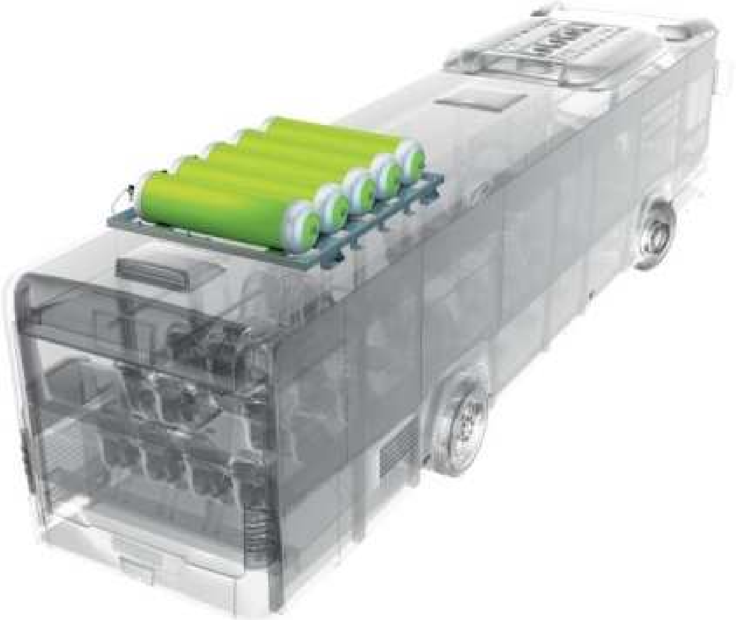
Service Manual



X-STORE

Type TC_660_3

Date: September 2015

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1 About this Service Manual

This service manual should be delivered with every cylinder. If the vehicle is sold, please ensure the new owner gets this manual as well.

1. Read the manual carefully before use, in particular the safety instructions.
2. Retain this manual during the entire service life of the pressure cylinder.
3. Ensure that the manual is accessible at all times to the operating and maintenance personnel.
4. Transmit this manual to any subsequent owners or users of the pressure cylinder.
5. Update the manual whenever you receive a supplement from the manufacturer.

1.1 Revisions

Date	**Version**	**What is new?**
September 2015	1.0	New Version

1.2 Validity

This service manual is valid for the following pressure cylinders:

Type	**Variant**
TC_660	• TC_540_5 (21 x 87”) • TC_660_2 (25 x 80”) • TC_660_3 (25 x 90”)

1.3 Symbols and Markings

The following symbols are used in this manual:

1.3.1 Instruction Elements

Instruction element	Meaning
▶	Action with one or more steps without a specific sequence.
1. 2.	Action that consists of several steps in a specific sequence.
⚠	Safety sign ▶ Follow all measures that are identified by a safety sign in order to avoid injuries or death.

1.3.2 Identification of Warnings

Signal word	Meaning
DANGER	Imminently hazardous situation that, if the safety measures are ignored, could result in death or serious injury.
WARNING	Possibly hazardous situation that, if the safety measures are ignored, could result in death or serious injury.
CAUTION	Possibly hazardous situation that, if the safety measures are ignored, could result in minor injuries.
NOTICE	Possibly hazardous situation that, if the safety measures are ignored, could result in material damage.

2 Safety

The pressure cylinder has been developed in accordance with the current state of the art technology and generally recognized safety rules and regulations.
Nevertheless, non-observance of this manual could result in danger to life and limb of the user or third parties and in impairment to the product and other material assets.

- Use this pressure cylinder only if it is undamaged, and technically in proper working order. Use it only for its intended purpose and keep safety and potential dangers in mind.

2.1 Intended Use

The X-STORE cylinder stores compressed natural gas (CNG).
Intended use also includes the following conditions:
Observance of this manual.
Observance of the permissible limits and ambient conditions.

2.2 Duties of the Owner-Operator

2.2.1 Personnel

- Follow national guidelines or regulations.
- Use only qualified personnel who have knowledge of CNG systems and are capable of recognizing risks and averting possible dangers on the basis of their training and experience / qualifications.
- Check the safety awareness of the personnel regularly.
- Provide the personnel with applicable accident-prevention and safety regulations.
- Provide the personnel with personal protective equipment (PPE).
- Ensure that the following conditions are fulfilled:

The personnel have read and understood this manual, in particular the chapter "Safety".
The personnel know and observe the applicable accident-prevention and safety regulations.
The personnel wear personal protective equipment.

2.2.2 Workplace

Ensure sufficient lighting.
Work in a well-ventilated area.

2.3 Personal Protective Equipment

Wear the following personal protective equipment if releasing gas:
Thermal protective gloves
Hearing protection
Eye protection

2.4 Constructional Changes and Spare Parts

Modifications and conversions to the cylinder can endanger operational safety.
The following actions are not permitted:

- Unauthorized constructional changes to the pressure cylinder void the warranty

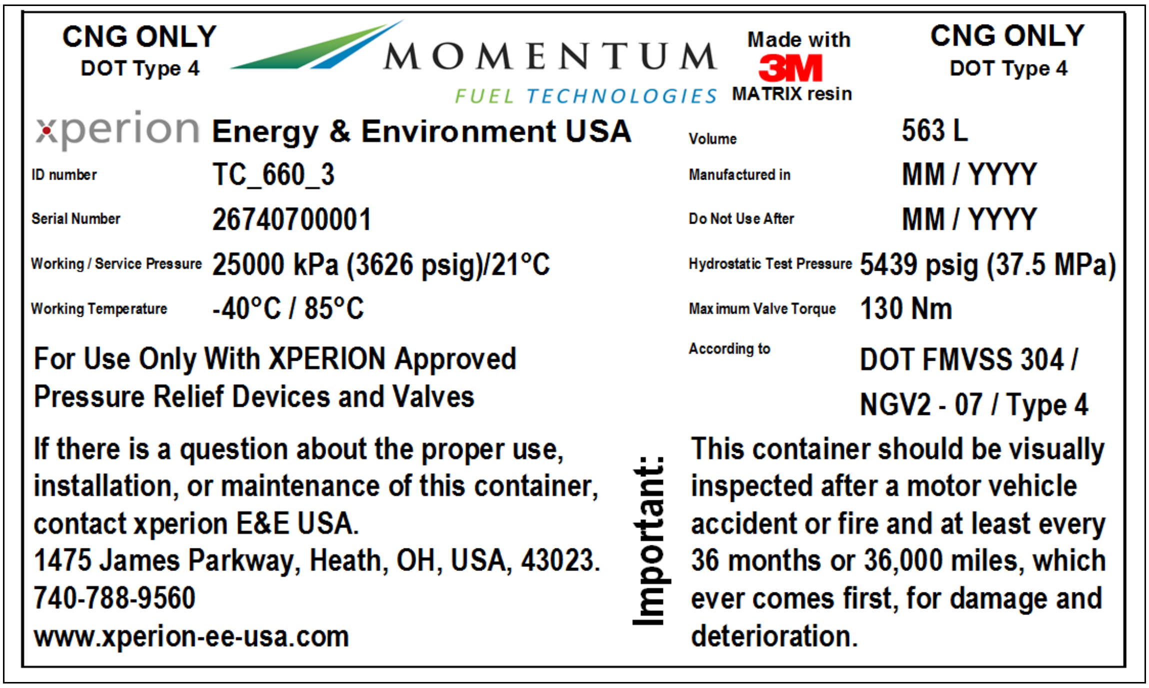
Original spare parts and accessories are designed especially for the pressure cylinder. The installation or usage of parts that have not been approved by xperion Energy & Environment GmbH can impair the safety and is strictly prohibited.

- Use only original spare parts from xperion Energy & Environment GmbH.

2.5 Protective Equipment

A TPRD (thermal pressure relief device) is installed on the valve.
Depending on the cylinder, an excess flow device may be installed on the valve, inside the cylinder.

2.6 Pressure Cylinder Labels



Label (example)

CNG ONLY	The cylinder is designed for compressed natural gas use only.
xperion Energy & Environment USA	Manufacturer
ID number	ID number of the cylinder. If applicable the version number.
Serial number	Consecutive serial number of the cylinder. ID number and serial number together provide unique identification of the cylinder.
Working pressure	Working pressure after temperature balancing. Directly after the filling of the cylinder, the pressure may exceed this value. For example: 25 MPa = 250 bar = 25000kPa = 3626 psi
Permitted working temperature	-40 ℃ to +85 ℃ (-40 ℉ to +185 ℉)
Volume	Nominal water volume at ambient pressure in liters.
Manufactured in	Month and year of production. Date format is mm/yyyy.
Do not use after	Maximum lifetime. After exceeding this date, the cylinder must be decommissioned. Date format is mm/yyyy.
Hydrostatic test pressure	Pressure applied to the cylinder during hydrostatic testing. For example: 37.5 MPa = 375 bar = 5439 psi
Maximum Valve Torque	Do not apply more than the shown torque
Type approval	Number which has been allocated after the approval by the certifying institute according to ISO 11439
ECE / NGV-2 type approval	Number which has been allocated after the approval by the certifying institute according to ECE R 110 / NGV-2

Label (example - descriptions)

2.7 Residual Risks

2.7.1 Explosion

Danger of explosion exists in the following cases:
Temperatures > +85 ℃ in or around the cylinder for a prolonged period.
Temperatures < -40 ℃ in or around the cylinder for a prolonged period.
Smoking and or open flames while working on the cylinder, or while filling the cylinder.

- Ensure that the cylinder is not exposed to any sparks.
- Ensure that there is no smoking or open flames in a radius of 10 meters (33 feet) around the cylinder while working on the cylinder, or while filling the cylinder.
- The cylinder should not be punctured, dropped, drilled and exposed to fire or corrosive fluids

2.7.2 Noise

Danger of noise level of more than 110 dB (A) exists in the following case:
When gas is released uncontrollably from the cylinder.

- Wear hearing protection.
- Wear eye protection.

2.7.3 Cold Surfaces

Danger of cold surfaces exists in the following case:
When gas is released uncontrollably from the cylinder.

- Wear thermal protective gloves.
- Wear eye protection.

2.7.4 Asphyxiation

Danger of asphyxiation exists in the following case:
When gas is released from the cylinder.

- Work in a well-ventilated area.

2.8 Behavior after a Traffic Accident or Fire

2.8.1 Traffic Accident

If a cylinder has been involved in a traffic accident (damage to the car frame), it must be tested by xperion or an authorized partner to re-confirm its further suitability.
It is important to provide all available documentation of the accident (i.e. photos).
Without testing, it is strictly prohibited to further use the cylinder.

2.8.2 Fire

If a cylinder has been involved in a fire, it must be disposed of as described in chapter 9.

2.9 Relevant Standards

For operation of CNG systems, observe the following standards:

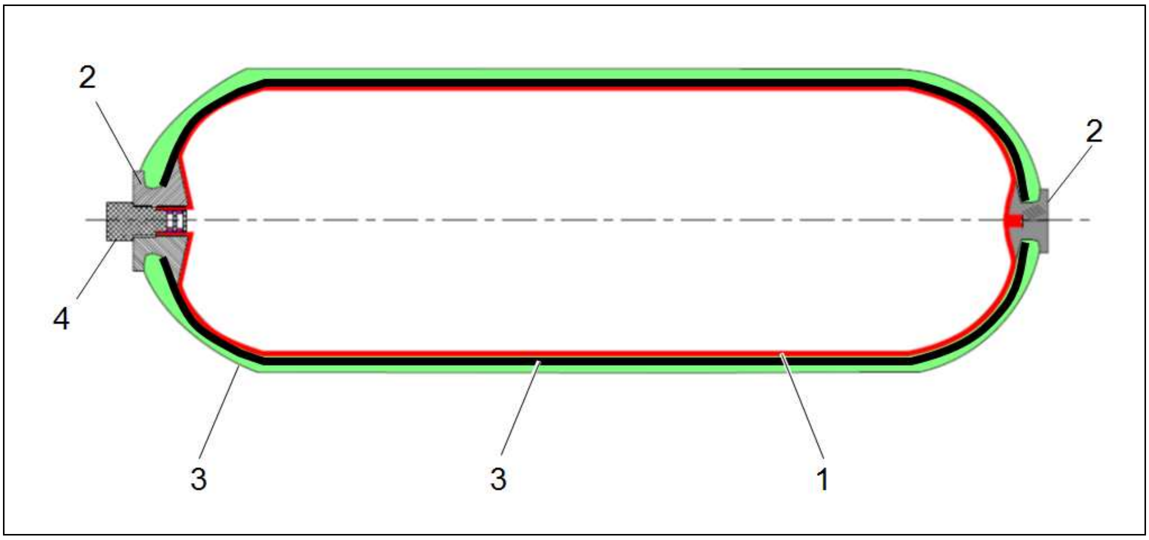
ANSI/NFPA 52 Vehicular Gaseous Fuel Systems Code,
U.S. Federal Motor Vehicle Safety Standard 49 CFR 571.303 Fuel System Integrity of Compressed Natural Gas Vehicles,
U.S. Federal Motor Vehicle Safety Standard 49 CFR 571.304 Compressed Natural Gas Fuel Cylinder Integrity,
ANSI/IAS NGV 2 Standard for Compressed Natural Gas Fuel Cylinders,
Compressed Gas Association CGA C-6.4 Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HV) Fuel Cylinders and Their Installations,
ANSI / AGA NGV3.1 / CGA 12.3 Fuel System Components for Natural Gas Powered Vehicles,
ANSI PRD 1 Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Cylinders,
and any other applicable federal, state and local codes and standards.

3 Description

Function

The X-STORE cylinder stores compressed natural gas.

Components



1 Liner

2 Boss parts

3 Laminate

4 Valve

X-STORE cylinders are Type 4 cylinders, meaning that they have a thermoplastic liner which is fully covered with a high performance carbon composite, including an epoxy resin. Both ends of the cylinder have precision machined 1.125 inch female threaded (12 UNF) fittings. Stainless Steel Extenders are factory installed and torqued to specific settings onto these threaded openings and they serve as part of the mounting mechanism of the cylinders also called neck mounting.

4 Transport and Storage

Transporting and handling cylinders without pressure is not allowed.
X-STORE cylinders are shipped with a maximum of 0.2 MPa (2 bar / 30 psi) at a temperature of 20 ℃ (68 ℉).
It is only allowed to go below this minimum level for service proposes for a maximum of 48 h.

If the pressure is discharged for any reason the cylinder should never be stored without pressure for longer than 3 months. To avoid damage to the liner during these 3 months, store the cylinder open to atmosphere (open valve). If the cylinder is to be stored for a longer period (more than 3 months), the cylinder must be pressurized up to p > 0.25 MPa (2.5 bar / 36 psi). Filling a cylinder that was open to atmosphere must be carried out according to the initial filling procedure as described in chapter (5.1).

DANGER! Possibility of damaging the cylinder in a manner that is not readily visible!

- ▷ Never lift cylinders at the valves/adapters.
- ▷ Ensure that no impact load may occur. For example: do not let the cylinders roll off the transport pallet.
- ▷ Do not stack items on the cylinders.

CAUTION! Injuries due to loose fiber ends!

- ▷ Wear protective gloves.

When storing cylinders, consider the following points:
Only store the cylinder in the original packaging.
Protect cylinders against UV-radiation.
Secure cylinders against rolling or sliding.
Store cylinders in a horizontal position.
If valves or adapters are screwed into the cylinder, close any openings with plastic plugs.
The surface of the cylinder must be protected against abrasion during transport and storage.
Store cylinders in a well-ventilated location.
If cylinders are stored with pressure, apply a label indicating: “CNG (compressed natural gas) UN 1971 pressure 25 MPa (250 bar / 3600 psi)”

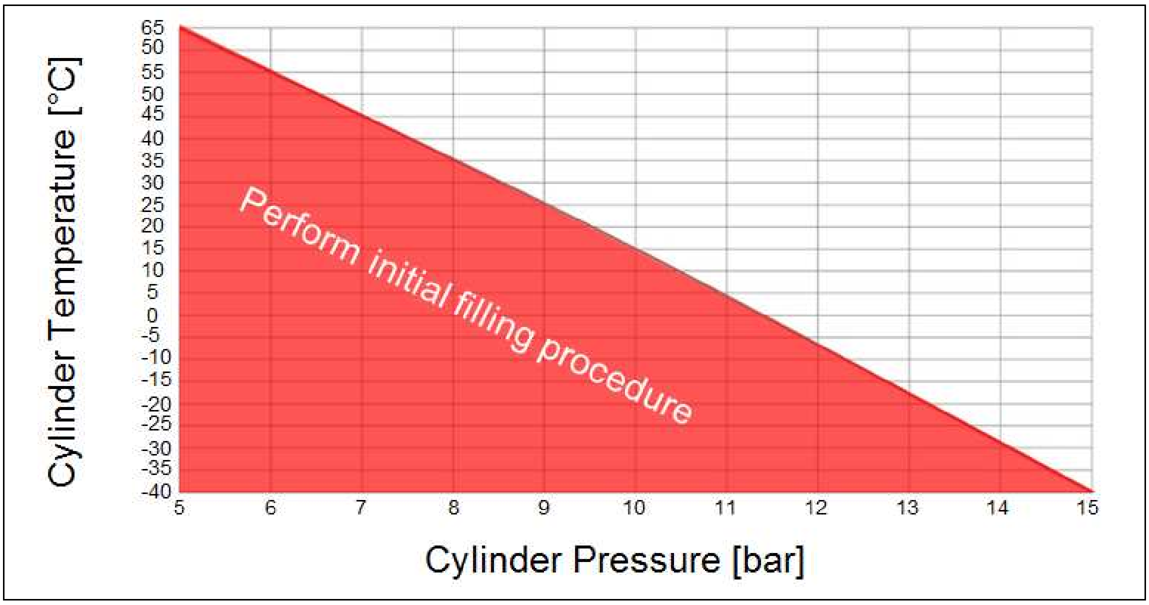
Caps (red in color in this figure) or plugs should remain on the valve during storage period prior to installation

5 Mounting, Installation and Commissioning

DANGER! All work on cylinders and gas equipment requires specially trained / qualified staff.

5.1 Initial Filling Procedure

When initially filling from ambient pressure, a special filling procedure must be followed in order to prevent damage to the cylinder. The same procedure must be used any time the pressure / temperature combination falls within the red area of the graph below, or the cylinder is depressurized for maintenance such as replacing a valve.



The following steps must be followed closely:

1. Prior to an initial fill (required any time the fuel system has been without pressure), the cylinder(s) in the fuel system must be exposed to a temperature of 60 °F (15 °C) or warmer for at least 24 hours. If the fuel system has been acclimatized indoors, and the initial fill will take place outdoors below 60 °F (15 °C), the initial fill must be started within 15 minutes; otherwise the 24 hour acclimatization must be repeated.
2. Perform a leak check with soapy water before operating according to chapter 7.6.8.

▶ After the initial filling procedure attention must be paid to the pressure. Allowing the pressure to fall below pressure defined at chapter 8.1 is prohibited; otherwise the initial filling procedure must be performed again.

▶ Handling and transportation of the cylinder has to be done at a pressure defined at chapter 8.1. Please be sure to follow all local regulations concerning maximum transportation pressure.

5.2 Installation

Installation and adjustments of CNG fuel systems should only be completed by a company having competent personnel and appropriate facilities for the installation, repair, adjustment, and testing of CNG fuel systems because of the risks of severe injury or death from improper installations and repair. Further, such companies should follow the requirements of the most up-to-date revisions of

ANSI/NFPA 52 Vehicular Gaseous Fuel Systems Code,
U.S. Federal Motor Vehicle Safety Standard 49 CFR 571.303 Fuel System Integrity of Compressed Natural Gas Vehicles,
U.S. Federal Motor Vehicle Safety Standard 49 CFR 571.304 Compressed Natural Gas Fuel Cylinder Integrity,
ANSI/IAS NGV 2 Standard for Compressed Natural Gas Fuel Cylinders,
Compressed Gas Association CGA C-6.4 Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HV) Fuel Cylinders and Their Installations,
ANSI / AGA NGV3.1 / CGA 12.3 Fuel System Components for Natural Gas Powered Vehicles, and any other applicable federal, state and local codes and standards.
ANSI PRD 1 Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Cylinders,
and any other applicable federal, state and local codes and standards.

5.2.1 Cylinder Protection

Per NFPA 52 requirements, when installed on the vehicle, CNG cylinders must be protected with a means to prevent damage that can occur due to road hazards, loading, unloading, direct sunlight, exhaust heat, and vehicle use, including accidental cargo leakage. Shielding must be used to protect the fuel cylinder from damage caused by road debris or contact with cargo or vehicle components. The shielding protects the fuel cylinder, and it must be removed to read the labels on the fuel cylinder during periodic inspections. Also per NFPA 52, the shields should be installed to prevent direct contact between the shield and the fuel cylinder, and also to prevent trapping of solid materials or liquids between the shield and fuel cylinder that could damage the fuel cylinder or its coating.
To prevent damage to the fuel cylinder:
Prevent direct contact between the fuel cylinder and the shielding.
Prevent trapping solid debris or liquids (like rain or melted snow) between the shielding and the fuel cylinder.

Prevent contact between the fuel cylinder and vehicle components (i.e., brake lines, suspension links, etc.) and with vehicle cargo.
Prevent contact with heat sources on the vehicle.
Prevent exposure to corrosive liquids and gases.
Prevent extended exposure to direct sunlight.
Prevent contact with excessive moisture.
Mount the cylinder on the vehicle so as to prevent contact with road or curb surface at any time, especially if the vehicle has flat tire or during the tire repair/change process.

5.2.2 Mounting Cylinder

IMPORTANT: Compliance with Safety Standards:
It is the responsibility of the fuel system installer to ensure that the completed vehicle installation is compliant with the current revision of the National Fire Protection Agency Code 52, Vehicular Gaseous Fuel Systems Code.

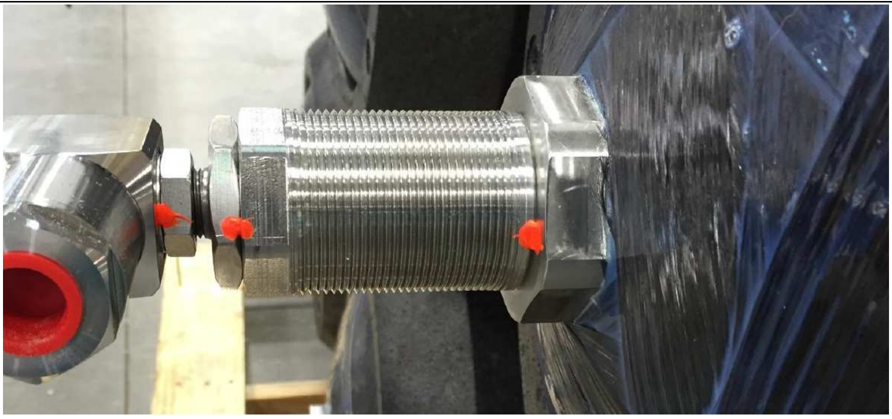
All installations of the cylinder into the mounting blocks must be completed as described in the installer's mounting mechanism instruction manual.

Cylinders covered in this manual use a neck mounting mechanism. The cylinders can only be mounted horizontally in the vehicle and held in place with the help of mounting blocks and other hardware. The mounting mechanisms are custom-made for each manufacturer's CNG fuel cylinders and therefore are not interchangeable. Cylinders are designed to be used exclusively with the mounting mechanism designed, fabricated and installed by Momentum Fuel Technologies for each individual fuel cylinder size. The mounting mechanism including extenders, mounting blocks, gaps between cylinder installations are designed to accommodate for expansion and contraction of the cylinder in circumferential (around the girth) and axial (lengthwise) direction during pressurization, depressurization and normal use. The customer is ultimately responsible for the design, fabrication and proper installation of these cylinders according to their engineering drawings.

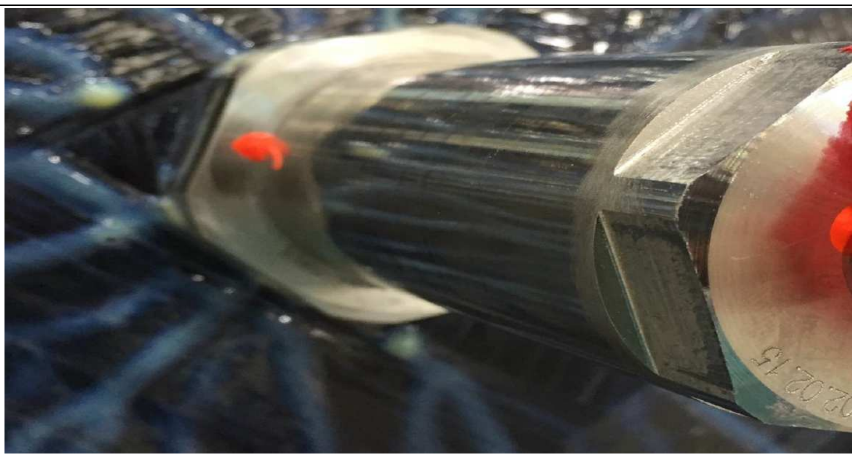
The pre-installed extenders are used to mount the cylinders. These extenders are torqued to a specific setting and should not be removed. One end of the extenders has a valve installed along with threads on the end. The threaded end is to mate with the threaded end of the mounting block in accordance with the applicable design tolerances provided in the engineering drawings. The threaded end, also called the fixed end, ensures that there is not translational motion in the direction of the threads and all the axial motion is transferred to the extender on the other end of the cylinder. The extender on the other end, also called the flexible end, is designed to accommodate any translational motion which happens during pressurization, depressurization and normal use.

All fuel cylinder and mounting mechanism installations must comply with the most up-to-date version of the NFPA 52 standard. The mounting blocks for the cylinders must be mounted in specific orientation with respect to the fuel cylinder to ensure robust mounting.

Although the mounting blocks themselves must have been designed and tested to ensure NFPA 52 compliance, it is the installers' responsibility to ensure mounting block and accessories installation is in compliance with the most recent revision of NFPA 52.



Threaded end of the extender installed on a cylinder. Also visible, red torque markings. .



Unthreaded or flexible or flat end of the extender installed on a cylinder. Red torque markings are visible.

5.3 Defueling (Depressurization) and Valve Removal

5.3.1 Defueling (Safe Depressurization)

⚠ DANGER! DO NOT ATTEMPT TO SERVICE OR REMOVE THE CYLINDER, VALVES, OR ANY FUEL SYSTEM HARDWARE WITHOUT FOLLOWING DEPRESSURIZATION PROCEDURES. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE.

⚠ DANGER! TO REDUCE THE RISK OF EXPLOSION AND FIRE, OR ASPHYXIATION FROM COMPRESSED NATURAL GAS (CNG), WHICH IF NOT AVOIDED WILL RESULT IN DEATH OR SERIOUS INJURY:

Always follow proper depressurizing procedures prior to servicing or decommissioning this cylinder.

Do not vent CNG in enclosed spaces. Breathing CNG can cause asphyxiation; a high pressure stream of CNG can penetrate skin, and a nearby source of ignition could spark an explosion.
Gas venting should only take place outdoors or following an alternative method which is in compliance with NFPA 52. This is to avoid the possibilities of asphyxiation or accumulation of an explosive gas mixture.
In all respects, the requirements of NFPA 52 must be followed for proper safe depressurization of cylinders.

It is the CNG Fuel System Installer or service provider’s responsibility to comply with all applicable federal, state and local codes and regulations regarding de-fueling and flaring or release of CNG. The method described in this section of the manual can only be used for defueling/depressurizing individual cylinders. In order to defuel a stack of cylinders or in a system setting, follow the fuel system installers defueling OR depressurization procedure. NFPA 52 requires a written defueling/depressurization procedure to be followed.
Cylinders may need to be defueled for maintenance or service of cylinder or fuel system after they have been in use for some time. The method of safe depressurization of the cylinder described in this section is termed as atmospheric venting or flaring. An alternative method of depressurization in accordance with NFPA 52 can be employed. The alternative method which discharges the gas into a closed transfer system must be devised by the fueling/defueling station providing such a facility.
General Description of Safe Depressurization
The proper general method of safe depressurization involves two steps: The first step is to activate or open the valve. Once the valve is open, depressurization will then take place. The second step is valve removal.

⚠ DANGER! IT IS MANDATORY THAT THESE INSTRUCTIONS FOR SAFE DEPRESSURIZATION BE FOLLOWED EXACTLY. NOT FOLLOWING EACH STEP AND IN THE ORDER LISTED COULD RESULT IN SERIOUS HAZARDOUS CONSEQUENCES.

The procedure outlined in this section to defuel the CNG fuel cylinder restricts the flow of gas out of the cylinder while maintaining the cylinder and valve components safely within service temperature limits allowed by NGV 2 specifications. In order to save time and de-fuel the cylinder in an efficient manner it is recommended to drive the vehicle such that the fuel remaining in the cylinder/fuel system is at a minimum. It should be kept in mind that the vehicle should only be driven if it is safe to do so.

<u>Procedure for De-fueling a Single Fuel Cylinder</u>
Personnel performing the depressurization should be properly trained to carry out the depressurization activity. Trained personnel must do the following:

1. Isolate the fuel cylinder to be de-fueled from rest of the fuel system including any other fuel cylinders. Secure or restrain the fuel cylinder which is undergoing depressurization using straps which are properly mounted, or otherwise restrain the fuel cylinder to prevent movement while it is under pressure.

2. As required in NFPA 52, use grounding cables and attachments to prevent static electrical charge buildup. Rapid discharge of CNG can generate a static electrical charge which can be sufficient to ignite the escaping gas. Ground both the valve attached to the CNG fuel cylinder as well as the venting system. A 3-gauge copper wire (for example a battery cable) should be used to connect the valve securely to an appropriate grounding source such as a water pipe that extends at least 8 feet underground. Alternatively an electrically conductive CNG hose connected to a properly grounded structure can be utilized.

3. Ensure that the manual tap or handle on the cylinder valve is closed and that the lines connected to the valve have been properly de-pressurized. Connect a quarter-turn valve approved for pressures greater than or equal to 5000 psig to the end of the cylinder valve.

4. Connect a stainless steel discharge line or electrically conductive hose or tubing approved for pressures greater than 5000 psig to the outlet port of the quarter-turn valve. The inner diameter of the discharge line should be less than or equal to 0.25 inch. The length of the discharge line should be no less than 3 feet long, and preferably longer than 3.5 feet in length. The diameter and length of the discharge line are important to control the gas flow rate and to locate the gas expansion a significant distance from the valve and the cylinder so that the most extreme cold temperatures will be sufficiently far away from the most sensitive components. This discharge line must be electrically conductive hose or tubing which is grounded in compliance with NFPA 52. One such recommend hose is manufactured by Parker with Parker catalogue part number 5CNG4. The conductive hose or tube must be grounded or connected to a system which is grounded.

5. The outlet side of the discharge line must be connected to the 2” diameter Schedule 80 pipe for venting and must be grounded, as required by NFPA 52.

6. When opening the discharge valve, the outlet should be pointed away from any personnel in the vicinity.

7. Open the cylinder valve by rotating the manual tap or the handle all the way. This step will effectively start flow of CNG out of the fuel cylinder.

8. Slowly open the quarter-turn valve between the fuel cylinder and the vent system. Initially the quarter-turn valve should be open to half of its open position (45 degree turn instead of full 90 degree turn). If CNG starts flowing out of the cylinder, the gas flow will be audible. A visual aid of condensation or ice forming over time on the front of the cylinder or the cylinder valve also indicates gas flow. The presence of condensation and ice is climate and condition dependent. If ice formation is visible, the quarter-turn valve should be moved towards its closing position in order to limit the flow of gas out of the cylinder. This step will help reduce or eliminate the ice formation process. It is advisable to use an infrared thermometer for temperature measurement during depressurization. If an infrared thermometer is used for temperature measurement, the best location to measure temperature would be the middle portion of the cylinder valve. Make sure that there is no ice on the cylinder valve and if there is ice then it should be scraped before a measurement is made. If the temperature measured at the cylinder valve is less than or equal to -30 °F (-35 °C), then reduce the flow of g as by closing the quarter-turn valve. Controlling the temperature so that is does not go below -30 °F (-35 °C) is important to protect the most sensitive sealing components in the valve and the cylinder. Once completely empty, proceed to valve removal.

5.3.2 Valve Removal after Safe Depressurization

⚠ DANGER! IF THE VALVE IS DIFFICULT TO REMOVE, STOP. DO NOT ATTEMPT TO REMOVE THE VALVE IF FOR ANY REASON YOU SUSPECT THAT THE VALVE MAY BE DEFECTIVE. A VALVE THAT IS DAMAGED OR MALFUNCTIONING MAY MISTAKENLY CAUSE YOU TO THINK THE FUEL TANK IS EMPTY WHEN YOU DO NOT HEAR CNG BEING RELEASED. HANDLE ALL CNG CYLINDERS, EVEN THOSE YOU THINK ARE EMPTY, AS THOUGH THEY CONTAINED CNG UNDER PRESSURE. IF THE VALVE IS DIFFICULT TO REMOVE, REPEAT THE SAFE DEPRESSURIZATION PROCEDURE.

Procedure to Remove Valve After Safe Depressurization
These cylinders are supplied with either an OMB Beta New valve or an Oasis TH104 valve. If for any reason, the pre-installed valve needs to be replaced, it should be replaced with exactly the same type of valve. In order to replace the valve, the tank needs to be de-fueled first according to the procedure described in Section 5.3.1.

Please refer to the valve product manuals for more details and installation and removal instructions.

Inspect the valve thoroughly once it has been removed. Check the valve threads and fuel cylinder threads for damage. Clean the fuel tank valve threads and O-ring groove with a clean, lint-free shop cloth, and isopropyl alcohol if necessary to ensure that they are completely clean. Inspect the O-ring groove for damage. Damage to the O-ring groove is not allowed because it can impede a safe and effective seal for the CNG fuel, and result in the escape of a flammable gas. Cylinders with damage to the extender O-ring groove are considered to have Level 3 damage and must be removed from service and decommissioned by qualified service and repair personnel.
Anytime a valve is removed from a CNG fuel cylinder, the O-ring must be replaced with a new, undamaged O-ring offered by the valve manufacturer. O-rings should never be re-used in the CNG fuel system application.

⚠ DANGER! TO REDUCE THE RISK OF EXPLOSION AND FIRE, OR ASPHYXIATION FROM COMPRESSED NATURAL GAS (CNG), WHICH IF NOT AVOIDED WILL RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE:
Always reject valves or fuel cylinders with damaged threads and/or damaged O-rings.
Also, reject fuel cylinders with extender O-ring groove damage since these damages prevent a safe and effective seal.

6 Operation: Gas Composition

- When filling the cylinders, ensure that the natural gas (CNG) corresponds with NGV-2 regulations (SAE J1616). The operator of the filling station is responsible for this.
- The cylinder is designed for a working pressure of 25 MPa (250 bar / 3600 psi) at a standard temperature of 21 °C (70 °F).
  The pressure is temperature related. For higher or lower ambient temperatures the pressure may be adjusted during filling process. Most filling stations compensate for this automatically.
- Ensure that the maximum pressure does not exceed 31.3 MPa (313 bar / 4540 psi) at any temperature.

7 Maintenance

7.1 Safety

7.1.1 Personnel Qualification

DANGER: TO REDUCE THE RISK OF FIRE OR EXPLOSION, WHICH IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE:

All inspections must be completed by a qualified inspector as described in CGA Pamphlet C-6.4.
All obligatory inspections described in Section 7.3 must be completed by a qualified inspector as described in CGA Pamphlet C-6.4, Methods for external visual inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HV) fuel cylinders and their installations.

7.1.2 Periodic Cylinder Inspection According to NGV- 2

DANGER: TO REDUCE THE RISK OF FIRE, EXPLOSION AND IMPACT, WHICH IF NOT AVOIDED WILL RESULT IN DEATH OR SERIOUS INJURY:

- Conduct fuel cylinder inspections upon receipt from the manufacturer, when removed from storage, and on a regularly scheduled basis, according to applicable federal state, and local regulations.
- Have a qualified inspector as described in CGA Pamphlet C-6.4 inspect the fuel cylinder immediately in the case of unusual behavior by the cylinder, or if the cylinder has been involved in a motor vehicle accident, fire, or any other incident that may cause damage to the cylinder

Federal Motor Vehicle Safety Standard 304, Compressed Natural Gas Fuel Cylinder Integrity, requires that the CNG fuel cylinder be visually inspected after a motor vehicle accident or fire, and at least every 36 months or 36,000 miles driven, whichever comes first, for damage and deterioration.

The cylinder should also be inspected promptly by a qualified inspector if:

1. The cylinder, or the vehicle it is installed in, has been involved in a fire
2. The cylinder was been dropped or subjected to impact
3. The cylinder has been exposed to excessive heat
4. The cylinder has been involved in a collision
5. The cylinder is believed to have been damaged by cargo, the vehicle or components, and/or environmental chemicals
6. The cylinder is believed to have been damaged by any other means
7. The fuel system shows any unusual behavior. This may include, but is not limited to, emission of a natural gas odor, unexpected loss of pressure in the fuel system, rattling or other indications of loose connections, or unusual hissing or snapping sounds.
8. The cylinder is transferred to another vehicle
9. Significant alterations are made to the cylinder installation
10. The cylinder has been re-installed after removal from the vehicle

11. The cylinder is believed to have been pressurized above the design standard.
12. The mounting mechanism shows evidence of damage
13. The valve or PRD show evidence of damage

During inspection, the vehicle owner/operator should be questioned about any incidents or conditions that may have caused damage to the cylinder, performance issues that may indicate a problem, repairs made since the last inspection, unusual observations, and service history of the fuel cylinder. Incidents include, but are not limited to: dropping the cylinder, impacts to the cylinder by sharp or blunt objects, exposure to fire or excessive heat, vehicle accidents including collisions of 5 mph or more, or exposure to harsh chemicals. Performance issues may include, but are not limited to: poor fuel system performance, too-frequent filling, and other unusual performance by the fuel cylinder.

The fuel cylinder and fuel system inspection should be conducted according to CGA C-6.4, Methods for external visual inspection of natural gas vehicle (NGV) and hydrogen vehicle (HV) fuel cylinders and their installations, and any other applicable federal, state, and local requirements.

7.2 Preparation for Inspection

The routine formal visual inspection conducted to satisfy the Federal Motor Vehicle Safety Standard does not require the breaking or opening of any fuel system connections or depressurization of the fuel system, as long as the identification label of the cylinder (see 2.6) is visible.
If maintenance is going to be performed on a cylinder or system and piping, and connections will be opened (such as replacing a valve or a fitting), special safety considerations and preparations must be undertaken.

DANGER! DO NOT ATTEMPT TO SERVICE OR REMOVE THE CYLINDER, VALVES, OR ANY FUEL SYSTEM HARDWARE WITHOUT FOLLOWING DEPRESSURIZATION PROCEDURES. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE.

7.3 Mounting Mechanism Inspection

DANGER! IF A MOUNTING BLOCK IS DAMAGED DURING USE, THE USER MUST HAVE A QUALIFIED INSPECTOR CONDUCT A PERIODIC INSPECTION OF THE CNG FUEL CYLINDER, SINCE THE CYLINDER MAY HAVE INCURRED DAMAGE IN THE SAME EVENT WHICH DAMAGED THE MOUNTING BLOCK.

Mounting mechanism inspection includes the following specific areas:

1. Verify that the fuel cylinder is firmly held in place.
2. Verify that all the mounting bolts that secure the cylinder mounting to the vehicle are in place and tight.
3. Verify that the mounting blocks at the fuel cylinder extenders are in place, undamaged, and positioned per fuel system installers recommendations.

4. Verify that the mounting blocks are in good shape, free of severe rust or other damage, and suitable for continued service.
5. Examine the blocks for any visible damage, such as wear indications.

The CNG fuel cylinder does not normally have to be removed from the mounting blocks for this inspection. If the fuel cylinder has to be removed to repair the blocks, the procedure should be completed only by authorized repair facilities with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures.

⚠ DANGER! DO NOT ATTEMPT TO SERVICE OR REMOVE THE CYLINDER, VALVES, OR ANY FUEL SYSTEM HARDWARE WITHOUT FOLLOWING DEPRESSURIZATION PROCEDURES. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE.

New mounting blocks between the cylinder and the mounting mechanism must be installed if either the block has been permanently deformed, worn, or damaged during use. Any time a mounting block is loosened after being in use, visually check for any wear that may have occurred to the block. If wear is visible, a new replacement block must be used to ensure all torque settings are correct to allow for expansion and contraction of the fuel cylinder during fueling and de-fueling. Refer to the mounting mechanism’s instruction manual and engineering drawings for further details.

7.4 Fuel System Inspection

⚠ DANGER! DO NOT ATTEMPT TO SERVICE OR REMOVE THE CYLINDER, VALVES, OR ANY FUEL SYSTEM HARDWARE WITHOUT FOLLOWING DEPRESSURIZATION PROCEDURES. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE.

Inspecting the <u>fuel system</u> includes checking all <u>non-fuel cylinder</u> components such as valves, tubing, hoses, end plugs, fittings, and pressure-relief devices (PRDs). During inspection, make sure that each piece of system hardware is properly and securely attached. If any hardware is damaged or loose, the fuel system must be taken out of service and must be replaced by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures. The (non-fuel-cylinder) fuel system component inspections should be conducted per the instructions outlined in CGA Pamphlet C-6.4 and any other applicable federal, state and local codes and regulations.

7.4.1 Extender, Valve, PRD, and Solid Plug inspection – Visual inspection only

⚠ DANGER! TO REDUCE THE RISK OF EXPLOSION AND FIRE, OR ASPHYXIATION FROM COMPRESSED NATURAL GAS (CNG) WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY:

- Do not attempt to disassemble the valve, extenders, PRD, or the solid plug. The valve, extenders, PRD, and solid plug contain no user serviceable parts.

Each CNG fuel cylinder has two extenders for neck mounting support, one valve attached to the threaded fitting on one end of the cylindrical fuel cylinder, and is protected by one or more thermally-activated pressure relief device(s) (PRD). Each CNG fuel cylinder has a plug threaded into the fitting on the opposite end of the fuel cylinder from the valve.

Visual Inspection procedure for the extender, valve, PRD, and plug:

1. Examine the extenders for any damage to its threads or the smooth areas as shown in threaded end of the extender and unthreaded end of the extender. Inspect for displacement or cracks in the torque seal.

2. Examine the valve and PRD assembly for damage. Note that the valve and PRD assembly should not be deformed or show other signs of damage. Damaged valve and/or PRD assemblies must be replaced by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization/de-fueling procedures. If the valve and/or PRD assembly shows any signs of damage, the fuel cylinder should be inspected for impact damage.

3. Examine the connection between the valve and the extender. These connections should be tightly sealed with no gaps or play between the parts. Inspect for displacement or cracks in the torque seal. Inspect for rubber shavings or other evidence of O-ring damage at these connections. If there is evidence of play or O-ring damage, then the fuel cylinder should be safely depressurized and evaluated by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures.

⚠ DANGER! DO NOT ATTEMPT TO SERVICE OR REMOVE THE CYLINDER, VALVES, OR ANY FUEL SYSTEM HARDWARE WITHOUT FOLLOWING DEPRESSURIZATION PROCEDURES. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY AND PROPERTY DAMAGE.

⚠ DANGER! TO REDUCE THE RISK OF EXPLOSION AND FIRE, OR ASPHYXIATION FROM COMPRESSED NATURAL GAS WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY:

- Never use an open flame or ignition source to test for gas leaks.

1. The connections between the valve and fuel cylinder and between the solid plug and fuel cylinder should be tested for leaks. Use an electronic leak detector or a leak solution (“bubble test” solution) to perform this test. If any leakage is suspected or observed, service should be conducted by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures.

2. The solid plug should be visually inspected for corrosion or damage during an inspection. If the solid plug is corroded, or damaged it must be replaced only by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures.

Solid plug shown on the flexible end extender of the cylinder

Vent lines from the fuel cylinder and PRD must also be inspected to assure proper performance during a fire. Verify there is no damage to the vent line(s) and no debris blocking the line or its outlet. Special care should be taken to ensure no water or ice is blocking or contained within the PRD blow down lines. Ice or water (which could be frozen to ice) would detrimentally affect the operation and blow down of the PRD in the event of a fire situation. Damaged or blocked vent lines must be replaced by an authorized repair facility with competent personnel trained to work on CNG fuel systems, and they must follow safe depressurization procedures.

7.5 Cleaning

- Wear protective gloves.

For cleaning, use water and a mild detergent. Do not use a high-pressure cleaner for the surface. Dispose of the used cleaning agents and, contaminated cloths etc. according to local regulations.

7.6 Cylinder Inspection

DANGER! TO REDUCE THE RISK OF EXPLOSION AND FIRE, OR ASPHYXIATION FROM COMPRESSED NATURAL GAS (CNG) WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY:

- All inspections must be completed by a qualified inspector as described in CGA Pamphlet C-6.4.
- Conduct fuel cylinder inspections upon receipt from the manufacturer, when removed from storage, and on a regularly scheduled basis, according to applicable federal state, and local regulations.

While the vast majority of the cylinder manufacturing process is highly automated, there are a few steps that require manual labor. Therefore small optical differences between the cylinders may occur.

The following photographs and descriptions show various ways a cylinder could possibly be damaged. The guidelines are based on information provide in ISO 19078:2013(E). Use the following table as a guideline on how to react to the various depths (D) of scratches.

Level 1 Damage	Level 2a Damage	Level 2b Damage	Level 3 Damage
D<0.25 mm	0.25 mm <D<0.9 mm	0.9 mm <D<1.25 mm	D>1.25 mm
D<0.01“	0.01“ <D<0.035”	0.035” <D<0.05”	D>0.05”
Continue use	Contact xperion	Contact xperion	Condemn tank

Damage levels according to ISO 19078:2013(E)

Different levels of cut/scratch damages are shown here. For cuts classified as level 2a and 2b xperion should be contacted

1. Record and compare the cylinder's data with the data from the logbooks (if applicable).
2. Check the cylinder's surface:
   - Superficial crack (7.6.2)
   - Abrasion marks and scratches (7.6.3)
   - Chemical damage (7.6.4)
   - Fire and excessive heat damage (7.6.5)
   - Loose fiber ends (7.6.6)
3. Check all connections and pipes between the cylinder and valve and search for leaks (7.6.8).
4. Check connected components:
   - TPRD (7.6.7)
   - Secondary TPRD (7.6.7)

7.6.1 Inspection Tools

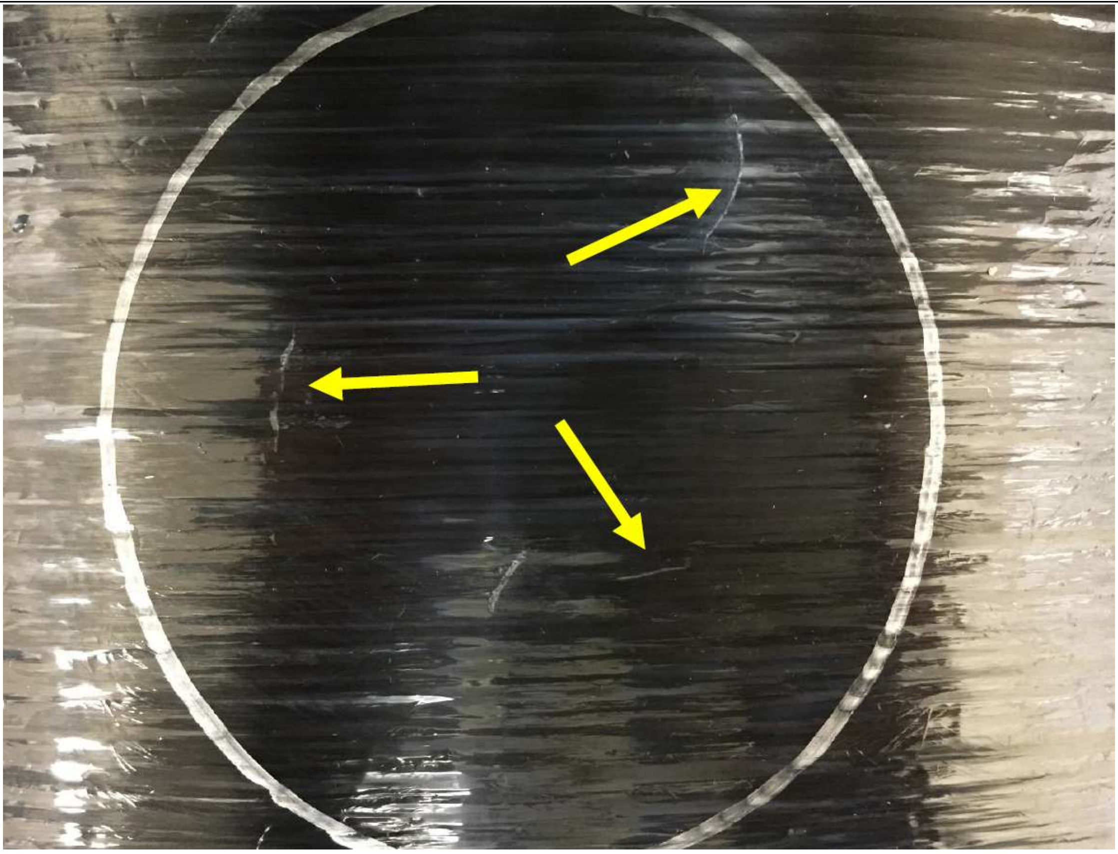
Inspection tools, clockwise from top:

- Dial indicator depth gauge
- Scale (ruler)
- Caliper with dial readout
- Torque wrench
- Digital camera
- Mirror
- Flash light
- Tape measure

DANGER! TO REDUCE THE RISK OF IMPACT WHICH, IF NOT AVOIDED, MAY RESULT IN MINOR OR MODERATE INJURY:

- Always wear appropriate personal protective equipment according to your local workplace practices when handling, storing, installing, or inspecting cylinders.

7.6.2 Superficial Cracks



Superficial cracks

During the manufacturing process, small insignificant cracks may develop. These superficial cracks on the surface are irrelevant to the function of the cylinder. If the cracks reach the fiber, the cylinder must be disposed of as described in chapter 9.

- In case of doubt, consult xperion or your local distributor.

7.6.3 Abrasion Marks and Scratches

Abrasion marks and scratches

Abrasion marks, scratches or scrapings, i.e. through loose mounting straps or rubber supports, are not harmful to the cylinder, as long as they do not reach the fiber itself. It is important to find the reason for this damage before reinstalling the cylinder in order to avoid further damage. If the scratches reach the fiber, the cylinder must be disposed of as described in chapter 9.
This part of the inspection is passed, if the scratches remain within the resin layer, but not the first fiber layer.

- In case of doubt, consult xperion or your local distributor.

See the different guidelines on the level of damage in the table in section 7.6.

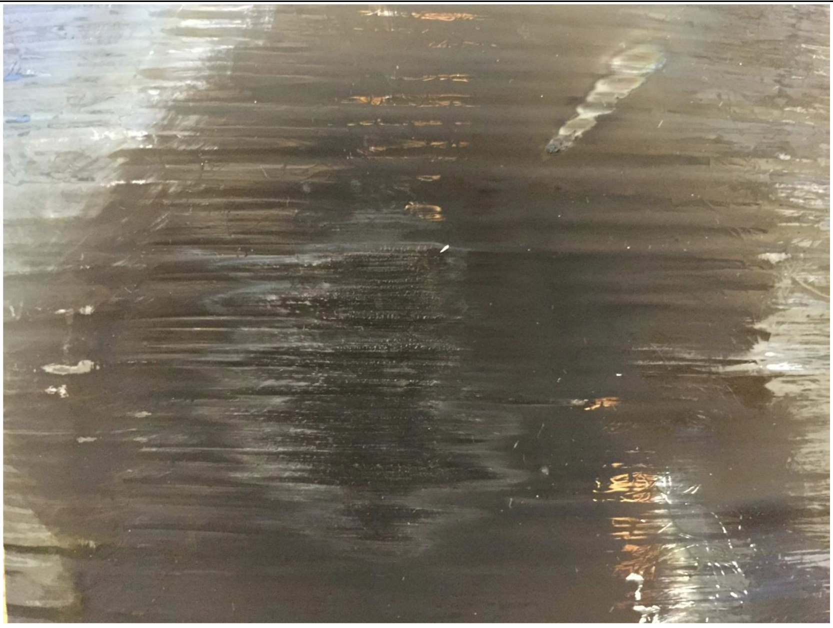
7.6.4 Chemical Damage

Chemical damage

While the resin coating is quite robust, chemicals such as acids may damage it. While slight discoloring that has not softened the coating is harmless, it is extremely important to locate the source of this exposure and eliminate it. If the chemical exposure has softened the coating, the cylinder must be disposed of as described in chapter 9.

- In case of doubt, consult xperion or your local distributor.

7.6.5 Fire and Excessive Heat Damage



Excessive Heat

All CNG fuel cylinders manufactured under NGV2 specifications have a maximum service temperature of 185 °F (85 °C). The effects of expos ure to fire or high heat are usually obvious. Resin will darken more with higher temperature and longer exposure times. Exposure to excessive heat may result from the fuel cylinder being improperly. Level 3 Fire or Excessive Heat Damage. Fire has caused blistering and distortion of the protective clear coat and caused localized darkening of the composite layer. Level 3 fire damage as shown above is too extensive. Due to the extent of the damage, the structural integrity of the fuel cylinder may have been reduced, so it must be immediately and safely removed from service, decommissioned and destroyed by a qualified repair facility with competent employees trained to work on CNG fuel systems. If the affected spot shows damage to the fiber, the cylinder must be disposed of as described in chapter 9.

- In case of doubt, consult xperion or your local distributor.

7.6.6 Loose Fiber Ends

Loose fiber and delamination of fiber ends are not acceptable.

- To evaluate the level of damage, send a photo to xperion or your local distributor.
- In case of doubt, consult xperion or your local distributor.

Delamination is highlighted with yellow arrows. Cut fibers have lifted from the composite surface.

7.6.7 TPRD

WARNING! Danger of noise level of more than 110 dB (A)!

- ▷ Ensure that the cylinder is depressurized.
- ▷ Wear hearing protection.
- ▷ Wear eye protection.

WARNING! Danger of cold surface!

- ▷ Ensure that the cylinder is depressurized.
- ▷ Wear protective gloves.

Thermal pressure relief unit (TPRD)

- Check that the valve is in proper working order.
- Replace any damaged components.
- Ensure that valves equipped with a thermal pressure relief device (for example; a glass bulb) are intact, and no scratches or cracks on the glass bulb are present.
  The glass bulb usually is about 10 – 15 mm (3/8" – 9/16") long and filled with a colored liquid. The picture shows the usual appearance of the TPRD.

Note: Cylinders longer than 1.6 m have a second TPRD on the other end of the cylinder (opposite the valve end). The procedure for checking a second TPRD is identical.

7.6.8 Leak Test

xperion recommends using a leak detection spray or soapsuds.
Testing by leak-measuring-devices (sniffer devices) may cause misleading results due to natural permeation of the CNG through the cylinder.
Evaluate the leak test under the regulations of the ECE R 110 - 17.1.5:
“The CNG system shall show no leaks, i.e. stay bubble-free for 3 minutes.”
Consider that small-sized bubbles may appear when using leak detection spray.
These bubbles must disappear after a few seconds.
These bubbles have nothing to do with permeation or leakage of the cylinder.
Should a cylinder or valve be permeable, a clear bubble growth can be detected.

Procedure

Test the complete cylinder for leakage, especially the connection: valve/cylinder/adapter:

1. Fill the cylinder up to the labeled working pressure.
2. Rest the cylinder for at least 2 hours to gain stable pressure and stable temperature conditions.
   If the cylinder is heated due to the filling, the leak detecting spray or soapsuds may evaporate, which causes incorrect test results.
   - ▷ If bubbles emerge within 3 min, the test has failed.
3. Replace any leaking components according to chapter 5.
4. Repeat the leak test.

7.7 Checklist for Periodic Inspection

The following list can be copied and be used as a check list.

1. Serial number of the cylinder: ______________________________
2. Year and month of the initial approval: ______________________________
3. Date of previous inspection: ______________________________
4. Executing company,
name of authorized personnel: ______________________________

5. Test criteria

5.1. Cracks reaching the first fiber layer?

☐ No ------- allowed ☐ Yes ----- not allowed

5.2. Abrasion marks and scratches reaching the first fiber layer?

☐ No ------- allowed ☐ Yes ----- not allowed

5.3. Damage-free or points of impact are minimal?

☐ Yes ------- allowed ☐ No ----- not allowed

5.4. Are loose fibers present?

☐ No ------- allowed ☐ Yes ----- not allowed

5.5. Valve and safety adapters are damaged?

☐ No ------- allowed ☐ Yes ----- not allowed

5.6. The complete cylinder and attached components are gas-tight?
and held the pressure for at least 30 seconds?

☐ Yes ------- allowed ☐ No ----- not allowed

______________________________ ________________

Signature of authorized personnel Date

Any test criterion with "not allowed" results in a failure of the inspection.
After repairs, the complete checklist must be performed again.
The periodic inspection is considered passed when all criteria result in “allowed”.

Approach at Failure of a Cylinder

xperion keeps records on all incidents which occur with X-STORE cylinders.
Inform xperion, if a cylinder fails during an inspection.
Send the serial number of the cylinder and the reason for failure to the contact address.

8 Technical Data

8.1 Ambient Conditions

Reference parameter	Value
Gas temperature range	-40 ℃ to +85 ℃ (-40 ℉ to + 185 ℉).
Requirements for installation	• Not near explosive material • No UV-radiation
Working pressure	25 MPa (250 bar / 3600 psi) at an ambient temperature of 21 ℃ (70 ℉)
Maximum pressure	37.5 MPa (375 bar / 5400 psi)
Maximum lifetime	20 years
Minimum pressure above -15 ℃ (+5 ℉)*	1.0 MPa (10 bar / 145 psi)
Minimum pressure below -15 ℃ (+5 ℉)*	1.5 MPa (15 bar / 218 psi)

*see in addition chapter 5.1

8.2 Requirements Arid Gas

Reference parameter	Value
Water vapor content	< 32 mg/m^3 (49 ppm)
Minimum pressure dew point at 20 MPa	-9 ℃
Hydrosulphide and other soluble sulphides	< 23 mg/m^3 (35 ppm)
Oxygen	< 1 Vol.%

8.3 Requirements Humid Gas

Reference parameter	Value
Water vapor content	> 32 mg/m^3 (49 ppm)
Pressure dew point at 20 MPa	> -9 ℃
Hydrosulphide and other soluble sulphides	< 23 mg/m^3 (35 ppm)
Oxygen	< 1 Vol.%
Carbon dioxide	< 4 Vol.%
Hydrogen	< 0,1 Vol.%

9 Disposal

The substances of the cylinder are environmentally harmless and can be disposed of after 20 years. Observe the respectively applicable national regulations for each material.

WARNING! Danger of noise level of more than 110 dB (A)!

- ▷ Releasing the pressure from the cylinder.
- ▷ Wear hearing protection.
- ▷ Wear eye protection.

WARNING! Danger of cold surface!

- ▷ Ensure that the cylinder is depressurized.
- ▷ Wear protective gloves.

WARNING! Danger of explosion!

- ▷ Natural gas reaches a flammable concentration between 4 and 15 % fuel / air mixture.
- ▷ No open flames or sparks.
- ▷ Ground personnel and cylinder on the same cable.

WARNING! Danger of asphyxiation!

- ▷ Do not work in an enclosed area.
- ▷ Natural gas is lighter than air and can collect in enclosed spaces.

WARNING! Danger of projectiles!

- ▷ Handle a pressurized cylinder with extreme caution. If a cylinder falls and the valve is sheared off, both the valve and cylinder may become dangerous projectiles.

NOTE! Releasing unused CNG!

- ▷ Do not work in an enclosed area.
- ▷ Natural gas is lighter than air and can collect in enclosed spaces.
- ▷ Local regulations may prohibit the venting of unburnt natural gas to the atmosphere. Follow local guidelines for disposing of the remaining natural gas.

9.1 Venting Remaining CNG from a Cylinder

1. Close the manual cylinder valve.
2. Purge the tubing to and from the cylinder.
3. Position a transmission hoist, or similar lifting device, under the cylinder.
4. Using protective material, make sure the tank is supported, while still allowing access to the cylinder's mounting brackets.
5. Use ratcheting straps to attach the cylinder to the lifting device.
6. Remove the cylinder mounting brackets.
7. Slowly and carefully lower the cylinder.
8. Take the cylinder outside to vent the remaining fuel.
9. Release the pressure from the cylinder according to 9.3, steps 1 through 8. Assure that all pressure has been released before removing the cylinder valve
10. A high torque is required to remove the tank valve. The empty cylinder can now be brought inside to a workbench.
11. Ensure that the surface of the cylinder is protected. Using ratcheting straps, secure the cylinder to a sturdy working surface.
12. Remove the valve according to 9.3

9.2 Purge the Cylinder

1. Connect a nitrogen bundle with a manometer and a venting valve to the cylinder valve inlet connector.
2. Open the bundle valve and allow the cylinder to fill above 50 bar. More than 100 bar is unnecessary.
3. Vent the cylinder completely through the bundle venting valve.
   Repeat steps 2 and 3, two more times.

9.3 Remove Valve and Valve Adapter

1. Purge the cylinder according to 9.2.
2. Close the manual valve.
3. Open the solenoid by applying 12 V (passenger car) or 24 V (truck/bus).
4. Open the manual valve slowly.
5. Wait until no more gas flows out of the cylinder.
6. Close the manual valve.
7. Wait 30 seconds. This allows the excess flow device to return to its normal position.
8. Start at step three again. Repeat this three times and continue to step 9.
9. Remove the valve and valve adapter with a special tool.
10. Before remounting, check the condition of valve, valve adapter and threads.

For further instructions regarding the removal and service of the valve, refer to the valve manufacturer instructions available by contacting xperion or your local distributor.

9.4 Disable Cylinder

1. Remove the valve as described in 9.3.
2. Drill a hole in the cylindrical wall with a diameter of at least 10 mm (3/8”).

10 Contact Address

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