

Viking Cylinders – Composite LPG cylinders

Part 3 – Inspection and Maintenance



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1 Summary and background

This document is part 3 of a series of documents on the properties, use, and handling of Viking Cylinders manufactured by Hexagon Ragasco AS, hereinafter referred to as Ragasco.

Part 3 provides guidance to LPG distributors on the filling of Viking Cylinders. Parts 1 and 2 contain vital information about the design and use that will complete the information necessary to safely operate the Viking Cylinders.

External visual inspection of the casing and the composite areas exposed in the casing openings shall be the primary method for determining whether the cylinder may be filled and whether it may remain in service until the next requalification.

The acceptance criteria for filling given in this document shall not replace international, national, or local official rules/standards. These criteria are to be regarded as Ragasco recommendations specific to the product. DOT SP 12706 has precedence in any conflicts in criteria between DOT SP 12706 and this document. Authority requirements always take precedence over this document. If such a conflict occurs, Ragasco must be contacted immediately for additional guidance.

Only competent and trained personnel shall be permitted to carry out filling, inspection and requalification of cylinders.

The instructions are based on experience from type approval test programs conducted in accordance with US DOT-SP¹ 12706 [1], TC-SU-5931 [2], Title 49 of the Code of Federal Regulations [3], "UN Recommendations on the Transportation of Dangerous Goods," ADR/RID, EN12245, EN14427, ISO11119-3, and other relevant local regulations, filling, and retesting standards (NFPA 58 [4], EN1439, EN16728, ISO 24431, and ISO 11623), as well as experience from manufacturing and practical use in service of more than 24 million cylinders.

2 The company

Hexagon Ragasco, a division of Worthington Enterprises, is the leading global provider of composite liquefied petroleum gas (LPG) cylinders for residential, leisure, and commercial applications. The product line offers key advantages such as enhanced safety, lightweight design, rust-resistant materials, and translucency.

Since 2000, Ragasco has manufactured and sold over 24 million cylinders worldwide. The cylinders from Ragasco meet a broad spectrum of international standards and certifications and are approved in more than 95 countries.

Partner with Hexagon Ragasco to increase your market share and strengthen customer loyalty. For more information, visit www.hexagonragasco.com and www.vikingcylinders.com.

¹ United States Department of Transportation – Special Permit

3 Inspection

3.1 General

Your attention is drawn to Part 1 of this series of procedures providing information on the design and properties of Ragasco composite LPG cylinders. These cylinders are very robust and exceed all national and international standards for strength and durability, however the properties of composite cylinders are different from steel cylinders and therefore require different inspection techniques to ensure their safety and function throughout their service life. Part two of this document series, Viking Cylinders® Composite LPG cylinders Manual part 2 - *Filling, Handling and Transport* (including inspection before, during and after filling)" defines when a cylinder must be inspected. It must firstly be inspected prior to filling and if the criteria for suitability for filling are not met it must be set aside for a further and a more detailed inspection or if the cylinder is out of test date or the test date cannot be ascertained it must incur requalification testing if it is to return to service.

Any inspection of the Viking Cylinders shall be done in line with DOT SP 12706, Appendix A. Further guidance is found in the sections hereinafter, as well as in the **Appendix 1 of the Hexagon Ragasco LPG cylinders manual - Criteria for cylinder inspection**, which is an annex to this series of documents.

3.1.1 Inspection at Filling

Before filling the cylinder should receive an external visual inspection applying the rejection criteria in table 1 below.

Table 1 - Acceptance and rejection criteria for Viking Cylinders.

Type of damage	Definition	Level 1 - accept	Level 2	Level 3 - reject	Remarks
Protective casing and handle					
Abrasion	Damage caused by wearing, grinding or rubbing material away by friction.	When the depth is less than 0,25 mm and not located at the dome area of the composite pressure vessel.	Greater than Level 1 damage. Casing shall be removed / replaced and composite pressure vessel thoroughly inspected by trained personnel.	Diameter of the damaged area is more than 50 % of the diameter of the cylinder. Damage to the upper casing "skirt" typical >20mm², depending on depth and mode. Abrasion penetrating the casing.	Diameter of the damage is the smallest diameter that circumference the damaged area. Any penetrating abrasion or crack on handle, positioned lower than 70 mm from the ring/handle interface, shall result in rejection of the cylinder.
Cuts / scratches / gouges	A sharp impression where material has been removed or redistributed.	When the depth is less than 0,25 mm.	Greater than Level 1 damage. Casing shall be removed / replaced and composite pressure vessel thoroughly inspected by trained personnel.	The total length of surface cuts >50 % diameter of the cylinder. A deep-penetrating cut under which cut fibre in the composite cannot be ruled out.	Any penetrating abrasion or crack on handle, positioned lower than 70 mm from the ring/handle interface, shall result in rejection of the cylinder.

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Type of damage	Definition	Decision			Remarks
		Level 1 - accept	Level 2	Level 3 - reject	
Cracks	Typically caused by impact or external load resulting in deformation until cracking.	Minor cracks in the top ring or upper part of handle, replace ring and handle.	Greater than Level 1 damage. Casing shall be removed / replaced and composite pressure vessel thoroughly inspected by trained personnel.	Cracks to the lower casing base and bottom "star" Cracks to the upper casing "skirt"	Any penetrating abrasion or crack on handle, positioned lower than 70 mm from the ring/handle interface, shall result in rejection of the cylinder.
Chemical attack	Cylinder is subjected to a chemical that dissolves or destroys the material	Clean off; no residue or effect, and chemical is known not to affect cylinder materials	Chemical unknown; effects on cylinder materials unknown; moves to Level 3 if these cannot be resolved	Significant discoloring, dissolution, sticky material surface.	Clean cylinder with high pressure water <65°C.
Heat or fire damage	Evident by discoloration, burning, deformation and melting of casing, labels and non-metallic components of the valve.	In case the melting is only affecting the top ring or an area on the handle not more than 15 mm below the ring/handle joint.	Larger damage than is accepted under level 1. The casing may be removed / replaced, for further investigation of the composite, by trained personnel.	Any other sign of heat affecting casing, boss or composite shall lead to rejecting the cylinder.	The cylinder should not be exposed to more than 65°C.

Type of damage	Definition	Decision			Remarks
		Level 1 - accept	Level 2	Level 3 - reject	
Composite pressure vessel					
Abrasion	Damage caused by wearing, grinding, or rubbing material away by friction.	When depth is less than 0,25 mm and no fibres were cut or separated.	Greater than Level 1 damage where no fibres are cut or separated, and that is accepted after thorough inspection.	Abrasion causing cut fibre tow. The abrasion area >20mm ² ,	
Cuts / scratches / gouges	Damage caused by contact with sharp objects in such a way as to cut into the composite, reducing its thickness at that point	When depth is less than 0,25 mm and no fibres were exposed, cut or separated	Greater than Level 1 damage where no fibres are cut or separated, and that is accepted after thorough inspection.	If any fibre tow is cut, independent of the depth of the cut/scratch/gouge.	
Cracks	May be caused by proof testing, impact or external load resulting in deformation until cracking.	Intra-laminar hairline cracks (between fibres, typically on the circumference after proof testing) are allowed if not in combination with impact damage.	Cracks related to impact or external load and/or area with cracks located on a vertical line or with a 180° facing; moves to level 3.	Any crack causing cut or broken fibre tow.	
Delamination	May appear as hairline cracks in the resin or delamination or cuts of the composite material. It may also appear as a whitish patch like a blister or air bubble beneath the surface.	Delamination less than 25% of the cylinder surface with no surface damage or cut fibres.	Delamination 25-50% of the cylinder with no surface damage or cut fibres and that is accepted after thorough inspection.	Any delamination in combination with surface damage, Cut fibres. Delamination covering more than 50% of the cylinder.	Areas with no adhesion between liner and overwrap shall not be regarded as delaminated.

Type of damage	Definition	Decision			Remarks
		Level 1 - accept	Level 2	Level 3 - reject	
Chemical attack	Vessel is subjected to a chemical that dissolves or destroys the material	Cleans off; no residue or effect, and chemical is known not to affect cylinder materials	Chemical unknown; effects on cylinder materials unknown; moves to Level 3 if these cannot be resolved	Dissolution of the resin matrix surrounding the fibres, where the cylinder is sticky.	Clean cylinder with high pressure water <65°C.
Heat or fire damage	Vessel exposed to heat or fire, evident by discoloration, scarring or burning of the composite overwrap, casing, labels and non-metallic components of the valve.	No sign of heat exposure to boss or composite.	No sign of heat to boss or composite, but severe melting of casing lower part or handle lower part, less than 50mm from the composite pressure vessel.	Any sign of heat e.g. brownish discolouring. Signs of melting on boss etc.	The cylinder should not be exposed to more than 65°C.
Internal defects (liner)	Cracks, stretch-marks, white lines from bending or stretching the liner as a result of partial liner collapse (transition from cylindrical to dome areas).	No cracks, stretch-marks, or white lines acceptable.	No cracks, stretch-marks, or white lines acceptable.	Any cracks, stretch-marks, or white lines in the cylindrical – dome transition area.	Seen in combination with partial lack of adhesion between liner and composite overwrap.

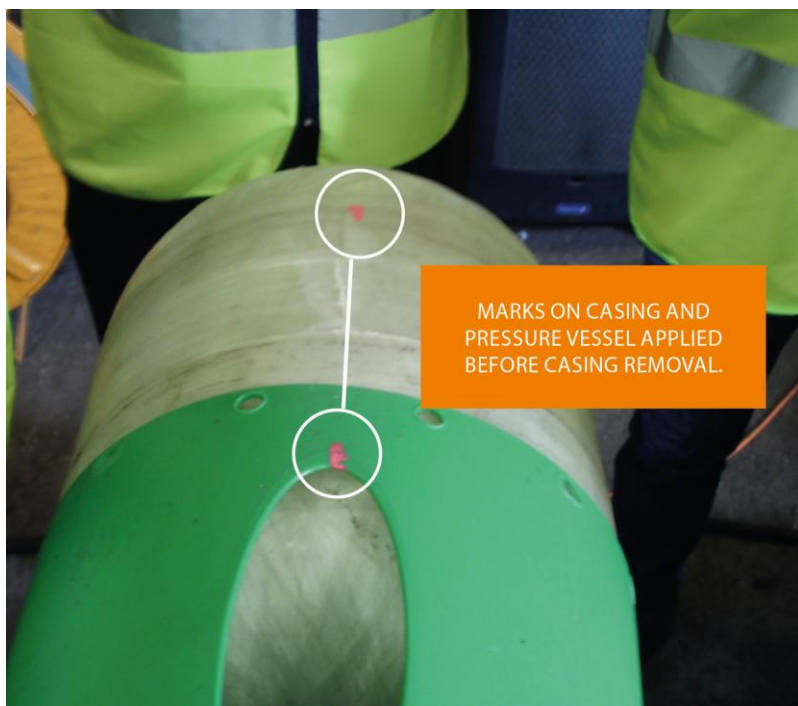
See **Appendix 1 to Hexagon Ragasco LPG cylinders manual - Criteria for cylinder inspection** for acceptance and rejection criteria supported with images for easier interpretation.

3.1.2 Further assessments

If trained personnel have detected damage to the casing and decide to inspect the pressure vessel further (after removal of the casing), the pressure vessel and casing must be marked in a way that enables the inspector to correlate the casing damage with the corresponding part of the pressure vessel after removal – see pictures below:

For replacement of casing parts see section 5.4 of this manual.

Attention: only personnel authorized by the cylinder manufacturer are allowed to replace parts of, or the whole casing.



Picture 3-1 Illustrations of marking of casing damage and pressure vessel area, as well as corresponding marks on casing and pressure vessel to show the positioning of the casing after removal.



Picture 3-2 Marking on casing and pressure vessel – before and after casing removal

Where a cylinder is rejected before, during or after filling due to a faulty valve and where the cylinder itself does not require further inspection or scrapping, the valve may be replaced if defective. See section 5.3 below for valve replacement.

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4 Requalification testing

4.1 General

Requalification testing shall be performed in accordance with DOT SP 12706, section 7.b.

Requalification shall be performed at least every 10 years and shall include visual inspection and proof pressure testing. However, the pressure test can be omitted if the body undertaking the requalification holds a VIN number for Special Permit 12706, and the requalification is instead performed every 5 years.

The procedure below shall be performed at time of requalification, by trained personnel only. Ragasco can provide training on request.

4.2 Test procedure for requalification, including pressure testing

(see later sections for further details)

- Look for any indication that special precautions may be necessary for handling the cylinder, e.g. leakage.
- Safely empty cylinder of any residual LPG and remove the valve. *Take care to ensure that the cylinder is completely empty before removing the valve.*
- Perform proof pressure testing in accordance with DOT SP 12706 7.a.(10)(i) and 7.b.
- Cylinder shall be cleaned and have damaged labels, tar, oil or other foreign matter removed from its external surface.
- External visual inspection shall be carried out with the casing on, using strong backlight. Acceptance/rejection criteria are defined in annex A of DOT SP 12706. Further guidance and pictures are found in Appendix 1 to Hexagon Ragasco LPG cylinders manual – Criteria for cylinder inspection.
- Retest marking to be applied, in accordance with 49 CFR 180.213(d)

When performing the requalification with pressure testing, there are additional important points to consider, see below:

- Ensure safe handling in the process. More than 90% of impact related damages are caused by rough handling and transportation with forklift trucks at filling stations and requalification facilities. Always perform a visual inspection as described, if it is suspected that the cylinder has been dropped or impacted in any way.
- Check the transportation system at the requalification station – does the cylinder fit to pallets, transportation chains etc.
- Pre-sorting – major damage should be sorted out early in the process
- The liner is saturated with LPG; thus, the pressure might increase if storing the cylinder with the valve installed after emptying all the gas, due to dissipation of LPG from the liner into the cylinder.
- Check the threads, the O-ring (no damage) and O-ring seal surface.
- When mounting the cylinder in the pressure test fixture a special adapter is needed.
- Ticking sound of surface resin micro cracking is normal during the pressure test- it does not affect the mechanical properties of the cylinder. Ticking should stop within 30 sec. When emptying the cylinder, due to the internal neck design, the cylinder will not be totally emptied from water by turning it upside down. Use a vacuum cleaner, forced ventilation with an air temperature of maximum 140°F or “sponge on a stick” to dry.
- Use external and/or internal strong light for optimizing internal visual inspection. Remains from the LPG (white/yellow/brownish crystals/“butter”) is normal, but not always present.
- When inspecting the liner, in the lower end, there are internal bulges from the manufacturing process. This is normal. Cracks and cavities in the liner are not acceptable.
- After valve assembly, to correctly position the outlet (outlet to the side), hold the casing by the handles and turn the pressure vessel within the casing in a controlled manner until positioned.

4.3 Test procedure for visual inspection ONLY (no pressure testing)

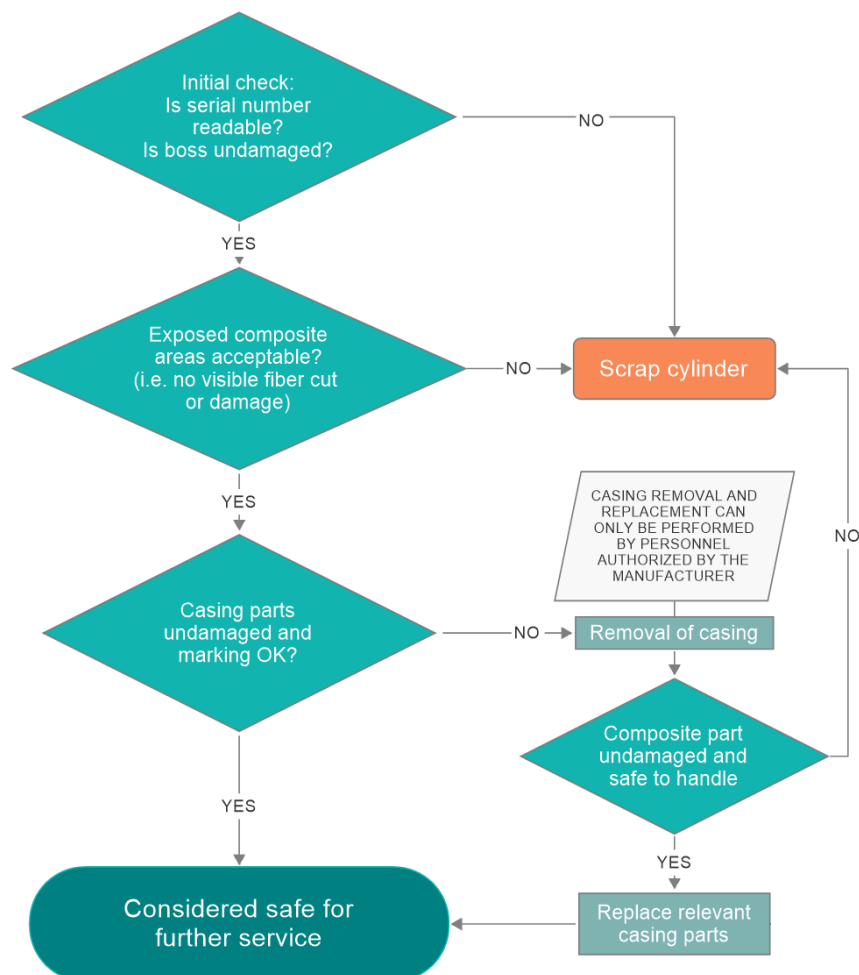
If the pressure test is to be omitted, requalification shall be performed every 5 years. Omission of the pressure test is only allowed if the LPG gas service meet the requirement limits in Table 1 of ASTM 1835, Standard Specification for Liquefied Petroleum (LP) Gases or an equivalent standard containing the same limits.

- Look for any indication that special precautions may be necessary for handling the cylinder, e.g. leakage or apparent damage.
- Cylinder shall be cleaned and have damaged labels, tar, oil or other foreign matter removed from its external surface.
- External visual inspection with the casing on, using strong backlight. Acceptance/rejection criteria are defined in the appendix of DOT SP 12706 [1]. Further guidance and pictures are found in Appendix 1 to Hexagon Ragasco LPG cylinders manual – Criteria for cylinder inspection.
- Retest marking to be applied, in accordance with 49 CFR 180.213(d)

4.4 External Visual Inspection

4.4.1 General

The acceptance/rejection criteria for requalification of the cylinder are based upon visual inspection of the outer casing and composite parts exposed. The container including outer casing is to be regarded as one total system where every product part is necessary to retain all safety properties and required marking. The casing shall not be removed during inspection, requalification or maintenance, unless specifically agreed with Ragasco and the local inspector. If the casing is being replaced due to maintenance, both the casing and the inner cylinder must be inspected. (See example flow chart for the inspection process here below:



Picture 4-1- Example flow chart for the external visual inspection process.

4.4.2 Preparation

Before cleaning, look for damage or signs that the composite pressure vessel has been rotated within the casing other than during valve positioning. If rotated unintentionally, the composite must be investigated by gradually turning the cylinder inside the casing while inspecting the composite via the openings in the casing. In case of damage, evaluate if it would be more effective to investigate the damage before or after cleaning.

If required, the cylinder may be cleaned and have labels, tar oil or other foreign matter removed from its external surface e.g. by water jet cleaning, chemical cleaning or other suitable methods. Do not wash the composite material with strong acids and/or solvents. The outer casing shall be kept on during the main inspection. Care shall be taken to avoid damaging the cylinder. Use a suitable strong backlight to see through the translucent wall for internal abnormalities on the liner internal surface or within the composite wall.



Picture 4-2 - Use of a strong back-light to inspect the cylinder. In this case, the remaining LPG in the cylinder is clearly visible.

4.4.3 Procedure for external visual inspection

The entire surface of the outer casing, and composite wall available in the cutaway portions of the casing, shall be inspected for:

- Cuts, gouges, bulges, cracks, or de-laminations applying the guidelines for acceptance criteria in table 1.
- Defects e.g. fire/heat damage applying to the guidelines for acceptance criteria in table 1.
- Integrity of all permanent attachments.

Any cylinder rejected by the trained person shall be segregated for reconditioning or scrapping.

4.4.4 Visible defects

Rejection criteria guidelines for physical and material defects on the cylinder casing are contained in the acceptance/rejection criteria in **Table 1** and in **Appendix 1 to Hexagon Ragasco LPG cylinders manual - Criteria for cylinder inspection.**

4.5 Hydraulic or pneumatic proof testing

- Pressure testing shall be performed in accordance with DOT SP 12706 7.a.(10)(i).
- When connecting a Ragasco composite cylinder to pressure test equipment, the same connection as the composite cylinder valve should be used utilizing an O-ring which seals against the smooth seal surface inside the boss. See picture 5.3 for description of the valve/cylinder interface. Do not position an O-ring on top of the boss assembly. Replace the valve in the cylinder in accordance with section 5.3 "Valve Replacement"

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Safety note: A pneumatic test must not be performed unless appropriate safety precautions are in place to ensure the safety of the test personnel in the unlikely event of a cylinder burst during the pressure test.

4.6 Procedure for internal inspection

An internal visual inspection shall be performed on cylinders after proof testing, to detect internal defects or the presence of foreign matter.

4.6.1 Internal inspection procedure

The internal inspection shall only be performed if the cylinder is being completely emptied of LPG and the valve is removed

- Empty ([section 5.1](#)) and clean ([section 5.2](#)) the cylinder and remove the valve ([section 5.3](#)) DO NOT APPLY VACUUM TO THE CYLINDER.
- Cylinders shall be inspected internally for any sign of defects that could affect its integrity, using a safe inspection lighting system with appropriate internal illumination (e.g. an endoscope or a camera suitable for the purpose) or with the bare eye directly (use a mirror for the domes) using a strong backlight from outside through the wall.
- Look for internal defects, abnormal shades, signs of foreign materials (heavy hydrocarbon sediment is ok) or major signs of internal discoloring.

4.6.2 Internal evaluation - criteria

- If there is a white line(s) indicating stretching or bending of the liner material, see Table 1 and Appendix 1, the cylinder shall be scrapped.
- If there is a crack or other damage in the liner, the cylinder shall be scrapped.
- If there are abnormalities, evaluate to find the cause.
- If there is contamination, dirt etc. – clean the cylinder. Heavy hydrocarbon fractions from the gas are normal and may be left in the cylinder.
- If there is color shading or delamination, see Table 1.
- If there is material loss, scrap the cylinder.

Note: During training and start-up of inspection of this type of cylinder, Ragasco recommends cutting open a few cylinders with "abnormal" internal colors, dirt, whitening etc. (if any is found) to investigate for training purposes.

4.7 Marking of accepted cylinders

After successful completion of the requalification, each cylinder shall be legibly marked in accordance with 49 CFR 180.213(d), (e), and (f). See pictures 5.2 and 4.3 for example marking.

- Markings must be applied on a label on a section of the exposed cylinder dome and overcoated with epoxy.

Note: Metal stamping on any part of the cylinder is prohibited

Where cylinders are not under the full control of any marketing organizations, test results may be kept on record by the organization responsible for re-qualification.



Picture4-2 Example requalification marks on pressure vessel



Picture 4-3 Example requalification marks on pressure vessel

4.8 Identification of contents

Cylinders that have been used with any other gas than LPG shall be removed from service and scrapped.

Approved contents is commercial propane, commercial butane, and mixtures thereof.

4.9 Information to the manufacturer

To construct a service history and data on the in-service performance of these cylinders, Ragasco urges the organization doing retesting to send a summary of findings from the retesting to techsupport@hexagonragasco.com.

If cylinders that might be of special interest for further inspection are identified, it would be appreciated if they could be set aside and Ragasco contacted, as they may possibly be subject to further testing.

4.10 Rejection and scrapping of cylinders.

4.10.1 General

The decision to reject a cylinder may be taken at any stage during the re-qualification procedure. With the agreement of the owner, a rejected cylinder shall be rendered unserviceable so that it cannot be re-issued into service as a pressure vessel. Rendering cylinders unserviceable is as a minimum performed by e.g. puncturing with two holes at >Ø20 mm, crushing or equivalent.

For disposal of composite cylinders that are rejected for commercial service and cannot be repaired it is suggested to observe the recommendations in Hexagon Ragasco White Paper and EPD.

5 Maintenance

5.1 General

Maintenance of a Viking Cylinder includes, but is not limited to, external cleaning, valve and casing replacement. Understanding the construction of the Viking Cylinder and following these guidelines to ensure safe performance of the cylinder after completed maintenance is crucial. Below picture shows the different parts of the Viking Cylinder. Further information can be found in Part 1 – Design and Properties.



Picture 5-1 Cylinder construction

5.2 Emptying the cylinder

Removing remaining LPG from the composite cylinder should be done in the same way as with traditional steel cylinders. Do not expose the cylinder to absolute pressure below 7,25 psia (500mbara). Do not expose the cylinder to less than 12 psia (800mbara) for more than 20 minutes. Do not store the cylinder with vacuum.

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5.3 Cleaning

Cleaning may be done e.g. by water jet cleaning, chemical cleaning or other suitable methods. Pay attention to any sign of discoloring or roughing up the surface of the composite or casing during cleaning. If this is observed abort the procedure. Hot water or steam is recommended. Up to 212°F (100°C) water temperature is permissible for less than 15 minutes. High pressure washing is acceptable. The cylinders can be washed with standard soaps. Ragasco recommends using an alkaline solution in powder or liquid form, mixed with water. It is important to rinse the soap away after washing. Do not wash the composite material with strong acids and/or solvents. To remove paint, ink or other items from the outer casing a short exposure to solvents is acceptable, if the area is thoroughly rinsed with water to remove any residuals.

5.4 Valve replacement

5.4.1 Clamping and unscrewing torque

The maximum pressure for keeping the cylinder in position by clamping during unscrewing and torque valves should not exceed 101,5 psi (70 N/cm² or 7,1 kg/cm²) at any area of the cylinder. Clamping equipment shall be shaped to ensure sufficient interface area (thus curved to fit the curvature of the cylinder). The minimum interface area between clamping equipment and the cylinder surface shall not be less than 3,1 in² (20cm²) for every equipment part in contact with the cylinder. The cylinder should not be exposed to a total force more than 450 lb (2000N) in any direction (vertical/horizontal). Clamp to the outer casing / side wall - never to the boss part.



Picture 5-2 Example of cylinder clamping device.

5.4.2 Procedures specific to the Ragasco parallel thread valve and O-ring seal interface

5.4.2.1 General

Use only valves with Ragasco special parallel threads and O-ring seal interface. The interface has an O-ring (on the valve) which seals against a smooth plastic surface (in the cylinder). This is the only durable seal in the construction. The threads have no permanent seal function. There is no adhesion between the plastic and brass, thus gas passing the O-ring may escape between the brass and plastic or over the threads.



Picture 5-3 Parallel threads, O-ring and seal area

5.4.2.2 Specific guidance

5.4.2.2.1 Safety precautions related to valving operations

Make sure that there is no pressure in the cylinder before removing the valve. The valve has an O-ring seal, so any remaining pressure in the cylinder will not be released as the thread is unscrewed as would be the case with a tapered thread on a metal cylinder. There is no whistling sound giving an early warning of remaining pressure before the threads release and the valve shoots out.

Remove the valve in the same manner as for traditional steel cylinders. Note the above limitations for clamping. Un-screwing torque shall not exceed 133 lbf (180 Nm). Do not use a power impact torque wrench, as it creates un-defined shocks to the construction. Boss plastic part resistance is marginally reduced with increasing temperatures. If dismantling at $>104^{\circ}\text{F}$ ($>40^{\circ}\text{C}$), the un-screw torque shall not exceed 110 lbf (150Nm).

Ragasco recommends measuring the un-screwing torque to ensure no overload. During dismantling, any displacement (movement, rotation) between the boss brass insert and the black plastic part shall lead to scrapping the cylinder.

The un-screw torque must in no case be more than 133 lbf (180Nm).



Picture 5-1 Boss parts

5.4.2.2.2 O-ring

Check the O-ring and threads on the valve for dirt and damage. See also ["5.3.2.3 Inspection of cylinder threads"](#) below. Apply grease to the O-ring all around the circumference. The grease must be compatible with propane and nitrile rubber. The type may be chosen from a local brand (Molykote® G5111 would be OK).

Don't apply any locking fluid. The valve tightening torque (see 4.6.7.3) is sufficient to secure the valve from unscrewing. Sealing is established with the O-ring.

Adding sealing fluid or Teflon tape to the threads will not create a permanent seal. Only the correctly implemented O-ring solution will assure a permanent gas barrier.

5.4.2.2.3 Valve assembly

Insert the valve by hand and ensure that the threads enter properly by screwing it in a couple of turns. No material (e.g. plastic collar, metallic ring etc.) should be fitted between the valve and metallic part of the boss, as it may compromise the torque.

Tighten the valve by controlled torque to 65 lbf (90 +/-20 Nm), checking at the same time, that the valve is screwed all the way down.

Ragasco recommends the operator establishes a 100% quality-controlled procedure for assuring that all valves are torqued correctly.

5.4.2.2.4 Valve positioning

If positioning of the valve outlet direction corresponding to the gap in the handle is needed, release the clamping, lock the casing e.g. by using the "star shape" in the bottom or the handle part, and turn the composite vessel clockwise within the casing by applying the necessary torque onto the valve. Do not apply any load to the black boss plastic part. If the torque needed to turn the cylinder in the casing is exceeding 89 lbf (120Nm), abort the procedure and retry directly after applying some water (to decrease friction) or heating the cylinder to 176°F (80°C) for 1 hour. It is recommended to put an "in-line-mark" on the composite and casing to detect rotation at a later stage.



Picture 5-2 Example of casing locking knobs for valve orientation (cylinder clamping not engaged).

5.4.2.2.5 Leak test

After assembly, a leak test is recommended, e.g., by electronic sniffer, trace gas sniffing, water jacket or other suitable methods. (Please note that the construction has natural cavities that could release air bubbles, thus sniffing would be more effective than water jacket and leak spray).

5.4.2.3 Inspection of cylinder threads

5.4.2.3.1 General

Cylinder thread inspection is only relevant when the valve has been removed. In general, removing the valve should be avoided. Whenever the valve is removed, the cylinder threads shall be inspected.

5.4.2.3.2 Thread inspection

The internal threads of the cylinder shall be examined to ensure that they are of full form and clean. They shall be checked for burrs, cracks, and other thread damage.

Cylinders with damaged threads shall be scrapped.

5.4.2.3.3 Check O-ring seal surface

The black plastic surface below the cylinder brass threads (seal area) shall be inspected visually and/or by feeling with a finger for signs of scratch marks, damage from threads, burrs, contamination etc. Foreign material shall be removed with a very soft brush, a clean cloth, air-blow or other methods that cannot damage the seal surface.

5.5 Replacement of outer casing parts

As stated in DOT SP 12706 7.b.(3), removal or replacement of the outer casing may only be performed by personnel authorized by the manufacturer. Before any such operation is carried out, Ragasco shall be contacted, to ensure training and the correct instructions are received for the operation.

The outer casing is an integral part of the design, fitted for protection from impact and other exposure, and cannot be removed without the use of special tools (contact Ragasco for details). It consists of a handle part, a top ring and a lower casing part.

Casings may be replaced using special Ragasco parts, tools and instructions with supporting video, provided the personnel is previously authorized in writing by Ragasco.



Safety Note: When any casing part is replaced

- a. Inspect thoroughly the exposed composite area.
- b. Inspect the outer casing parts for damage before mounting.
- c. Ensure by visual inspection that **all** snap interlock connections are correctly positioned.
- d. Hold the handle and shake the product hard in vertical and rotationally as a quick test for correct assembly.
- e. If the customer requires, one may make a small mark with durable paint or similar on the composite and casing to indicate of any subsequent rotation of the composite vessel within the casing during use.

6 References

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- [3] DOT, *49 CFR Part 107 Subpart B*, Pipeline and Hazardous Materials Safety Administration, Department of Transportation.
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- [8] DOT, *49 CFR Part 107 Subpart C*, Pipeline and Hazardous Materials Safety Administration, Department of Transportation.