

User manual

for Luxfer CNG-containment system



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TDAF 001
Revision No. 01

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1. SCOPE

This user manual covers use and maintenance of a Luxfer Gas Cylinders CNG-containment system equipped with safety devices and built in accordance with ECE R 110 for use on natural gas vehicles.

Systems described in this manual are designed for mounting outside a vehicle passenger compartment. Systems must be suitably protected from the elements by covers and/or shields.



WARNING: This manual does not cover local rules and regulations not referenced in ECE R 110. The customer or user is responsible for operating the system in accordance with all applicable rules and regulations.

2. COMPRESSED NATURAL GAS (CNG)



WARNING: Strict compliance with proper safety and handling practices is essential when operating this CNG fuel system.

Follow these general precautions when dealing with high-pressure natural gas fuel systems and system equipment:

- A portable fire extinguisher must be installed on the vehicle in a accessible location.
- Do not start the engine if a natural gas leak is detected.
- Do not transfer compressed natural gas fuel from one vehicle to another, as a build-up of static electricity could cause a spark and ignite the gas.
- Never weld on a compressed natural vehicle unless the compressed natural gas fuel system has been purged with inert gas.
- Never dismount system components unless the compressed natural gas fuel system has been purged with inert gas.
- The system pressure must not exceed regulations and cylinder design specifications (usually 200 bar or 248 bar).
- Do not smoke in the proximity of a natural gas vehicle or fuel-dispensing station.
- Keep compressed natural gas equipment well ventilated.

Prepared By : Nikolaos Kalantzis	Date: 08/06/2011
Approved By: Romary Daval	Date: 10/06/2011

3. SYSTEM SPECIFICATIONS

A system includes the following three groups of components:

1. **The frame** on which cylinders are fitted.
2. **Cylinders.**
3. **Accessories** of cylinders and the frame.

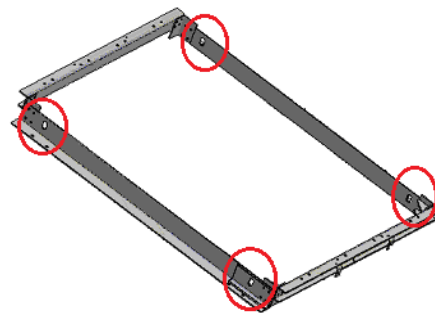
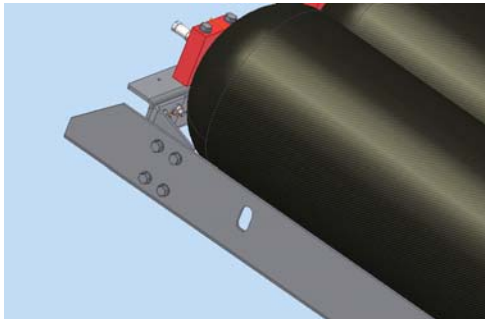
3.1. The frame



WARNING: Strict compliance with proper safety and handling practices is essential when mounting or dismounting this system on/from a vehicle.

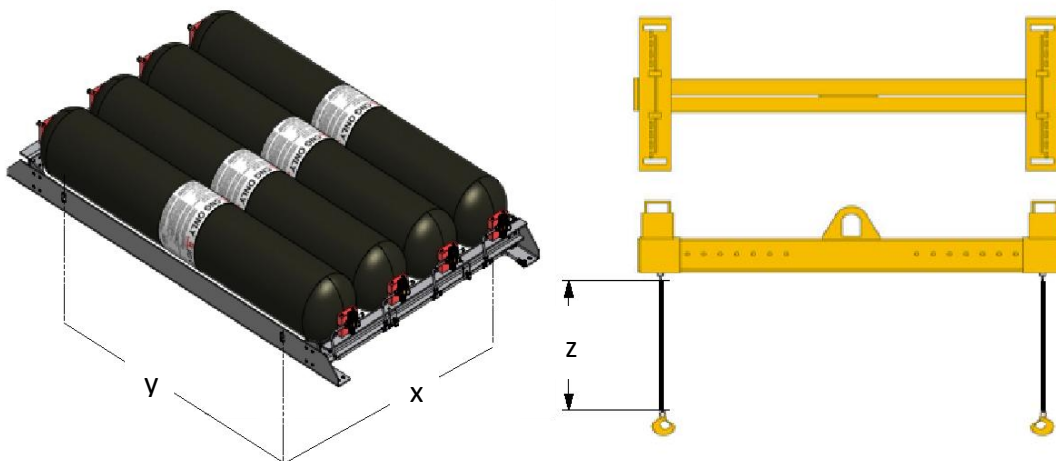


WARNING: Use only a compatible H tool and crane for handling the system with chain and carabiner fixed in specific location slots on the system frame shown on the schematic below.



WARNING: For the H tool to be suitable, the distance between the carabiners in the width direction of the system (x on the schematic) must be equal or greater than the maximum width of the system. The y direction of the H tool should be set up in a way as to secure the safe and secure handling of the system (as a guide you can use $\pm 10\%$ of the distance between the location slots). The length of the chain in the H tool (z in the schematic) should be at least 1.5 times the height of the gas system.

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WARNING: In case of damage to the system frame due to a collision or other incident, damaged beams must be replaced.

Do not attempt repairs, as these would compromise the initial structural integrity of the frame and invalidate the manufacturer's finite element analysis (FEA) calculations and the original homologation of the system with the vehicle.



WARNING: Clearance of covers and fittings surrounding the system.

Luxfer composite cylinders are mounted using specially designed neck-mounting blocks or straps. These allow longitudinal expansion and contraction of the cylinders during fueling and defueling and are designed to cope with vibrations experienced during day-to-day operation of the vehicle. Covers, wiring harness and other components and systems in the cylinder fuel pod area must be secured and not be able to make contact with the cylinders. Failure to adhere to this could result in contact points causing damage to the cylinder resin surface and carbon fibres beneath. If such damage is detected, refer to the "Luxfer Carbon Composite Cylinder User Manual."



WARNING: Luxfer CNG systems must be adequately protected by covers and/or shields.

Luxfer CNG systems are designed with a corrosion-resistant frame, tubes and high-quality valves and safety devices from leading manufacturers. However, Luxfer is not responsible for covering or shielding system components mounted in a compartment open to rain, ice, snow, road salt/dirt or marine and saltwater environments. The customer or user is responsible for adequately protecting Luxfer CNG systems with suitable covers and/or shields.

In addition, all cylinders and systems mounted must be shielded along the length of the cylinder or system, ensuring that cylinders and all accessories (valves, PRD and tubing) are protected against ballistic impacts from the environment (e.g., road stones and debris, hail). The system should be ventilated to avoid temperature build-up that may result in triggering the thermal pressure-relief devices (at 110°C).

Prepared By : Nikolaos Kalantzis	Date: 08/06/2011
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WARNING: Substitutions or modifications to an approved system are not permitted due to homologation considerations.

Luxfer Gas Cylinders CNG systems are designed and built in accordance with ECE R 110 and independently approved by a notified body. Any system substitutions or modifications made without prior approval from Luxfer Gas Cylinders and the notified body will invalidate the system approval status. **Do not remove the id plate.**

3.2. Cylinders



Regarding the alternative fuel (AF) gas cylinders of the gas containment system, refer to the “Luxfer Carbon Composite Cylinder User Manual.”



WARNING: Do not use valves or safety devices that have not been tested and approved by Luxfer.

In accordance with ECE R 110, Luxfer Gas Cylinders has designed and approved each cylinder with specific manufactured components, valves and safety devices. These components must not be replaced with other non-approved components and must not be combined with other non-approved components to form cylinder sets with mixed valves and safety devices. No substitutions or modifications to the original design are allowed, including substituted components.



ALWAYS:

- Always be alert for leaks when filling cylinders.
- Always keep threads and cylinder interiors dry and free from oil, dirt and other contaminants.
- Always fill cylinders with the proper gas.
- Always follow inspection recommendations. (Refer to the “Luxfer Carbon Composite Cylinder User Manual”).
- Always follow the fuel system manufacturer’s procedures and recommendations.
- Always follow the valve manufacturer’s installation procedures and recommendations.
- Always maintain all accessory equipment in accordance with the manufacturer’s recommendations. (Refer to the “EMER Manual and Maintenance Instructions” and/or the “VTI Operation Manual.”)

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NEVER:

- Never fill a cylinder if it leaks.
- Never fill a cylinder that has a defect. Refer to the “Luxfer Carbon Composite Cylinder User Manual” to assess/repair defects.
- Never completely discharge a cylinder (except when you are planning to remove the valve) since this can cause moist air to seep into the cylinder.
- Never fill or partially fill a cylinder with any gas not identified on the label.
- Never artificially heat a cylinder.
- Never fill a cylinder that is past its required periodic inspection date.
- Never fill a composite cylinder past its allowable life.
- Never over-torque a valve. (Refer to the valve manufacturer instructions: “EMER Manual & Maintenance Instructions” and “VTI Operation Manual”.)
- Never remove, obscure or alter a manufacturer’s labels or stamped markings.
- Never use a cylinder that has been exposed to an extremely corrosive atmosphere or environment without having it pass a periodic inspection.
- Never use a cylinder that has been involved in a traffic accident or a fire.
- Never use leak-detection fluid that contains ammonia or harsh chemicals.

3.3. Accessories



WARNING: In case of disassembly and reassembly of part or all of the system, use only original valves, safety devices, fasteners and fittings or new valves, safety devices, fasteners and fittings of the same specification. Use fastener torque settings found in Appendix 1, and follow manufacturer components and fittings guidelines (find a list of the related documents in section 5 of this manual.)

3.3.1. Valves

Features of valves and safety devices used with Luxfer CNG systems are shown below:

Valve and safety devices suppliers and references	Excess flow valve	Over-pressure relief device	Fusible plug	Solenoid
EMER Valves: MARK 100 series Safety devices: 200 series	Yes	Optional	Yes	Yes
VTI Valves RV 200 series Safety devices SP 260 Series	Yes	Optional	Yes	Yes

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Regarding valves and safety devices in the gas containment system, refer to manufacturers' user manuals ("EMER Manual & Maintenance Instructions" and "VTI Operation Manual").

3.3.2. Tubes and fittings



Regarding tubes and fittings in the gas containment system, refer to the manufacturer's user manual. (An installer's pocket guide for SWAGELOK)

3.3.3. Neck-mount blocks or belly-mounted straps



Regarding belly-mounted straps or neck-mounted blocks, please refer to the "Luxfer's Carbon Composite Cylinder User Manual."



When dismantling or remounting blocks or straps, do not change the class of bolt used and tighten bolts only to torque value(s) shown in Appendix 1. Changing bolt classes or torque values will affect the FEA of complete systems and may result in serious injury if a vehicle is involved in a collision or accident.

4. GENERAL SYSTEM RECOMMENDATIONS

For routine maintenance, the entire fuel system can be leak-tested with compressed natural gas using leak detection solution and/or a methane detector. Since the gas-containment unit forms an integral part of the fuel system, the following guidelines are provided:

In the event of component replacement, or if the vehicle is involved in an accident, the natural gas in the system must be removed by running the engine until it stops. Once all natural gas is removed and components have been replaced or repaired, a pressure test with Nitrogen is required before re-filling the system with natural gas.

If installing a CNG system onto a vehicle, a pressure test of the entire CNG fuel system with Nitrogen is required before the system can be filled with natural gas

4.1. Pressure Test Using Inert Gas (Nitrogen)



WARNING: Nitrogen is safe to breathe only when mixed with the appropriate amount of oxygen. Make sure that the leak test is taking place outdoors. If the leak test is to take place indoors, or in an enclosed area, the implementation of warning systems, gas extraction systems and continuous atmospheric monitoring of enclosures is highly recommended.

Prepared By : Nikolaos Kalantzis	Date: 08/06/2011
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- 4.1.1. Before starting the pressure test with Nitrogen, fully remove all CNG from the entire system.
- 4.1.2. Once the system is fully plumbed (when it is being installed) or fully repaired, ensure that the engine ignition is in the “off” position (use OEM lockout procedure) and the vehicle is at least 5 meters away from any open flame or source of ignition.
- 4.1.3. Turn the cylinder shut-off valves (one on each cylinder) clockwise to the “off” position.
- 4.1.4. Enable the manual shut-off valve on the entire system.
- 4.1.5. Connect the pressure-test equipment to the system fueling receptacle using the appropriate fueling nozzle connected to a Nitrogen source with flex-hose rated to the system service pressure of 300 bar. Slowly fill the system with Nitrogen to a pressure of 10 bar. While filling the system, listen for any leaks. *Stop* if leaks are detected.
- 4.1.6. Perform the 10-bar leak test using leak-detection solution that *does not contain ammonia or harsh chemicals*.
- 4.1.7. If a leak is detected, disconnect the Nitrogen fill line from the system fueling receptacle, depressurize the system, repair the problem and repeat from step 4.1.5.
- 4.1.8. If no leak is detected, slowly increase pressure to 100 bar at no more than 20 bar per minute until a system pressure of 100 bar is reached. If a leak is detected during this time, disconnect the Nitrogen fill line from the system fueling receptacle, bleed the system pressure, repair the problem and repeat from step 4.1.5.
- 4.1.9. Perform the 100-bar leak test using leak detection solution that *does not contain ammonia or harsh chemicals*.
- 4.1.10. Continue slowly to increase the pressure to 300 bar at no more than 20 bar per minute.
- 4.1.11. Once the system is pressurized to 300 bar, disconnect the Nitrogen fill line from the system fueling receptacle.
- 4.1.12. Perform the 300-bar leak test using leak detection solution.
- 4.1.13. After all Nitrogen leak tests have been performed, the pressure must remain constant at 300 bar for 10 minutes with no signs of a pressure drop. If the system pressure drops during this 10-minute time frame, start at step 4.1.5 and repeat procedure.
- 4.1.14. At this point, the system has been properly pressure tested up to the primary solenoid lock-off valve (This procedure assumes that there is a solenoid valve mounted between the gas containment system and the engine. For more precise information please refer to the vehicle manufacturer (OEM)). To test the connections downstream of the solenoid lock-off valve, energize the solenoid by hooking it to a 12-volt battery other than the one on the vehicle. This will allow nitrogen to flow through the rest of the system and up to a secondary solenoid shut-off valve before the engine (For more information consult the OEM). **DO NOT TURN THE ENGINE ON** to activate the primary solenoid lock-off valve for this part of the test. Leak test using leak-detection solution that *does not contain ammonia or harsh chemicals*.

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4.1.15. Once the procedure has been performed and approved, the Nitrogen can be vented to the atmosphere. Be careful not to bleed the system pressure too quickly as this could cause injury.



Caution: Ensure that all safety guidelines from the previous section are followed prior to fueling the system with CNG.

4.2. Hazards & General Components Inspection

The CNG-containment system has been designed to provide the best possible protection against damage in adherence to ECE R110 geometry and structural requirements. However, the following advice is provided to the vehicle manufacturer/assembler:

- The alimentation line from the CNG containment unit towards the vehicle's engine should be supported with a bracket no further than 200mm from the end of the Luxfer system, along the refilling/emptying tube.
- The CNG-containment unit should be operated under a suitable cover to protect the cylinders from shock and the valves from exposure to environmental hazards.

Visually inspect all components to ensure that no components are damaged:

- Ensure all PRD vent lines have end caps securely in place, as a PRD vent line with a missing end cap may indicate that a PRD has activated. If a PRD has activated, contact the maintenance department or cylinder manufacturer.
- Ensure that all NGV components are solidly mounted.
- Ensure that fuel-supply tubes and flexible lines are in good condition.
- Ensure that no fuel leaks are present at any fittings or components.
- Ensure that there are no coolant leaks at the hose connections to the high-pressure regulator.
- Visually inspect structural components for signs of wear, fatigue or cracking.
- Visually inspect rubber for cracking and wear.
- Inspect fastened joints for loose fasteners according to the instructions by the fittings manufacturers – refer to “An Installer’s Pocket Guide for SWAGELOK”.



Caution: Ensure that all safety guidelines from the previous section are followed prior to fueling the system with CNG.

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Approved By: Romary Daval	Date: 10/06/2011

5. DOCUMENTS REFERENCED IN THIS USER MANUAL OF THE LUXFER CNG-CONTAINMENT SYSTEM

Here is a list of the documents referenced in the present manual, mentioning their versions at the time of issue.

REFERENCE 1: LUXFER CARBON COMPOSITE CYLINDER USER MANUAL

A guide to the use, maintenance and periodic inspection of Luxfer carbon composite AF cylinders

v.1.2

REFERENCE 2: EMER manual and maintenance instructions

Handbook for use and maintenance for cylinder valve type mark

v.1.2

REFERENCE 3: VTI operation manual

Operation Manual VTI CNG remote valve RV200

K17-2.14 xxx Rev 1.1

REFERENCE 4: SWAGELOK tube fitting instructions

An Installer's Pocket Guide for Swagelok

May 2011, R7 MS-13-151

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APPENDIX 1 : TORQUE VALUE FOR METRIC SCREWS

Use the following table to choose the torque values for screws used in the system assemblies and sub-assemblies in LEAFC. Choose highest value of each configuration.

Torque value for metric screws **With self locking nuts increase the values by 15%**

NORM DIN 267	CLASS	4.8		5.8		6.8		8.8		10.9		12.9	
		OLD REF		45		55		65		85		10K	
		PITCH		PITCH		PITCH		PITCH		PITCH		PITCH	
↓	mm	coarse mm	fine mm	coarse Nm	fine Nm	coarse Nm	fine Nm	coarse Nm	fine Nm	coarse Nm	fine Nm	coarse Nm	fine Nm
M2	4	0.4	-	0.2	-	0.2	-	0.2	-	0.3	-	0.4	-
M2.5	5	0.45	-	0.3	-	0.4	-	0.5	-	0.6	-	0.9	-
M3	5.5	0.5	-	0.5	-	0.7	-	0.8	-	1.1	-	1.5	-
M3.5	6	0.6	-	0.6	-	0.8	-	1.0	-	1.3	-	1.9	-
M4	7	0.7	-	1.3	-	1.5	-	1.9	-	2.5	-	3.5	-
M5	8	0.8	-	2.5	-	3.1	-	3.7	-	4.9	-	6.9	-
M6	10	1.0	-	4.2	-	5.3	-	6.4	-	8.5	-	12	-
M7	11	1.0	-	7.0	-	8.7	-	10	-	14	-	20	-
M8	13	1.25	1.0	10	11	13	14	15	16	20	22	29	31
M10	17	1.5	1.25	20	21	25	26	30	32	40	42	57	58
M12	19	1.75	1.5	34	36	43	45	52	54	69	72	97	101
M14	22	2.0	1.5	55	59	68	74	82	89	110	118	154	166
M16	24	2.0	1.5	85	90	108	112	128	135	168	180	240	253
M18	27	2.5	2.0	118	124	147	154	176	186	235	248	330	349
M20	30	2.5	2.0	166	174	208	217	248	261	332	347	467	489
M22	34	2.5	2.0	206	218	258	273	310	327	413	436	580	614
M24	36	3.0	2.0	227	237	284	296	341	355	454	474	639	666
M27	41	3.0	2.0	284	298	355	373	426	448	568	597	798	840
M30	46	3.5	2.0	287	309	359	386	431	463	574	617	808	866
M33	50	3.5	2.0	357	390	446	488	535	586	714	781	1,004	1,088
M36	55	4.0	3.0	429	448	525	561	630	673	840	897	1,181	1,261
M39	60	4.0	3.0	525	570	656	712	788	855	1,060	1,139	1,477	1,602
M42	65	4.5	3.0	573	624	716	780	859	936	1,148	1,248	1,611	1,754
M45	70	4.5	3.0	714	795	893	984	1,072	1,193	1,429	1,580	2,009	2,236
M48	75	5.0	3.0	775	836	968	1,045	1,162	1,284	1,549	1,673	2,179	2,381
M52	80	5.0	3.0	970	1,058	1,212	1,335	1,488	1,608	1,941	2,136	2,720	3,004
M56	85	5.5	4.0	888	1,046	1,246	1,310	1,488	1,572	1,987	2,086	2,809	2,948
M60	90	5.5	4.0	1,246	1,326	1,561	1,658	1,873	1,989	2,497	2,662	3,511	3,730
M64	95	6.0	4.0	1,292	1,382	1,615	1,698	1,936	2,028	2,584	2,703	3,633	3,802
M68	100	6.0	4.0	1,601	1,710	2,002	2,137	2,402	2,564	3,203	3,419	4,504	4,808
M72	105	6.0	4.0	2,005	2,175	2,507	2,718	3,006	3,282	4,011	4,349	5,640	6,118
M76	110	6.0	4.0	2,806	2,119	2,507	2,648	3,006	3,178	3,911	4,237	5,541	5,958
M80	115	6.0	4.0	2,820	2,701	3,149	3,376	3,779	4,051	5,008	5,401	7,086	7,596
M85	120	6.0	4.0	2,407	2,582	3,006	3,227	3,610	3,873	4,813	5,163	6,768	7,261
M90	125	6.0	4.0	3,018	3,287	3,773	4,122	4,527	4,946	6,036	6,585	8,488	9,274
M95	130	6.0	4.0	3,100	3,299	3,875	4,124	4,650	4,949	6,200	6,698	8,749	9,379
M100	135	6.0	4.0	3,801	4,223	4,878	5,278	5,881	6,334	7,801	8,445	10,970	11,876
M105	140	6.0	4.0	3,838	4,008	4,798	5,010	5,757	6,012	7,678	8,017	10,795	11,273
M110	145	6.0	4.0	4,824	5,096	6,031	6,372	7,237	7,647	9,649	10,196	13,569	14,336
M115	150	6.0	4.0	4,755	4,950	5,983	6,188	7,132	7,425	9,509	9,908	13,372	13,923
M120	155	6.0	4.0	5,801	6,309	7,401	7,886	8,988	9,464	11,985	12,618	16,854	17,744
M125	160	6.0	4.0	5,746	6,039	7,183	7,549	8,619	9,059	11,492	12,078	16,161	16,985
M130	165	6.0	4.0	7,235	7,711	9,044	9,638	10,853	11,586	14,470	15,422	20,349	21,487
M135	170	6.0	4.0	6,540	7,263	8,675	9,079	10,405	10,895	13,879	14,527	19,513	20,428
M140	175	6.0	4.0	8,758	9,269	10,946	11,621	13,137	13,882	17,516	18,578	24,653	26,126

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Date: 08/06/2011

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