Viking Cylinders – Composite LPG cylinders

Part 2 – Filling, Handling & Transport

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1 Summary and background

This document provides guidance to LPG distributors on the filling, handling and transport of Viking Cylinders manufactured by Hexagon Ragasco AS, hereinafter referred to as Ragasco, highlighting their unique design and properties compared to traditional metallic cylinders. The document aims to provide help and guidance to the user of 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. Local authorities' requirements shall always take precedence over this document. If a local requirement conflicts with our recommendation, Ragasco must be contacted immediately for additional guidance.

Only competent personnel shall be permitted to carry out the inspection and filling of cylinders.

The instructions are based on experience from type approval test programs conducted in accordance with US DOT-SP[1] 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 Filling Procedure

3.1 General

A container shall only be accepted for filling after it has successfully passed a visual inspection of both the outer casing and the composite parts exposed through the casing openings. The container, including the outer casing, is to be regarded as a complete system in which every component is necessary to maintain all safety features and required markings. The casing shall not be removed unless expressly approved by Ragasco and the local inspector.

3.2 Cleaning

Cleaning may be performed using methods such as water jet cleaning, chemical cleaning, or other suitable techniques. Care must be taken to monitor for any signs of discoloration or roughening of the composite or casing surface during the cleaning process. If such signs are observed, the cleaning procedure shall be stopped immediately. Hot water or steam is recommended, with water temperatures up to 212°F (100°C) permissible for a duration of less than 15 minutes. High-pressure washing is acceptable, and standard soaps may be used.

Ragasco recommends using an alkaline solution in powder or liquid form, mixed with water. It is essential to rinse thoroughly to remove any soap residues after washing. Do not use strong acids or solvents on the composite material. To remove paint, ink, or other substances from the outer casing, short exposure to solvents is acceptable, provided the area is thoroughly rinsed with water afterward.

3.3 Inspection before filling

3.3.1 Cylinders suitable for filling

A cylinder shall be considered suitable for filling when:

a) The DOT Special Permit number "DOT-SP 12706" is clearly marked on the cylinder boss.
b) The tare weight and water capacity markings on the top ring are legible.
c) For DOT, the water capacity is marked in pounds, while for TC, the maximum propane content is marked in kilograms. Both markings are located on the top ring.
d) The cylinder is within the test date as indicated by the most recent marked requalification date.
e) The cylinder has no defects as described in *Appendix 1 of the Hexagon Ragasco LPG Cylinders Manual – Criteria for Cylinder Inspection,* which is an annex to this series of documents
f) There is no physical evidence of misuse of the cylinder.
g) The cylinder is equipped with a pressure relief valve, where required by the applicable standard.
   - **Note:** In the USA and Canada, all Viking Cylinders shall be fitted with a pressure relief valve.
h) The valve is undamaged (refer to Part 3 – Inspection and Maintenance of the Hexagon Ragasco Composite LPG Cylinders Manual for valve replacement guidelines).

3.3.2 Cylinders for requalification

A cylinder shall be set aside for requalification under the following conditions:

a) The cylinder is past its test date; or
b) The test date of the cylinder cannot be verified (e.g., the date marking is not visible or legible).

3.3.3 Cylinders requiring further assessment

A cylinder exhibiting any of the following defects shall be set aside for further assessment, disposal, or other appropriate action:

a) The tare weight marking on a cylinder filled by mass is missing or illegible.
b) The cylinder is faulty or defective, such as damage to any part of the outer casing, foot-ring, cut fiber tow, abrasion, or fire damage.
c) The cylinder, valve, or pressure relief device (if fitted) is damaged or has been previously identified as leaking.
d) The required permanent markings on the cylinder are obscured and cannot be easily identified.

3.4 Filling Instructions

3.4.1 General guidelines

Filling should be performed in accordance with local regulations and the filling organization's procedures, similar to traditional metallic cylinders.

3.4.2 Static electricity considerations

Due to the low electrical conductivity of composite cylinders, Ragasco recommends the application of small amounts of water to the cylinder surface and/or the use of other methods to discharge the polymer surface immediately before filling. The filling operator shall evaluate the risk of static electricity and take appropriate action to ensure a safe filling procedure.

It is important to note that when filling at a plant or station, the cylinder shall not be used as part of the grounding system for the filling equipment.

3.4.3 Additional Guidelines for Forklift Cylinders

When filling forklift cylinders from a bobtail truck at a customer location, it is recommended to employ one or more of the following measures to avoid electrostatic discharge (ESD) and potential sparking:

- **Wet the cylinder surface:** Reduce the potential electrostatic charge by spraying water onto the cylinder surface.
- **Reduce Venting Flow**: Minimize the venting flow through the FMLL [4] gauge[2] as much as possible by only opening it enough to allow gas to vent. It is not necessary to open it fully.
- **Bonding of the cylinder valve:** Attach a bonding wire between the cylinder valve and a designated grounding point on the bobtail truck. This equalizes the electrical potential between the cylinder and the truck, reducing static buildup.
- **Ground the Cylinder:** Connect a grounding wire between the cylinder valve and the ground under the cylinder. For soft surfaces, a ground spear is beneficial. For hard surfaces, the grounding wire can be pinned beneath the cylinder.
- **Limit venting duration to 15 seconds**: Do not vent liquid LPG for more than 15 seconds. If venting more than 15 seconds is required, implement at least one safety measure before proceeding.

3.4.4 Filling Rate Determination

The filling rate for a Viking cylinder is influenced by several factors, including the type of valve used, the LPG product mixture, ambient conditions, and the pressures and flow capabilities of the LPG system. To optimize the filling process for maximum efficiency, it's recommended to perform trial runs on sample cylinders under typical operating conditions when setting up automatic cylinder filling equipment.

3.4.5 Safe filling quantity

Cylinders must not be filled beyond their designated safe filling quantity. This quantity is determined by the safe filling ratio as established by the relevant national competent authorities. When the FMLL gauge on a forklift cylinder indicates that the safe filling quantity has been reached, the filling process must be stopped immediately. Both the FMLL gauge valve and the fill valve shall then be promptly closed.

3.4.6 Safe filling mixture and quality

Cylinders shall be filled with the appropriate LPG mixture and quality. Special care shall be taken to ensure that no contaminants that could cause damage are present in the LPG.

3.4.7 Accuracy of filling equipment

Filling equipment and check scales shall be periodically calibrated and verified for accuracy at least once per working day.

[2] Fixed Maximum Liquid Level Gauge: A fixed liquid level gauge that indicates the liquid level at which the container is filled to its maximum permitted filling limit. Ref.: sec. 3.3.34.2 in NFPA 58 [4].

3.4.8 Filling methods

Cylinders may be filled by mass or by volume.

- **Filling by Mass:** The correct tare mass of each individual cylinder shall be used to set the filling scales.
- **Filling by Volume:** When using the FMLL gauge, the gauge shall be checked for proper operation. When liquid is observed coming out of the FMLL gauge, indicating that the safe filling quantity has been reached, the filling sequence shall immediately be stopped, and the FMLL gauge and fill valve shall be promptly closed.

3.5 Checks after filling

3.5.1 Verification of filled quantity

Each cylinder must be checked to ensure that it does not exceed the maximum allowable filling mass. This verification can be accomplished either by check-weighing each cylinder to confirm that its mass is within the tolerances specified by the relevant national competent authorities, or by assessing the remaining ullage space to ensure it has not been overfilled. Where permitted by national authorities, alternative methods may be used, especially when the gas filling process is automatically controlled. These methods include sample weighing—where a representative sample of cylinders is weighed instead of every individual cylinder—or applying statistical data analysis techniques to monitor and control the filling process, ensuring compliance with safety standards.

3.5.2 Actions for overfilled or underfilled cylinders

- **Overfilled Cylinders**: For overfilled cylinders, remove the excess LPG promptly and re-check the cylinder to ensure it meets safety standards. Any LPG discharged into the air must comply with section 7.3 in NFPA 58 [5] evacuating gas through the FMLL gauge on a forklift cylinder valve, consider the risk of electrostatic discharge (ESD). To minimize ESD risk—especially during liquid LPG discharges exceeding 15 seconds—implement precautions outlined in section 3.4.
- **Underfilled Cylinders:** If a cylinder is underfilled, the appropriate amount of LPG shall be added, and the cylinder re-checked.

3.5.3 Final checks

Before dispatch or storage, inspect the cylinder, valve, and the connection between them for any signs of leakage. Since the cylinder contains a gas-tight liner (barrier), the load-bearing composite does not need to be gas-tight. Pores in the composite and small air pockets—especially in non-adhesion areas between the liner and composite at the domes or top, and at the boss/valve interface—may cause surface bubbles during soapy water tests or water jacket leak tests. Therefore, it is recommended to use a gas detection system for leak detection. If a water-based test shows bubbles, store the cylinder for two days and then retest, or retest using an LPG sniffer/detector. Note that air bubbles will not trigger a gas detector.

Additionally, ensure that valve caps or plugs are properly fitted, and that valve protection caps or guards are securely installed. Confirm that all required labeling is present and correctly affixed to the cylinder.

4 Handling, Transport, and Storage of cylinders at the filling plant

4.1 General recommendations

Cylinders should be stored and transported in compliance with national regulations and the procedures specific to the filling facility. Both the cylinder and valve should be protected from drops, impacts, and physical damage. For transport or long-term storage, the cylinder stacks should be stabilized using straps, transport cages, storage cages, or similar methods.

Transport and storage equipment, such as trucks or pick-up vehicles, should be well-ventilated to prevent the accumulation of LPG.

Special care should be taken when handling cylinders with a forklift truck. Experience shows that approximately 80% of all impact damages occur due to pallets falling over or cylinders being struck, such as by forklift forks during handling. Stacking shall not exceed the limits specified in Table 1.

Table 1: Cylinder stacking

Size (water capacity)	Max height per pallet, empty or filled cylinder
12.5 L	6 layers
18.2 L	5 layers
20.6 L	5 layers
24.5 L	4 layers
26.2 L	4 layers
27.4 L	4 layers
33.5 L	3 layers

If closed pallets or cages are used for the transportation and handling of composite LPG cylinders, it is recommended that these pallets or cages be equipped with guides for the forklift forks. This will help reduce the risk of the forklift operator accidentally striking the tops of the cylinders with the forks, which could potentially damage the composite cylinders. Figure 1 illustrates an example of forklift fork guides within a transport cage.

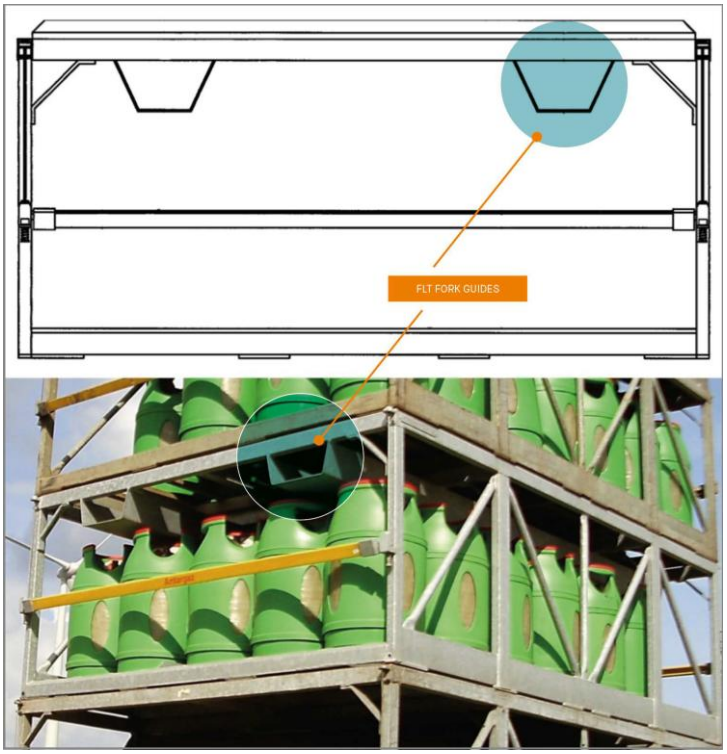

Figure 1: Forklift fork guides in transport cage.

4.2 Handling loose cylinders

It is not recommended to transport composite cylinders loose in trucks or trailers or on any other form of vehicle. The potential for impact and abrasion damage is too high. As composite cylinders are much lighter than steel cylinders it is easy to handle these cylinders manually into and out of pallets and cages. At dealers' premises it may be necessary to remove cylinders from cages to make a delivery. In this case additional care must be taken to prevent falling and impact damage. Special care should be exercised when the cylinders are handled in and out of the transport pallets or cages used at the filling centre. This is typically done at reseller, dealer, stockist and point-of-sale etc. locations. In these locations manual handling, trolleys and carts are often used to move small quantities of cylinders around. Therefore, the risk of impact damage to the cylinder is increased. Dealers, resellers and stockists etc. (both belonging to the operator of the cylinders as well as 3rd party) should be made aware of, and preferably trained in, the handling procedures and precautions to be observed for these cylinders.

4.3 Vehicles and handling devices

National and international regulations for the transport of dangerous goods by road, rail and waterways, including Title 49 of the US Code of Federal Regulations, as well as the UN Recommendations on the Transportation of Dangerous Goods and ADR/RID, determine the types of vehicles to be used for the transport of LPG cylinders. Generally, these vehicles must be well ventilated and comply with the relevant fire and explosion risk safety standard for the region of operation. In filling plants, individual countries interpret the regulations on explosion risk differently and may require manual handling equipment such as forklift trucks to comply with explosion prevention standards. An expert on the prevention of explosion risk should define the risk in the various operational areas and provide a zoning diagram for the location which will determine the type of equipment to be used. Normal industrial equipment may be used in non-hazardous areas.

5 References

[1] U.S. Department of Transportation, "phmsa.dot.gov," 05 01 2022. [Online]. Available: https://www.phmsa.dot.gov/hazmat/documents/offer/SP12706.pdf/offerserver/SP12706. [Accessed 18 09 2024].

[2] Transports Canada, 13 01 2023. [Online]. Available: https://www.vikingcylinders.com/wp-content/uploads/2023/01/HexagonRagascoAS_SU5931.pdf. [Accessed 18 09 2024].

[3] NFPA, 58 - Liquified Petroleum Gas Code, 2020 ed., Quincy, Massachusetts: National Fire Protection Association, 2019.

[4] NFPA, "7.3 - Venting LP-Gas to Atmosphere," in *58 - Liquefied Petroleum Gas Code*, 2020 ed., Quincy, Massachusetts: National Fire Protection Association, 2019.

[5] NFPA, 77 - Recommended Practive on Static Electricity, 2019 ed., Quincy, Massachusetts: National Fire Protection Association, 2019.

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

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

[8] DOT, *49 CFR 171.2,* Pipeline and Hazardous Materials Safety Administration, Department of Transportation.