) SHIPPING

Type 4 cylinders should always have a minimum internal pressure of 2 bar, in order to keep the cleanliness and internal hygiene of the cylinder.

The Standards or Codes that classify the goods as dangerous or not dangerous, and regulate their transport, are:

ADR for land transport, *ADN* and *IMDG* for ship transport, *RID* for railway transport and *IATA* for air transport.

ADR, *ADN*, *IMDG* and *RID* regulations allow to transport pressurised breathing air cylinders (and other gases that are part of the same group) with an internal pressure ≤ 2 bar without the transport being classified as dangerous and, therefore, transportable without special precautions.

IATA regulation states that the air transport of compressed gases is always to be considered, and must always be handled, as a dangerous transport, even if the cylinder has an internal pressure of only 2 bar.

For this reason, Carbon Cylinder Srl recommends following the instructions given below, so that the cylinders are not to be shipped as dangerous goods and, at the same time, they are used in the best way possible.

Table 5. Allowed transport methods

Method	Type of transport			
	Truck	Ship	Train	Airplane
Figure 4	X	X	X	-
Figure 5	X	X	X	-
Figure 6	-	-	-	X
Figure 7	-	-	-	X



Figure 4: Cylinder with bicycle-type valve and internal pressure



Figure 5: Cylinder with valve and internal pressure



Figure 6: Cylinder with cap and without internal pressure



Figure 7: Cylinder with open valve and anti-tampering tape

Carbon Cylinder Srl recommends, when allowed, to always keep an internal pressure of 2 bar. In the case a pressurised transport is not allowed (e.g. air transport), it is recommended to carry out the following operation within the first three/four hours after receiving the cylinder:

1. Fill the cylinder with at least 50 bar of breathable air according to EN 12021:2014
2. Empty the cylinder with a recommended flow of 12÷15 l/min
3. Fill the cylinder with at least 2 bar of breathable air according to EN12021:2014 to store it, or charge the cylinder at working pressure to have it ready to use

10) SCRAPPING AND DISPOSAL

Cylinders deemed unsafe or of which the label cannot be read clearly must be immediately REJECTED.

A safe way to SCRAP the cylinder and make it UNUSABLE is to drill a hole in the structural layer of the cylinder.

Proceed as follow:

- Make sure that the valve works properly
- Slowly open the valve so to discharge the cylinder completely
- Make sure that the cylinder is COMPLETELY EMPTY
- Leave the valve open and remove it only if it is necessary for the disposal, according to the type of waste
- Lock the cylinder body on a suitable locking device (workbench with vise), wear suitable personal protective equipment for drilling such as gloves, safety goggles, safety shoes, etc.
- Drill a small diameter hole (e.g. 6 mm) on the cylindrical part of the cylinder
- Properly dispose according to the applicable regulation

Carbon Cylinder Srl pressure tanks are made of: composite material made of carbon fibre and epoxy resin, aluminium and/or steel, rubber and/or polyester. Recycle these materials according to local recycling regulations. DO NOT TOSS IT INTO THE ENVIRONMENT.