

CTS CYLINDERS

INSPECTION AND TESTING MANUAL

Damage evaluation Periodic inspection and testing



Table of contents

Introduction	3
1) Intervals between periodic inspection and testing	4
2) External damage evaluation	4
2.1) Damages to the finishing (protective sleeves and caps).....	4
2.2) Damages to the composite material	4
2.3) Thread damages.....	4
2.4) Level 1 damages pictures	5
2.5) Level 2 damages pictures	6
2.6) Level 3 damages pictures	6
3) Internal inspection	7
3.1) Macro blistering - Level 1 damage	7
3.2) Micro blistering - Level 1 damage	8
3.3) Liner damage - Level 3 damage	8
4) Cylinders' testing	9
4.1) Test method	9
4.1.1) Proof test	9
4.1.2) Leak test.....	11
4.1.3) O-ring replacement.....	11
5) RMA procedure	11

Introduction

This manual follows broadly ISO 11623:2005.

The principal aim of periodic inspection and testing is that at the completion of the test the cylinders may be reintroduced into service for a further period.

The aim of the periodic inspection and testing is to assess whether or not the cylinder(s) shall or shall not be reintroduced into service for a further period.

This manual does not expect to report every possible case. Any question regarding non-standard cases shall be directed to CTS at info@ctscyl.com.

1) Intervals between periodic inspection and testing

According to ISO 11623, the re-test period for cylinders used for underwater operations and self-contained breathing apparatus shall not exceed five years.

Some Countries, according to their own laws or regulations, provide a re-test period shorter than 5 years.

It is important that the user knows the laws and the regulations of the nation(s) where he/she operates.

According to ISO 11623, responsibility of the owner or user is to submit the cylinders for a periodic inspection within the specified interval.

2) External damage evaluation

Damages that could arise on the cylinder during its lifetime while using an SCBA, can be classified in three categories:

- Damages to the finishing
- Damages to the composite material
- Damages to the threads

Not all damages declare the cylinder's end of life. This brief guide analyses the most common ones. In case of any doubt, please seek assistance at your authorised dealer or directly to info@ctscyl.com

2.1) Damages to the finishing (protective sleeves and caps)

The finishing includes the caps (top and bottom), the sleeves and the stickers.

Their structural resistance cannot be compared to the composite material one, thus their damaging does not compromise the cylinder functionality and safety. If they have been damaged, please ensure that the composite material underneath has not been damaged as well.

In presence of damages, such as tears and cuts, all these components can be replaced with a simple procedure from an authorised dealer. Please seek assistance at your authorised dealer or directly to info@ctscyl.com

Damages on the protective sleeves or caps that do not reach the composite layer, they do not affect the safety of the cylinder (Level 1 damage according to EN ISO 11623:2016).

2.2) Damages to the composite material

If the composite material underneath the finishing presents damages, please do as following:

- In case of scratches, the correct cylinder behaviour is not compromised. The epoxy resin can get scratches but this does not create any structural problem for the cylinder nor for its safety.
- In case of dents, lack of material or cracks, the cylinder must be inspected by authorised personnel. **DO NOT USE THE CYLINDER. DO NOT ATTEMPT TO RECHARGE THE CYLINDER.** Please seek assistance at your authorised dealer or directly to info@ctscyl.com

Damages on the composite layer shall be evaluated to assess if these damages affect or not the cylinder safety (Level 1, Level 2 and Level 3 damage according to EN ISO 11623:2016).

2.3) Thread damages

The correct procedure to screw and unscrew the valve from a CTS S.p.A. cylinder is described in the CTS S.p.A. user manual and in the CTS Quick Start Guide. Both these manuals can be required to info@ctscyl.com

Proceed with a visual inspection: the thread must not present dents or stripping.

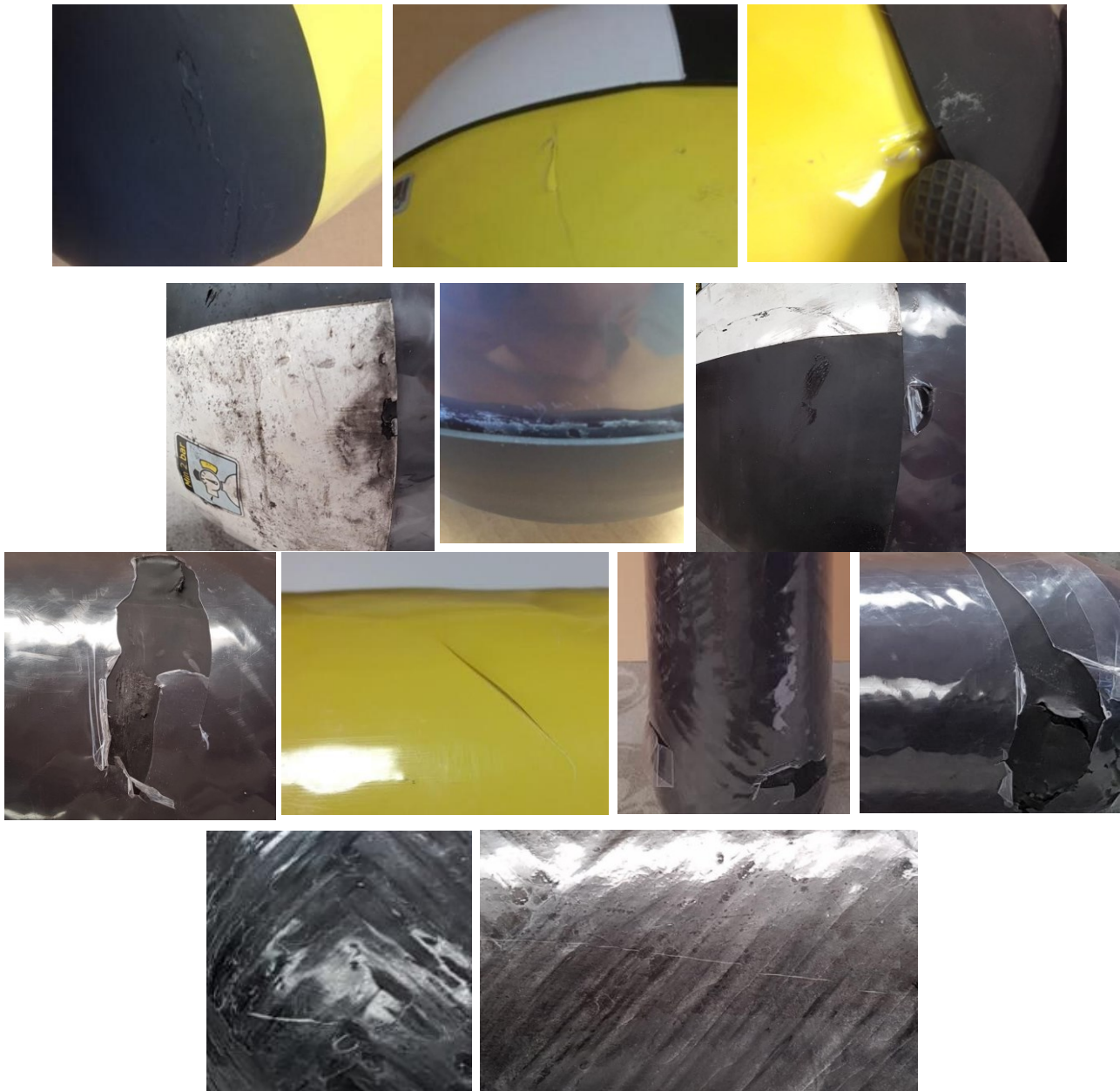
To verify the correct integrity, please do as follow:

Screw the valve in by hand. It must screw in with no blockage of any kind until it locks itself on the nozzle head. Then, unscrew it. Again, it must turn with no obstructions of any kind.

In case of damaged or stripped thread, the nozzle must be analysed by authorised personnel. **DO NOT USE THE CYLINDER. DO NOT ATTEMPT TO RECHARGE THE CYLINDER.** Please seek assistance at your authorised dealer or directly to info@ctscyl.com

Damages on the threads shall be evaluated to assess if these damages affect or not the cylinder safety (Level 2 and Level 3 damage according to EN ISO 11623:2016).

2.4) Level 1 damages pictures



This kind of damages on the cylinders are classed as Level 1 damage and are acceptable, hence no repair is required. Such damage has no adverse effects on the safety of the cylinder and its continued use.

2.5) Level 2 damages pictures



Level 2 damage can be subjected to rejection after testing. This type of damage is either proved to be acceptable (Level 1) by CTS S.p.A. tests' and investigation results, or else evaluated to be a Level 3 damage.

2.6) Level 3 damages pictures



Level 3 damage is sufficiently severe that the cylinder cannot be repaired: it shall be rejected and subsequently made unserviceable.

3) Internal inspection

Type 4 cylinders are made of a plastic internal liner and of an outer shell in composite material. The plastic internal liner has the only purpose of containing the gas even though it has no structural property. In fact, all the mechanical properties of the pressure vessel are demanded to the outer shell.

The internal plastic liner can be damaged only because of an incorrect use of the cylinder, such as filling or washing it with hot water or with hot gases or with corrosive substances. The internal plastic liner can be also damaged because of a long exposition to very high temperatures or to an aggressive environment especially when the cylinder is empty.

The internal liner, being of plastic material, is the most elastic material of the entire cylinder so, to not use the cylinder according to the manual, may create blisters. The blistering phenomenon is merely aesthetical and does not affect in any case the safety nor the correct functioning of the cylinder. The blistering phenomenon may be of two kinds: macro and micro blistering.

3.1) Macro blistering - Level 1 damage

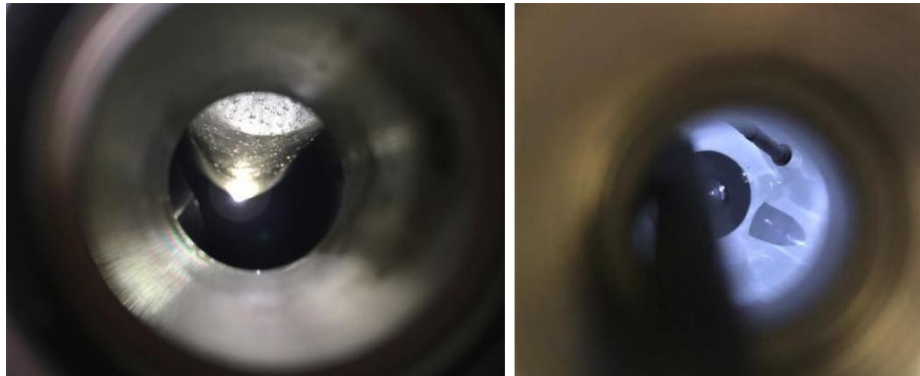
Macro blistering: one or more big blisters oriented towards the inside of the cylinder.

The blisters are due to a depressurization inside of the cylinder (for example during a flight with no pressure in the cargo).

This phenomenon, purely aesthetical, does not cause any problem to the correct functioning of the cylinder nor to any of its mechanical or sealing properties and, in any case, it does not affect the safety of the product.

In fact, thanks to the high level of elasticity of the plastic material, in order to restore the correct shape of the internal liner, it is sufficient to fill the cylinder with breathing air at 12-15 l/m. Usually, it is sufficient to fill the cylinder at 50 bar but, in some cases, it is necessary to fill the cylinder up to the working pressure.

Examples of macro blistering



3.2) Micro blistering - Level 1 damage

Micro blistering: micro blisters on the internal side of the liner.

This type of blistering is due to the permeation phenomenon: if a cylinder is kept charged for a long time and then is completely emptied, the air molecules, that were permeating from the inside of the cylinder to the outside through the plastic material, are subjected to a molecular expansion creating the micro blisters on the internal surface of the plastic liner. This phenomenon, purely aesthetical, does not cause any problem to the correct functioning of the cylinder nor to any of its mechanical or sealing properties and, in any case, it does not affect the safety of the product.

Example of micro blistering



CTS S.p.A. state once again that both macro and micro blistering are merely aesthetical phenomena that, in any case, do not affect or compromise the safety, the sealing and the correct functioning of the cylinders. The internal plastic liner has the only purpose of being gas-proof. All the mechanical properties of the cylinder are demanded to the outer composite shell.

3.3) Liner damage - Level 3 damage

The internal plastic liner can be damaged because of an incorrect use of the cylinder, i.e., filling or washing the internal surface with hot water, hot gases or with corrosive substances. The internal plastic liner can be also damaged because of a long exposition to very high temperature or to an aggressive environment especially when the cylinder is empty.

This incorrect use leads to a leaking cylinder that cannot be used anymore.

Example of a damaged internal plastic liner (bottom part)



Level 3 damage is sufficiently severe that the cylinder cannot be repaired: it shall be rejected and subsequently made unserviceable.

4) Cylinders' testing

4.1) Test method

The test method described in this manual is based on UNI EN ISO 11623:2016 standard as well as on CTS S.p.A. experience.

4.1.1) Proof test

Each cylinder shall be subjected to a proof test using a suitable fluid – water is commonly used as test medium. In any case, the test medium shall not reduce the integrity of the cylinder.

The test pressure is marked on the cylinder label.

Adequate safety precautions shall be taken during the test.

For Type 4 cylinders the test method is the proof test, that shall be performed according to Test 4 EN 12245:2009 + A1:2011:

Test 4 - Pressure test of finished cylinders at ambient temperature

Procedure

Where cylinders are subjected to autofrettage, the pressure test may immediately follow or be part of the autofrettage operation.

When carrying out the pressure test, a suitable fluid (e.g. normally water) shall be used as the test medium.

The fluid pressure in the cylinder shall be increased at a controlled rate until the test pressure (p_h) is reached. The cylinder shall remain at the test pressure (p_h) for at least 30 s.

The limit deviation on attaining test pressure shall be + 3 % - 0 % of test pressure (p_h).

Alternatively a pneumatic pressure test can be used provided that appropriate measures are taken to ensure safe operation and to contain any energy that can be released, which is considerably more than in the hydraulic test.

Criteria

- a) Pressure shall remain steady;
- b) there shall be no leaks;
- c) after the test, the cylinder shall show no visible permanent deformation.

Parameters to monitor during the test

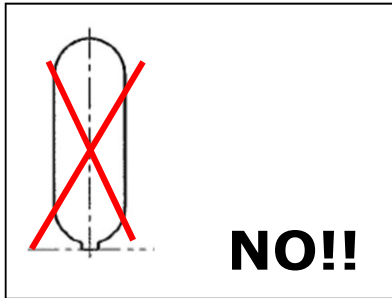
Pressure.

Type 4 cylinders are not subjected to autofrettage.

With regards to Type 4 cylinders pressure test, it is important to know that:

- Type 4 cylinders must not be subjected to vacuum, so it is important to assure that the testing machine does not create vacuum during the filling procedure and, above all, during the emptying procedure.

To empty the cylinder manually, do **NOT** place the cylinder in a vertical position:



Instead, the following method must be **USED**:

Step 1: empty approximately half the cylinder in a horizontal position

Step 2: carefully tilt the cylinder to approx. 45°

Step 3: carefully tilt the cylinder to the vertical position and finish the emptying

- Type 4 cylinder proof test does not include water jacket test or any other kind of test that records the water capacity increasing. To check the water capacity increasing during the proof test is not useful and sometimes even misleading, because of the high mechanical elasticity of Type 4 cylinders.

4.1.2) Leak test

A leak test may be performed after the proof test.

As suggested by the standard EN ISO 11623, the following test method shall be followed:

- Pressurise the cylinder to 2/3 of the test pressure with gas compatible with air or nitrogen
- Maintain this pressure in the cylinder **not less than 2 hours**
- Conduct a bubble leak test for at least 10 minutes. The cylinder shall be visually checked for leaks using soapy water - many times a foam leak detector proved to be misleading

Leakage greater than 1 bubble/min (i.e. 6 ml/h) in the bubble leak test, shall constitute a failure of the cylinder.

Adequate safety precautions should be taken to contain any energy that can be released.

4.1.3) O-ring replacement

If during the leak test a leak is found between the internal and the external nozzle, this leak is due to a damaged internal O-Ring.

It is possible to replace the internal O-Ring in CTS S.p.A. Type 4 cylinders thanks to CTS patented nozzle. The operative instruction manual and all the spare parts can be requested via email at info@ctscyl.com.

5) RMA procedure

CTS S.p.A. adopted a return merchandise authorization (RMA) procedure.

This procedure is issued once CTS S.p.A. receive a copy of the RMA form duly filled and signed. It is compulsory to send the filled and signed form before sending the cylinders to CTS S.p.A.

To fill and email the RMA form are essential actions in order to be authorised to deliver the cylinders to CTS S.p.A. so that they can be repaired, substituted or analysed. This is applicable whether the cylinders are still inside the warranty period or not.

It is possible to download the RMA form from CTS S.p.A. website www.ctscyl.com or request it via email at info@ctscyl.com.

Cylinders sent without a filled and signed RMA will be rejected by CTS S.p.A.