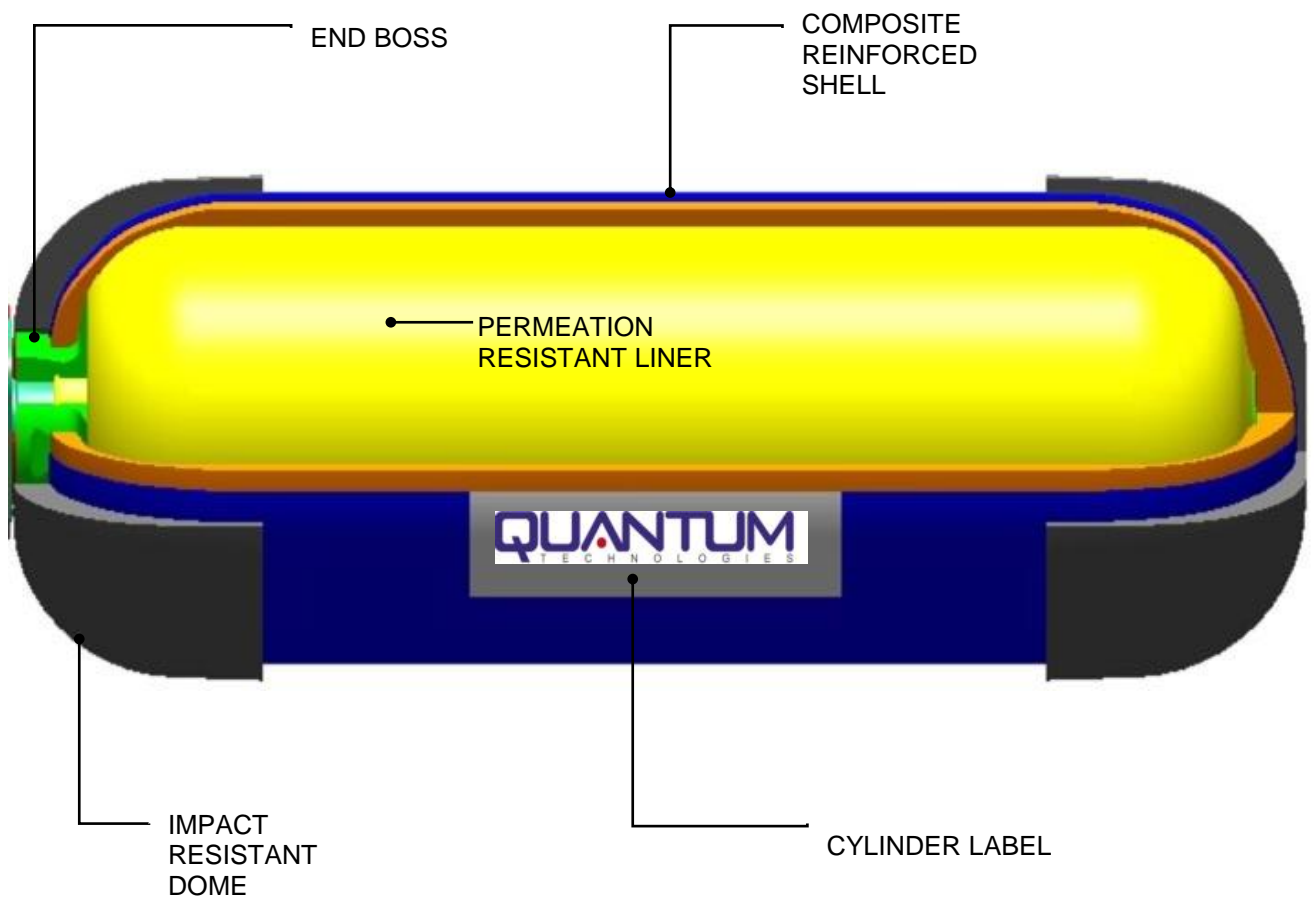




Type 4 Compressed Natural Gas (CNG) Cylinder Installation and Maintenance Guide



Foreword

This User Guide provides the information for the safe installation of the Quantum Type 4 composite Compressed Natural Gas (CNG) cylinder manufactured by Quantum Fuel System Technologies Worldwide, Inc. and contains instructions for end user installation, maintenance and self inspection of the cylinder in its installed environment. A thorough and complete understanding of the information contained in this publication is required for the continued safe use of this product. Read this manual in its entirety and keep it for future reference.

The CNG cylinder should only be installed by qualified personnel who have read this guide from cover to cover. Individual operator training is the responsibility of the company, firm, or organization performing the installation.

This manual contains Notices, Cautions and Warnings that must be observed at all times to reduce the risk of personal injury during installation or maintenance. Improper installation or maintenance procedures may damage the cylinder or make the cylinder unsafe to operate. These Notices, Cautions and Warnings are not all inclusive. Quantum Fuel Systems Technologies Worldwide, Inc. cannot possibly warn of all the potentially hazardous consequences caused by a failure to follow these instructions.

If you need further information or have any questions, please contact:

Quantum Fuel Systems Technologies Worldwide, Inc.
25242 Arctic Ocean Drive
Lake Forest, CA 92630
USA
Tel: 949-930-3400
Fax: 949-930-3401

This guide also provides the criteria for regulatory inspection requirements. The following publications are required to achieve a full understanding of these requirements:

- CGA C-6.4 (Latest revision), Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HV) Fuel Containers and Their Installation.
- NGV2 (Latest revision), American National Standard for Compressed Natural Gas Vehicle Fuel Containers.
- CSA B51 (Latest revision) Part II, High Pressure Cylinders for the On-Board Storage of Natural Gas and Hydrogen as Fuels for Motor Vehicles.
- NFPA 52 (Latest revision) Vehicular Gaseous Fuel Systems Code

All information, illustrations and specifications contained in this guide are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

This information is the intellectual property of Quantum Fuel Systems Technologies Worldwide, Inc. and may not be altered in any way. This information is protected by the copyright laws of the United States of America, and other countries, and may not be reproduced, stored in any retrieval system, or transmitted in any form or by any means (including but not limited to electronic, mechanical, photocopying, and recording) without the prior written permission of Quantum Fuel Systems Technologies Worldwide, Inc.

© 2011 Quantum Technologies Inc. All rights reserved

Litho USA

How to Use This Publication

This publication contains information specific to the CNG cylinder. It does not explain everything you need to know about your vehicle installation. You must use this supplement along with the information provided by the equipment manufacturer(s) for the remainder of the components used, and regulatory requirements applicable to your use. Only then will you be able to properly install and maintain your cylinder.

Please read this supplement from beginning to end when you first receive your product. If you do this, it will help you learn about the special features. In this supplement, you will find that words and pictures work together to make things easy to understand.

Table Of Contents



Introduction	1
Safety Information	2
Definitions	6
Receiving Inspection	8
Cylinder Handling Instructions	8
Service Conditions	9
Preparing the CNG Cylinder for Installation	9
CNG Cylinder Valve/PRD Installation	10
Typical CNG Cylinder Valve Installation	10
PRD Installation – General Instructions	11
CNG Cylinder Initial Pressurization/CNG Cylinder Valve Initial Interface Leak Test	12
CNG Cylinder Installation	14
Purge Instructions	18
Leak Testing	19
Cylinder Pressurization/Fill	20
Cylinder Depressurization	21
Inspection and Maintenance	22
Cylinder Inspection	22
Fuel Cylinder and Bracket Inspection	22
Cylinder Label Inspection Procedure	23
Cylinder Wrap Inspection Procedure	23
Level 1 Cut or Abrasion:	23
Level 2a Cut or Abrasions:	24
Level 2b Cut or Abrasions:	24
Level 3 Cut or Abrasions:	25
Heat or Chemical Exposure	25
Weathering Exposure	26
Gas Leakage	26
Stress Corrosion Cracking	27
Crazing	27
Resin Surface Defects	28
Impact Damage	28
Cylinder Impact Inspection	29
Mounting Bracket Inspection Procedure	30
Regulatory Inspection and Requalification	30
Valve/PRD Replacement	31
Removing Cylinders from Service	32
Removal Procedure	32
Other Available Specifications and Information	32
Warranty and Limitation of Liability	33

Appendix A – Typical Inspection and Repair Equipment.....	34
Appendix B - Sample Inspection Form	36
Appendix C - Sample Cylinder Inspection Record Form	37

Introduction

The Quantum CNG Cylinder is a rugged, state-of-the-art component of a CNG vehicle fuel system designed for permanent vehicle installation. The Quantum CNG cylinder utilizes aerospace-quality composite and metallic materials in the construction of a type 4 cylinder providing resistance to fatigue, environmental degradation, stress corrosion cracking and impact damage over its service life under normal conditions defined in this document. The corrosion-free inner-liner is resistant to CNG permeation, leaks and contaminants. The Quantum CNG cylinder is engineered to be lightweight, easy to handle and install, and is designed to meet or exceed the requirements of applicable U.S., Canadian, and European standards of burst strength, cyclic fatigue, extreme temperatures, impact and corrosion resistance, fire and gunfire safety, permeation and high temperature creep resistance.

Quantum manufactures CNG cylinders for use at 24.8 MPa (3,600 psig) service pressure rating at 21° C (70° F).

Quantum CNG cylinders are designed to meet the following standards:

- NGV2 (Latest revision) – “American National Standard for Compressed Natural Gas Vehicle Fuel Containers”.
- CSA B51 (Latest revision) – “Boiler, Pressure Vessel and Pressure Piping Code”, “Part 2, High pressure cylinders for the on-board storage of natural gas and hydrogen as fuels for automotive vehicles”.
- ABSA (Alberta Boilers Safety Association) Regulations (as required)

Quantum CNG cylinders may be designed and manufactured to meet additional and/or different standards when required by customer requirements and specifications.

This document guides an installer through the basic steps for safely installing the Quantum CNG cylinder onboard a CNG-powered vehicle and provides important instruction for safe use and maintenance. Installation will vary according to the use or application of the CNG cylinder. The installer must ultimately ensure all local, state and federal regulations were followed when installing the CNG cylinder.

WARNING

Read this entire manual before proceeding with the installation. Installation of CNG cylinders should only be performed by competent CNG system installers, following applicable local, regional, and national codes and regulations. Failure to do so may result in serious injury or death.

Safety Information

CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

Proper installation and maintenance of compressed natural gas (CNG) fuel cylinders is important to ensure the safe, reliable operation of CNG-fueled vehicles.

The procedures recommended and described in this guide are effective methods of performing maintenance, inspection, and repair. Some of the procedures require the use of tools specifically designed for this purpose.

Accordingly, anyone who intends to use a service/inspection/maintenance procedure or tool which is not recommended by the cylinder manufacturer, must first determine neither their safety nor the safe use of the cylinder will be jeopardized by the replacement procedure or tool selected.

It is important to note that this guide contains various "Warnings", "Cautions", and "Notices" that must be carefully observed to reduce the risk of personal injury during the installation and maintenance, or the possibility that improper installation and maintenance may damage the cylinder or render it unsafe. It is also important to understand that these "Warnings", "Cautions" and "Notices" are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

The various symbols with accompanying definitions appear below:



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



NOTICE is used to address practices not related to personal injury.



CAUTION, without the safety alert symbol, is used to address practices not related to personal injuries.

General Safety Information

 DANGER

Never pressurize a CNG cylinder that is not restrained by approved brackets properly mounted or otherwise acceptably restrained to prevent movement while under pressure.

Installation of a valve or Pressure Relief Device (PRD) not approved for use in this cylinder can result in a cylinder rupture. Contact Quantum regarding valves and PRDs approved for use in your cylinder.

Use of this cylinder for storing media other than Compressed Natural Gas (CNG) or exceeding the cylinder rated pressure may damage the cylinder. Use the cylinder for storage of CNG only, if there is a question about the proper installation or use of this cylinder contact Quantum Technologies.

Failure to follow these instructions will result in death or serious injury.

 WARNING

Installation of this cylinder must be performed by competent personnel in accordance with all Federal, State, and Local regulations applicable to the application.

The Pressure Release Device (PRD) must not be shielded in any way. Shielding may prevent the PRD from functioning in the event of a fire resulting in cylinder failure.

When working with flammable gasses in a confined area, always use gas-monitoring equipment and ground all equipment. If natural gas ignites, you could be severely burned.

A vehicle fire may damage the cylinder or valves. Immediately remove from service any CNG cylinder involved in a fire.

When servicing the CNG cylinder or valves, the proper tools must be used to avoid damage to the components being serviced.

Failure to observe these warnings may result in death or serious injury.

 **CAUTION**

Natural Gas is extremely flammable. If something ignites it, you could be severely burned. If you are refueling a vehicle, keep sparks, flames and ignition sources a minimum of five meters (16 feet) from natural gas. Do not use cell phones or other electronic equipment while refueling, defueling or servicing a vehicle.

Turn the vehicle OFF while refueling, defueling or servicing.

Refuel, defuel or service compressed natural gas fuel cylinders in a well-ventilated area.

Use the proper grounding procedure to an earth ground to prevent a build-up of static electricity, which can lead to an electrical discharge.

The compressed natural gas system must be purged and leak checked with inert gas:

- Before initial use.
- Before and after service.
- Before shipping.

Inspect the CNG cylinder and brackets every 3 years or 36,000 miles (60,000 km), whichever comes first. The frequency and level of inspection may vary based on state and local requirements.

Additional inspections may be necessary if the following conditions are present.

- The cylinder has been exposed to corrosive chemicals such as acid or alkali.
- Unusual or excessive vehicle corrosion is observed in the area near the cylinder.
- Obvious vehicle damage is observed in the area near the cylinder.
- The vehicle has been involved in a collision and damage is observed in the cylinder area.

The compressed natural gas system is designed for use with dry compressed natural gas only. Do not use liquid natural gas, hydrogen, butane, LPG or other gaseous fuels as a fuel source.

A cylinder may be damaged if overfilled. A cylinder must never be filled above 125% of the rated service pressure, per ANSI/NFPA 52.

A vehicle fire may damage the cylinder or valves. Immediately remove from service any CNG cylinder involved in a fire.

Failure to observe these cautions may result in injury or damage.

NOTICE

Do not remove, plug or tamper with any of the factory installed hardware or components or the system could be damaged.

Verify that all fuel cylinder labels are in place and legible.

Contact Quantum Technologies if any of the following conditions exist:

- *The cylinder label is illegible*
- *The cylinder label is peeling*
- *The cylinder label is missing*

Verify that the "DO NOT USE AFTER DATE" indicated on the cylinder matches the fill area label. If needed, replace the fill area label so the "DO NOT USE AFTER DATE" matches the cylinder label.

Definitions

Below are a few terms you should be familiar with when reading this manual.

Abrasion damage: Damage to a container caused by wearing, grinding, or rubbing away of the container material by friction.

Carbon fiber: Type of reinforcement fiber used in composite overwrap.

Composite: Structural material composed of load bearing fibers embedded in a protective resin matrix.

Crazing: Hairline cracking of the resin giving it an opaque "frosty" appearance.

Cut damage: Damage caused by a sharp object coming in contact with a composite surface.

External/exterior coating: Clear or colored surface treatment applied to the container for environmental protection and improved appearance.

Helical wrap: Layers in the composite overwrap filament wound to provide primarily longitudinal strength and some hoop strength for the cylindrical region of the container.

NOTE-The strands of reinforcing fibers are oriented at an angle to the longitudinal axis of the container.

Hoop wrap: Composite reinforcement wound at an angle to the longitudinal axis that generally carries the major portion of the load in the hoop direction and little load in the longitudinal direction.

Impact damage: Damage caused by dropping or by a blow from another object.

NOTE-Impact damage can be at the surface, internal to the structure, or both

Inspection mark: Mark, label, or tag placed by an inspector on the container indicating acceptance of the container.

NOTE-The mark shall at least identify the inspecting agency and the date of inspection (month and year)

Liner: Internal component of the container that prevents leakage of gas through the composite container structure.

Over pressurization: Pressures exceeding those allowed during filling procedures specified in the standards referenced in this document.

Pressure Relief Device (PRD): Device installed in the container or integrated with a valve that will release the contained gas in specific emergency conditions.

Resin: Plastic material in the composite overwrap that fills the space between individual reinforcing fibers.

Scuff: Minor abrasion damage to the protective coating, paint, or resin-rich composite surface.

Service pressure: Authorized pressure marking indicated on the cylinder labeling.

Valve, manual: Device installed in one of the ports of the container used to regulate gas flow into and out of the container, which is turned on and off manually with a handle.

Valve, solenoid: Device installed in one of the ports of the container used to regulate gas flow into and out of the container, which is turned on and off electronically.

Vent line: High pressure line used to conduct gas from a PRD to a location away from the cylinder or outside the vehicle.

Receiving Inspection

Inspect all shipments for damage at time of receipt in presence of carrier. If damage is suspected due to shipping package appearance, do not unpack product. Notify carrier and Quantum Technologies. Document condition concerns with photographs, if possible. Note condition on receiving document(s) and obtain driver's signature.

Cylinder Handling Instructions

Anytime the fuel cylinder(s) are not in the vehicle, store it in a dry and safe location that prevents damage from vehicles or other shop equipment. Protect all open ports and fittings with the appropriate plugs or caps in place. Do not store the fuel cylinders in direct sunlight or in close proximity to a heat source or open flame.

Following a few simple safety precautions will prevent injuries resulting from the use of a damaged cylinder:

WARNING

Failure to follow these precautions may cause damage to the cylinder assembly resulting in serious injury or death.

Do:

- Protect the cylinders from damage when it is not installed in the vehicle.
- Examine the cylinders for damage after any vehicle crash or grounding.
- Examine the cylinders and brackets for damage anytime there is evidence that the stone shield has been struck by a solid object (if equipped).
- Ensure that the compressed natural gas going into the vehicle is not contaminated.
- Perform regular leak inspections on high-pressure lines.
- Attach a tag or label to the cylinder valve indicating that the fuel cylinder is defueled and purged.
- Protect the cylinder from ultra-violet (UV) radiation and physical damage while removed from the vehicle.
- Inspect any fuel cylinder that has been removed from the vehicle for damage prior to installation.

Do Not:

- Drill holes in the cylinder or any of the components.
- Drop the fuel cylinder or fuel cylinder assembly.
- Block off or plug the thermal PRD vents except with the Quantum supplied dust caps.

Refer to Compressed Gas Association pamphlet CGA C-6.4 "Guidelines for Visual Inspection and Re-qualification of Fiber Reinforced High Pressure Cylinders" for more detailed instructions and descriptive photographs of damages. It should be noted however, that the recommendation in CGA C-6.4 must be used in conjunction with recommendations from Quantum Technologies, Inc.

Service Conditions

WARNING

Vehicles undergoing repairs involving welding or the application of heat to any part within five feet of a filled cylinder must have the cylinder removed or shielded from the source of the heat. Failure to do so may result in serious injury or death.

CAUTION

A cylinder may be damaged if overfilled. A cylinder must never be filled above 125% of the rated service pressure, per ANSI/NFPA 52. Failure to observe this caution may result in injury and or damage to the vehicle.

The Quantum Cylinder is designed for permanent installation in vehicles for storage of CNG at ambient temperatures for use as a fuel for vehicles. The standard service conditions specified in the ANSI/AGA NGV2 and CSA B51 Part II standard is the basis for the design, manufacture, inspection, testing and approval of these cylinders.

The operator must ensure that the cylinder service conditions are compatible with the following:

- Maximum fill pressure
- Service temperature range
- Natural gas quality (level of contaminants)
- Cylinder exposure to corrosive agents and physical damage, and gas permeation rate defined in the above standards and indicated on the cylinder label.
- Contact Quantum Technologies, Inc. for clarification if extraordinary service conditions are expected.

Preparing the CNG Cylinder for Installation

DANGER

Install only approved valves and Pressure Relief Device (PRD) in your CNG cylinder, installation of the incorrect part may cause a cylinder to rupture. Contact Quantum for information regarding the proper components for your cylinder. Failure to follow this instruction will result in death or serious injury.

The following steps performed in the order below will ensure proper installation of the CNG cylinder.

Note: Certain cylinders may not require all of the steps listed.

1. Install the CNG cylinder valve and/or PRD device if the CNG cylinder was not equipped with these components at time of manufacture by Quantum Technologies. General instructions are provided in this document. Refer to [CNG Cylinder Valve/PRD Installation](#) in this manual.
2. Perform the initial CNG cylinder pressurization and initial CNG cylinder valve interface leak test. Instructions are provided in this document. Refer to [CNG Cylinder Initial Pressurization/CNG Cylinder Valve Initial Interface Leak Test](#) in this manual.

CNG Cylinder Valve/PRD Installation

Typical CNG Cylinder Valve Installation

NOTICE

The following procedure applies to a Quantum CNG cylinder manufactured without factory-installed CNG cylinder valve and/or PRD(s). The procedure shown is a typical procedure; follow the manufacturer's installation guidelines for your specific components.

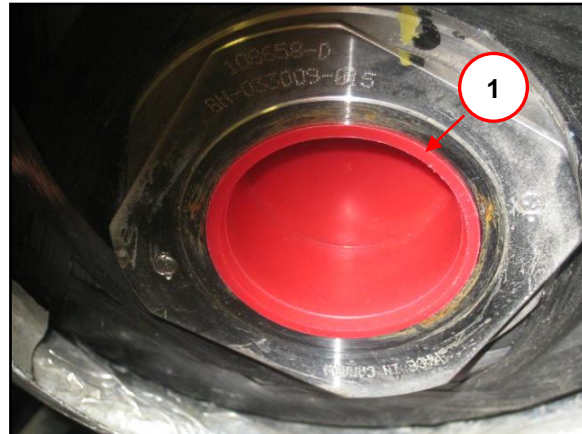
3. Secure the CNG cylinder to a suitable workstation to prevent the CNG cylinder from rotating during CNG cylinder valve installation. The workstation must be capable of preventing CNG cylinder rotation while protecting the CNG cylinder from damage.



4. Remove the dust plug (1) from the boss adapter and verify the adapter bore and threads are undamaged and clean.

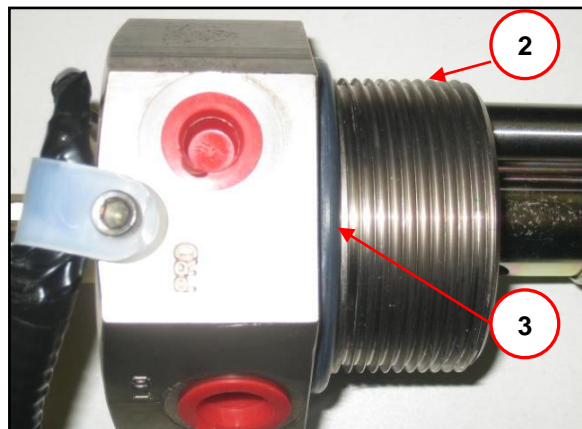
⚠ DANGER

Install only approved valves and Pressure Relief Device (PRD) in your CNG cylinder, installation of the incorrect part may cause a cylinder to rupture. Contact Quantum for information regarding the proper components for your cylinder. Failure to follow this instruction will result in death or serious injury.



Verify the CNG cylinder valve is correct for this application by verifying the following:

- The part number is approved by Quantum for installation in the CNG cylinder.
- The thread pitch (2) and seal type (3) match the adapter boss.

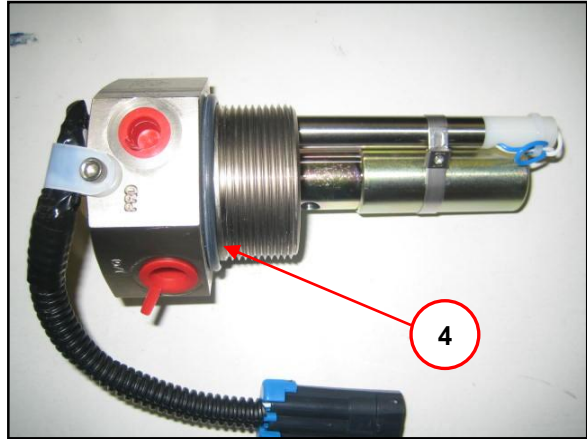


⚠ WARNING

Use proper tools to install or remove cylinder valves or PRDs. Use of an incorrect tool may cause damage to the components resulting in fuel leakage. If ignited serious injury or death may result

Install the CNG cylinder valve per the valve manufacturers' instructions. During the installation, the following must be adhered to:

1. Lubricate the CNG valve o-ring seal (4) just prior to installing in boss adapter. Use SAE 10 wt. non-detergent motor oil or other lubricant compatible with natural gas and seal material. Use just enough lubricant to apply a thin film to the entire seal surface.
2. Hand-install the CNG cylinder valve until fully seated in adapter boss. If valve cannot be seated by hand, remove and re-inspect valve and boss threads for damage, contaminants, etc. Clean interface components and re-install by hand.
3. Final tighten the CNG cylinder valve using a calibrated torque wrench with a current calibration certificate to the valve manufacturers specifications. It is good practice to apply verification marks (paint pen, torque seal compound, etc.) to all connections handling pressurized gas after performing final tightening operations to indicate the status of these connections.



PRD Installation – General Instructions

⚠ DANGER

Install only approved valves and Pressure Relief Device (PRD) in your CNG cylinder, installation of the incorrect part may cause a cylinder to rupture. Contact Quantum for information regarding the proper components for your cylinder. Failure to follow this instruction may result in death or serious injury.

Most CNG cylinder valves designed for vehicular use are equipped with an integral PRD (Pressure Relief Device) or a PRD pre-installed by the valve manufacturer.

Some CNG cylinders also use an auxiliary PRD installed at the opposing cylinder dome from the CNG cylinder valve. The use of a PRD at this location will be based on regulatory requirements or bonfire test performance.

If your installation requires PRD(s) to be installed, the following must be adhered to:

- Verify the correct components are used
- Install the devices according to the device manufacturers' instructions
- Leak test all interface areas and the device(s) at initial pressurization and system operating pressure

CNG Cylinder Initial Pressurization/CNG Cylinder Valve Initial Interface Leak Test

WARNING

Never pressurize a CNG cylinder that is not restrained by approved brackets properly mounted or otherwise acceptably restrained to prevent movement while under pressure. Failure to observe this warning may result in death or serious injury.

WARNING

Failure to use an orifice in the venting system may subject the valve and cylinder to extremely low temperatures during venting resulting in severe damage to (or failure of) these components. Use an orifice specified by the valve or tank manufacturer when venting. Failure to follow this instruction may result in serious injury or death.

CAUTION

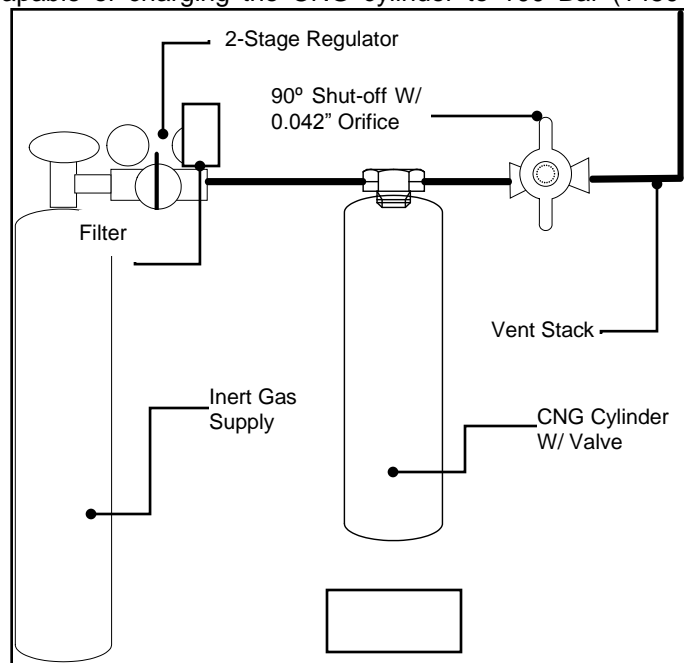
Verify all equipment used is rated for the highest pressure that can be generated during the procedure. Failure to do so may result in injury.

NOTICE

Quantum recommends the use of clean, dry, inert gas (Nitrogen, >99.5% purity) for this procedure. If it is necessary to use flammable gas, this procedure should be performed after the CNG cylinder vehicle installation is completed

The following equipment (Fig. 5) is necessary to conduct the initial fill and initial interface leak test:

- Compressed Nitrogen Source capable of charging the CNG cylinder to 100 Bar (1450 psi).
- Dual stage pressure regulator fitted to nitrogen source capable of regulating down to 5.0 Bar (73.0 psi).
- Inline filter >10 micron <50 micron upstream of CNG cylinder valve inlet port.
- Fuel transfer system from dual stage regulator outlet through filter to CNG cylinder valve inlet port.
- CNG cylinder outlet port connected to an approved CNG cylinder vent stack arrangement equipped with a ¼ turn valve between outlet port and vent stack in reach of operator. The valve must contain a 0.042" orifice.
- Liquid leak detection fluid or an electronic combustible gas detector.



⚠ CAUTION

Failure to follow the initial pressurization instructions may irreversibly damage the fuel storage cylinder, leading to CNG leakage. Fuel leakage may result in personal injury or damage to the vehicle.

⚠ CAUTION

Performing this procedure when the CNG cylinder temperature is less than 0° F (-18° C) may result in damage to the cylinder. Allow the CNG cylinder to warm to room temperature (>60° F, 13° C) for a minimum of 12 hours before pressurizing. If ambient conditions where test is performed are less than 0° F (-18° C), complete the procedure within 40 minutes after removing cylinder from room temperature environment. Failure to follow this requirement may result in injury.

NOTICE

When a cylinder is pressurized from empty, a small quantity of AIR (not fuel) is compressed out from between the liner and composite shell. This may cause bubbling around the surface of the shell and/or the end bosses during leak tests. This is a normal condition known as “permeation” and the bubbling should subside typically within 30 minutes. If there is any doubt leave the cylinder pressurized overnight. If the pressure is unchanged and the bubbling has subsided, this is considered normal permeation of entrapped air.

The recommended steps for this procedure are outlined in order below:

1. Ensure the cylinder is properly installed in a vehicle or retained in a appropriate test fixture before proceeding.
2. Confirm the compressed gas supply is “OFF” and connect the gas supply from the regulator to the CNG cylinder valve inlet.
3. Connect the vent stack inlet to the CNG cylinder valve outlet port.
4. Install suitable port plugs in any remaining inlet/outlet ports.
5. Close the CNG cylinder valve (manual type valve) or close the cylinder isolation lock-off screw (automatic type valve).
6. Close the ¼ turn valve at the vent system flow path.
7. Verify the nitrogen supply regulator is fully backed-off. Slowly open the nitrogen supply valve until the 1st stage pressure gauge indicates supply pressure.
8. Slowly increase the regulator outlet pressure to 30 Bar (430 psig) while listening for gross leakage. Test all connections and interfaces in the circuit with a liquid leak test fluid. Observe all connections and interfaces for bubble formation over a two minute period. If no bubbles are present, continue with procedure. If bubbles are found, close the supply valve and vent the system by opening the vent circuit ¼ turn valve and repair any leak(s) before proceeding.
9. Increase the supply pressure to 100 Bar (1450 psig) and close the supply valve. Re-test per step 7 and repair any leaks discovered. When leak test is successfully passed, vent the system through the vent circuit. These steps validate the equipment setup and operation for testing the CNG cylinder valve/PRD interface.
10. Reduce the gas supply regulator outlet pressure to 1.0 Bar a (0.0 psi).

11. Open the CNG cylinder valve (manual valve) or the cylinder isolation lock-off screw (automatic valve).
12. Open the gas supply valve. Slowly increase the gas supply regulator output pressure to 34.5 Bar (500 psig) and allow gas flow to stabilize. When gas flow stops, close the gas supply valve.
13. Apply liquid leak detection fluid to the CNG cylinder valve interface and any user-installed PRD interface(s). Observe interface(s) for two minutes. If bubbling present, depressurize cylinder and repair as necessary. See “Cylinder Depressurization” section of this document for proper procedure. If no bubbles present, continue the procedure.
14. Open the gas supply valve and slowly increase gas regulator outlet pressure to 100 Bar (1450 psig) and repeat the liquid leak detection fluid application. Wait two minutes while observing interface connection(s) for bubbles. If no bubbles detected, initial test is passed. If bubbles detected, diagnose & correct cause of leak and re-perform this procedure.
15. Close the gas supply valve. Vent the CNG cylinder to nearly empty (1.0 – 3.0 Bar (14.5 – 45.0 psi)) residual pressure of inert gas remaining in cylinder. This will assist the CNG cylinder purge operation performed prior to initial fuel fill. Refer to [Cylinder Depressurization](#) in this manual.

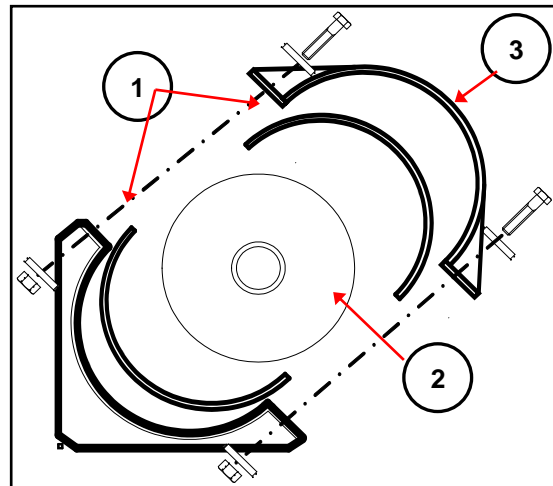
CNG Cylinder Installation

⚠ WARNING

Quantum CNG cylinders are designed for horizontal mounting only. Vertical mounting of cylinder requires special mounting provisions and considerations. Improper mounting of the cylinder may result damage to the cylinder or valve resulting in serious injury or death. If considering vertical cylinder mounting, contact Quantum for further information.

The Quantum all Composite CNG Cylinder is installed as part of an overall CNG vehicle fuel system. This manual provides information for the installation of the cylinder using a typical dual saddle mount approach, as an example only (Fig 6). The storage cylinder must be mounted at a safe location, following all applicable codes, regulations and crash worthiness requirements in effect at the time of installation.

1. UPPER AND LOWER ISOLATOR
2. FUEL CYLINDER
3. UPPER CYL BRACKET
4. LOWER CYL BRACKET (ATTACHED TO VEHICLE)



General Installation Guidelines:

WARNING

A minimum air gap of 0.5 inch (13mm) must be provided all around the cylinder. If relative movement is possible between cylinders or between a cylinder and the adjacent vehicle structure or brake cables, etc., when the vehicle is loaded or operated, the clearance must be increased appropriately. Chafing damage to the cylinder may lead to cylinder failure resulting in serious injury or death.

NOTICE

Attachment brackets are designed to secure the cylinder in place and to prevent slippage, loosening or rotation. It is the installer's responsibility to confirm the installation complies with all applicable codes and regulations at the time of installation. Brackets must meet the minimum specifications defined in the latest updates of the following standards:

- a) ANSI/NFPA 52 Vehicular Fuel Systems Code
- b) CGA B149.4 M1991 NGV Installation Code
- c) FMVSS 304
- d) CSA B109 Natural Gas for Vehicles Installation Code
- e) ANSI/AGA NGV3.1/CGA 12.3, Fuel System Components for Natural Gas Powered Vehicles

This section provides general guidelines for the installation of the CNG Cylinder. Consult local regulatory standards for required installation requirements. A partial list of local regulatory standards is included in this document.

- The installer should use hardware appropriate for the installation location.
- Outside venting is required for CNG cylinders in enclosed areas.
- Do not allow any part of the CNG Cylinder or Fuel System to extend beyond the sides or top of the vehicle.
- A clearance of at least 6 inches (152mm) is recommended between the cylinder and the extremities of the vehicle to minimize damage due to collisions or overturning.
- Installer must provide sufficient impact resistant cages to side mounted cylinders unless specific impact tests are carried out to prove otherwise. *Cylinders mounted below the vehicle body must be protected to minimize the possibility of foreign object damage or damage from stationary bodies.*
- Installer must insure valves are protected from physical damage using the vehicle structure, valve protectors or a metal shield.
- If stone shields are necessary to protect the cylinder beneath the vehicle, the shield must not come in contact with, or trap solid or fluid matter against the cylinder surface.
- Do not mount the cylinder or Fuel System ahead of the vehicle front axle or behind the rear bumper mounting face, unless specifically approved by appropriate regulatory authorities.
- Install the cylinder with not less than the minimum ramp angle and road clearance of the vehicle when loaded to its gross vehicle weight rating.
- Secure the cylinder to the vehicle body, bed or frame using only approved installation brackets that prevent damage from road hazards, slippage, loosening or rotation.
- Installer must ensure cylinders located less than 8 inches (203mm) from the exhaust system are shielded against direct heat.
- Do not allow the cylinder and Fuel System installation to adversely affect the driving characteristics of the vehicle.

⚠ DANGER

The PRD vent line must allow for unrestricted gas release. Under no circumstances allow backpressure build-up in the PRD line. Backpressure may cause rupture of the PRD head resulting in death or serious injury.

⚠ DANGER

The Pressure Relief Device (PRD) must not be shielded in any way. Shielding may prevent the PRD from functioning or activating properly, this can result in a cylinder failure resulting in death or serious injury.

Brackets must be securely fastened to the vehicle at a location that provides sufficient strength to retain the cylinder in the event of collision. Single-wall sheet metal may not provide sufficient strength for the attachment of cylinder brackets. Refer to applicable regulations for anchorage strength requirements. Figure 7 (below) shows a typical aftermarket saddle bracket kit.



Figure 7

⚠ WARNING

Improper installation may result in cylinder failure. Follow manufacturer instructions and all federal, state and local regulations for cylinder installation. Improper installation may result in serious injury or death.

The installer is responsible for determining proper cylinder bracket selection and installation requirements.

Auxiliary Label

The label contains important information regarding the safe operation of the cylinder and must be visible. If it is not possible to install the cylinder with the original label visible, an auxiliary label must be applied to the cylinder in a visible location or installed in a location as near as possible to the cylinder while maintaining visibility.

Grounding

Externally mounted cylinders exposed to airflow must be grounded to prevent a static charge from accumulating in the composite as a result of airflow friction. The grounding connection may be made to the stainless steel fuel pipe connection adjacent to the valve using a 14-gauge multi stranded wire. Place 3 turns of copper strands around the pipe and secure with a stainless steel screw clamp of suitable size. Secure the other end of the ground wire to the vehicle body using a crimp-on eye lug and a self-tapping, stainless steel screw. Ensure ground is adequate, check for continuity and seal to prevent corrosion from damaging the contact points.

Venting Requirements

All CNG Fuel Cylinders installed in an enclosed area require venting to the outside of the vehicle. Venting systems must meet the requirements of applicable local codes or venting regulations.

Installation Verification

Perform the following verification immediately following the installation and also after three months of initial operation. Verify the cylinder installation for:

- Integrity of attachment to vehicle.
- Potential damage occurring during service.
- Leak tightness of the fuel-line connections.
- The installer should verify that the cylinder certification and installation meets all local jurisdictional requirements. If the cylinder has been in service before, verify the service history to ensure that the previous vehicle(s) has not been involved in any serious accidents or subjected to fire.

Integrity of Attachment to the Vehicle

Visually examine all bracket-to-bracket and bracket-to-vehicle connections. Verify that all connections are secured and that backing plates are in place at single wall anchorage points. Verify that the brackets are not bent or damaged due to excessive tightening of fasteners

Potential for Damage during Service

Check for minimum air gap around the cylinder. Ensure that the rubber gaskets are properly in place. Verify that the specified clearances are maintained between the cylinder body and the vehicle structure and moving cables even when the vehicle is fully loaded and the cylinders are filled. Verify that the cylinder is properly shielded from exhaust heat. For underbody mounted cylinders, ensure that the protective shield locations are adequate to protect the cylinder from damage during service. Visually examine the cylinder to ensure that it was not damaged during installation. Ensure that the PRD(s) are not shielded in any way.

Purge Instructions

WARNING

Do not allow atmosphere to enter the fuel storage cylinder during purging. The fuel storage cylinder pressure should not drop below 5 psig during the purging process. Introduction of atmosphere (oxygen) in the cylinder may create a combustible mixture that if ignited may result in serious injury or death.

Only perform the purge process when the ambient temperature is above 0° F (-18° C). If cylinder was stored at temperatures below 0° F allow cylinder to warm up to room temperature (>60° F) before proceeding.

Prior to the initial pressurization, air must be purged from the cylinder. The recommended procedure is:

1. Fill the fuel storage cylinder with a dry inert gas (nitrogen, argon, etc.) to 100 Bar \pm 3.5 Bar (1400 psig \pm 50 psig). Selection of the inert gas should take into consideration what will be most compatible with the system. Refer to the fuel system component manufacturer for system compatible purge gas recommendation.
2. Drain the fuel storage cylinder to approximately 1.0 Bar \pm 0.5 Bar (10 psig \pm 5 psig).
3. Refill the fuel storage cylinder with the inert gas again to 100 Bar \pm 3.5 Bar (1400 psig \pm 50 psig).
4. Drain the fuel storage cylinder again to approximately 1.0 Bar \pm 0.5 Bar (10 psig \pm 5 psig).
5. Fill the fuel storage cylinder to service pressure per applicable codes.

This process will reduce the air in the fuel storage cylinder to a value substantially below the lower explosive limit for CNG.

Leak Testing

⚠ DANGER

The cylinder must be first purged with an inert gas to ensure that no explosive mix is formed at any point during the fill. Refer to [Purge Instructions](#) in this manual. Failure to follow this instruction may result in death or serious injury.

⚠ DANGER

Never check for gas leaks with an open flame use only approved leak detection methods. Use of an open flame may result in a fire or explosion, in case of a fuel leak. Failure to follow this instruction may result in death or serious injury.

NOTICE

When a cylinder is pressurized from nearly empty to full, a small quantity of AIR (not fuel) is compressed out from between the liner and composite shell. This may cause bubbling around the surface of the shell and/or the end bosses during leak tests. This is a normal condition and the bubbling should subside typically within 30 minutes. A gas detector can be used to confirm that the bubbling is caused by air only. When a cylinder is fast filled for the first time to the service pressure, some minor cracking noises may be heard. This is due to differential movements within the cylinder, and is a normal condition for composite cylinders. The noises should stop within 5 to 10 fills.

Verify the leak-tightness of the connection between the cylinder shut off valve or in-cylinder regulator and the CNG cylinder by pressurizing the system to the rated service pressure of the cylinder. An inert gas such as nitrogen is preferable for the initial test. CNG cylinder mounted PRD's must be tested in the same manner.

Leak testing must be done in stages: an initial 500 psi fill and verification, followed by a fill to service pressure if no leak is detected at 500 psi. Positively ensure there are no leaks prior to filling the cylinder to service pressure. Conduct another leak test at service pressure.

A non-corrosive foaming agent is recommended for leak testing (example: Snoop® or equivalent available from most tube fitting suppliers). An electronic combustible gas detector may also be used, if using CNG for the test medium. Be sure to follow the manufacturers' instructions to ensure proper equipment operation.

Testing must be conducted under adequately vented conditions and at least 25 feet away from any open flame or other sources of ignition. Ensure all safety procedures are observed when working with high pressure or flammable gasses.

Action in Case of a Serious Leak

If a serious leak is encountered:

- Shut off all electrical equipment and sources of heat and flame in the immediate vicinity.
- Clear people at least 100 feet away, in an up-wind or cross wind direction until the source of leakage is detected and gas flow is stopped.
- In the event of an ignition contact the fire department immediately.
- If any leaks are detected in the body of the cylinder or around the end bosses or valve, the cylinder must be depressurized and taken out of service.
- Contact Quantum Technologies, Inc. or its agents for instructions at 1-949-399-4500, dial "0" for Operator.

Cylinder Pressurization/Fill

WARNING

Failure to follow the fill instructions may irreversibly damage the fuel storage cylinder, leading to fuel leakage. The fuel storage cylinder must be handled in a safe and responsible manner. Failure to do so may result in serious injury or death.

- Under normal operating conditions, a residual pressure of 300-350 psig is maintained in the fuel storage cylinder and may be filled normally following all applicable state, local, and fire codes, to a temperature compensated (70°F) (21°C) service pressure.
- If pressure in the fuel storage cylinder falls below 300 psig the cylinder can be filled normally if the ambient temperature is above 0°F (-18°C).
- If pressure in the fuel storage cylinder falls below 300 psig and ambient temperature is below 0°F (-18°C), please let the vehicle/cylinder warm up to room temperature (>60°F (15.5°C)) in a heated garage. Once the vehicle/cylinder has warmed up, the vehicle can be driven to a fill station, but must be filled within ½ hr to 40 minutes after leaving the heated garage.

Cylinder Depressurization

⚠ WARNING

Failure to use an orifice in the venting system may subject the valve and cylinder to extremely low temperatures during venting resulting in severe damage to (or failure of) these components. Use an orifice specified by the valve or tank manufacturer when venting. Failure to follow this instruction may result in serious injury or death.

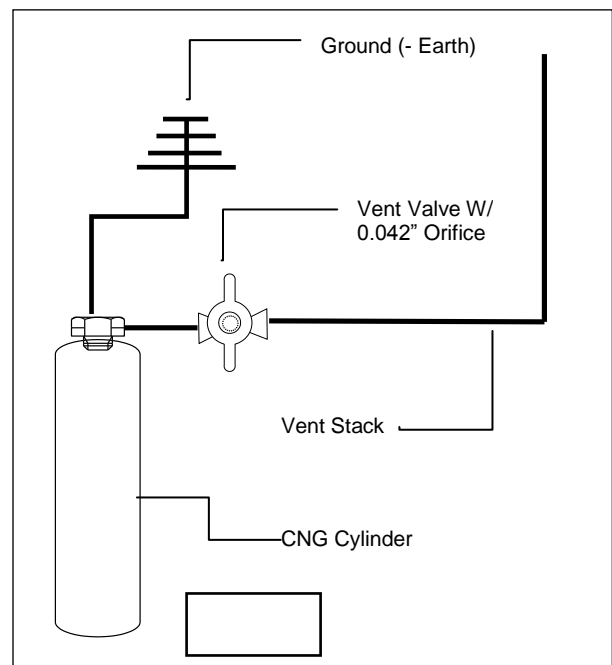
⚠ WARNING

During the venting process static may build up in the cylinder or vent system, if this static creates a spark the fuel may be ignited. The cylinder and vent system must be properly grounded to an earth ground. Failure to follow this instruction may result in serious injury or death.

The venting operation should be performed by qualified personnel and in a manner that meets all federal, state and local regulatory requirements. The main considerations for safe venting are listed below:

- The release of gas to the atmosphere must be done in a manner that complies with all applicable codes concerning release of gas to atmosphere.
- Must be performed outdoors in an open area.
- Must be a minimum of 100 feet away from a source of ignition

Must use a venting system that meets the valve or tank manufacturer's specifications for the vent rate. In the absence of another specification Quantum recommends the use of a 0.042" orifice in the vent system.



Inspection and Maintenance

The Quantum Cylinders are designed for low maintenance and dependable operation for the duration of the service life specified on the cylinder label. Quantum Technologies, Inc. recommends that the cylinders be visually inspected periodically to ensure that the cylinders have not been damaged and made unfit for continued service. The cylinders may also require periodic inspection and re-qualification as required by applicable regulatory authorities. No maintenance measures are required, other than those arising from self inspection. The owner must maintain inspection records during the cylinder life.

Cylinder Inspection

WARNING

Inspection and maintenance of this cylinder must be performed by competent personnel in accordance with all Federal, State, and Local regulations applicable to the application. Failure to properly identify and repair cylinder damage may result in serious injury or death.

Fuel Cylinder and Bracket Inspection

Inspect the CNG fuel cylinder and brackets as determined by the maintenance schedule, after any vehicle accident or fire or after the CNG cylinder has been removed from the vehicle and reinstalled. Record the inspection information in the vehicle's permanent file and in the inspection record contained in the cylinder pamphlet supplied with your cylinder.

See Appendix A for typical tools and materials for measuring and repairing overwrap damage.

NOTICE

Do not remove the cylinder from the vehicle for general inspections. Cylinder removal is only necessary if the following conditions are present:

- The cylinder has been exposed to corrosive chemicals such as strong acid or alkali.
- Unusual or excessive corrosion is observed in the cylinder area.
- Obvious damage is observed in the cylinder area.
- The cylinder straps are loose or damaged.
- The vehicle has been involved in a collision and damage is observed in the cylinder area.
- The vehicle has been involved in a fire (the PRD may or may not have activated).

If the cylinder is replaced, perform the following steps:

- Obtain a new fill area cylinder expiration label.
- Record the new cylinder's "DO NOT USE AFTER DATE" onto the label. This date is permanently printed on the face of the cylinder label.

Cylinder Label Inspection Procedure

The CNG cylinder is marked with the label indicating the critical tank information as well as a safety label, if either of these labels are missing or illegible contact Quantum Technologies for assistance.

Verify that all fuel cylinder labels are in place and legible.

Contact Quantum Technologies if any of the following conditions exist:

- The label is illegible
- The label is peeling.
- The label is missing.

Verify that the “DO NOT USE AFTER DATE” indicated on the cylinder matches the fill area label. If needed, replace the fill area label so the “DO NOT USE AFTER DATE” matches the cylinder label.

Cylinder Wrap Inspection Procedure

Important: Gaps of the fiber wrap around the dome area of the cylinder may occur during manufacture. Also, resin and paint runs may appear as a hard circle or spot on the cylinder surface. This is normal. Cylinder strength is not affected and does not require repair.

Inspect and resurface abrasions or cuts in the cylinder as follows:

Level 1 Cut or Abrasion:

- Level 1 cut, scratch or abrasions are minor cuts or abrasions that are less than 0.25 mm (0.010 in) deep.
- It is not necessary to resurface Level 1 abrasions.



Level 2a Cut or Abrasions:

Important: Cylinders with cuts or abrasions that exceed Level 2a specifications must be removed from service.

Level 2a cuts or abrasions have some exposed fibers or have flat spots with a depth between 0.26-0.89 mm (0.011-0.035 in). It may be necessary to remove loose fibers in order to accurately gage the depth of the cut or abrasion.

Resurface Level 2a cuts or abrasions before returning the cylinder to service by performing the following:

- Remove any loose fibers.
- Sand (or file) the cut or abrasion in order to taper the affected area.

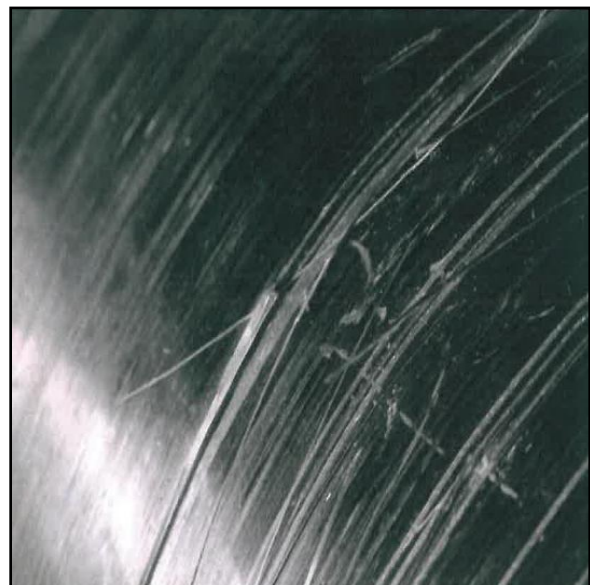
Important: Use hand tools only. The repair process should not remove surface material in excess of level 2a damage (see above) or the cylinder must be removed from service during this step. The fuel cylinder need not be removed from the vehicle for this repair procedure.

- Optional – Fill any low spots created using a five minute fast cure epoxy.



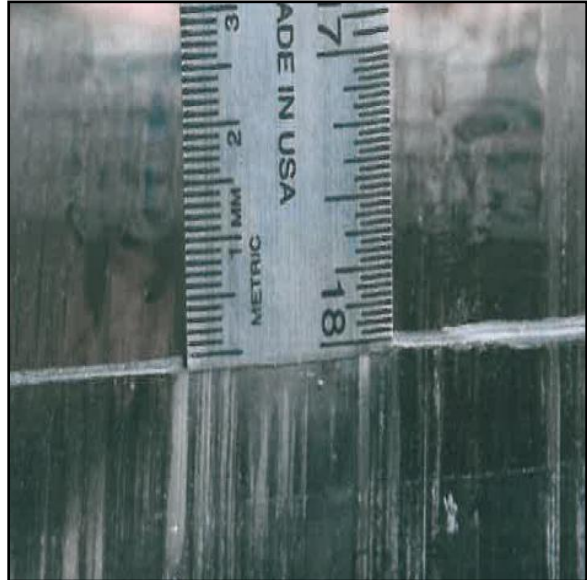
Level 2b Cut or Abrasions:

- Level 2b cuts or abrasions have some exposed fibers or have flat spots with a depth between 0.90-1.27 mm (0.036-0.050 in). It may be necessary to remove loose fibers in order to accurately gage the depth of the cut or abrasion.
- Contact Quantum Technologies for direction with level 2b damage



Level 3 Cut or Abrasions:

- Level 3 cuts or abrasions have some exposed fibers or have flat spots with a depth greater than 1.27 mm (0.050 in). It may be necessary to remove loose fibers in order to accurately gage the depth of the cut or abrasion.
- See “Removing Cylinders from Service” below.

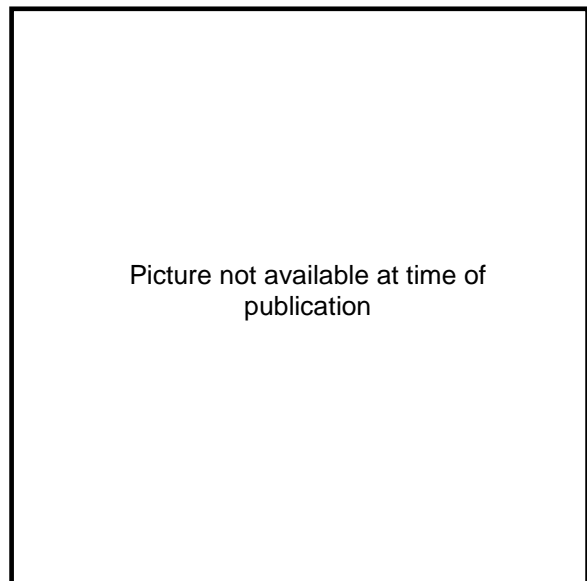


Heat or Chemical Exposure

Any indication that the vehicle has been involved in an accident or fire requires careful examination of the cylinders. Generally, if Type 4 cylinders are exposed to excessive heat, or any discoloration occurs that does not wash off, it is considered Level 3 damage.

Acids and other chemicals can severely damage the cylinder. Chemical attack can also lead to Stress Corrosion Cracking. Cylinders suspected of being exposed to acid should be depressurized as soon as possible to prevent rupture and removed from service.

- Inspect the cylinder for heat exposure such as darkening or charring/sooting of the surface.
 - Inspect for the following evidence chemical exposure:
 - Blistering of the external surface.
 - Localized swelling of the surface.
 - Softening of the surface finish.
 - Resin removal or loss by any means not attributed to mechanical action.
- Fracturing of the external sacrificial fibers by any means not attributed to mechanical action.
- Any cylinder with indications of heat or chemical exposure must be removed from service.



Weathering Exposure

Inspect for excessive weathering exposure such as discoloration or light flaking of the surface coating.

Repair weathering exposure by performing the following:

1. Sand or file the affected area.

Important: Use hand tools only. The repair process should not remove surface material in excess of level 2a damage or the cylinder must be removed from service during this step.

2. Fill low areas with 2-part epoxy following the manufacturers' directions for mix ratio and cure time.
3. Optional – Lightly sand (180 grit) cured epoxy and coat repair with clear acrylic enamel.

Picture not available at time of publication

Gas Leakage

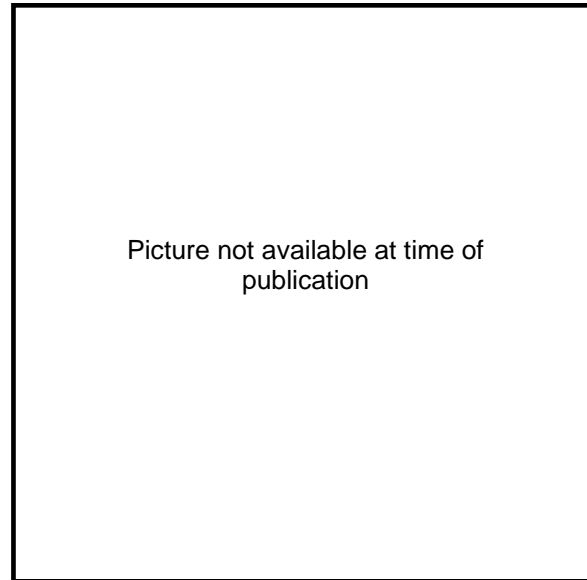
Important: Bubbles are typically observed on the cylinder surface for several hours after pressurization of a cylinder initially placed into service or a re-pressurized cylinder that has been completely vented before being returned to service. The bubbles are caused by air trapped between the liner and the structural composite shell and do not indicate gas leakage. This is a temporary phenomenon and will disappear with time.

Any cylinder that exhibits gas leakage must be removed from service.

Picture not available at time of publication

Stress Corrosion Cracking

This occurs when the cylinder is cycled repeatedly causing expansion and contraction of the cylinder, which is usually a sign of age or over pressurization. The fiber wrap cracks longitudinally causing loss of the cylinder pressure safety factor. Any identified stress or fatigue cracking is Level 3 damage. A contributing factor can be chemical attack e.g., battery acid.

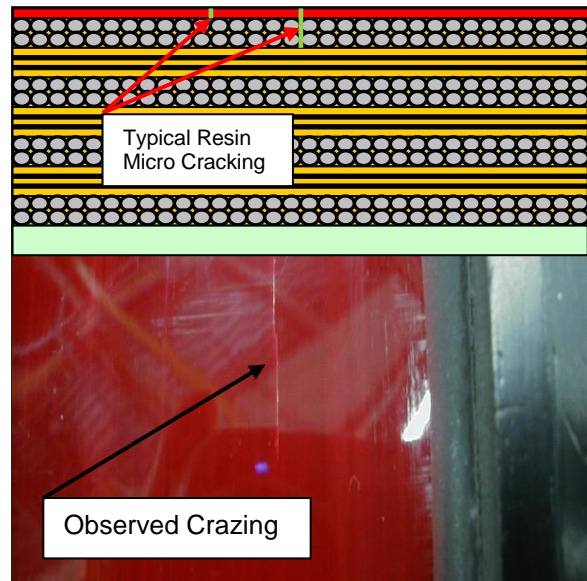


Crazing

Crazing is defined as micro-fracture of the resin coating or as “apparent fine cracks at or under the surface of an organic matrix”. Crazing is common in fiber-reinforced composites, typically in a direction parallel to the fiber direction.

Crazing is a common occurrence in Type IV pressure vessels. Quite often crazing is accompanied by audible noises as the strain is relieved in the resin. Occasionally crazing in fiber-reinforced structures may sound like a metallic object striking the pressure vessel or like a dull crack.

Crazing of the matrix material has no influence on the pressure vessel performance since the fiber material supports 99.9% of the pressure load. In a composite shell involving multiple layers of fiber at different angles, micro-fractures are often confined to a layer and do not propagate to the next layer of different angle.



Resin Surface Defects

During the manufacturing process it is possible for bubbles to form and pop in the resin during the curing process. This can leave a crater type impression on the surface of the cylinder. This is a normal condition that does not require any action unless:

- Loose fiber is observed in the defect.
- The fiber is discolored in or around the defect.

Picture not available at time of publication

Impact Damage

Blunt impact damage on Type 4 cylinders is very hard to evaluate and can be dangerous. Extreme care must be taken to determine if any deformation of the cylinder is present indicating fiber damage. This is a sign that the cylinder may not be structurally sound and is considered Level 3 damage.

Picture not available at time of publication

Cylinder Impact Inspection

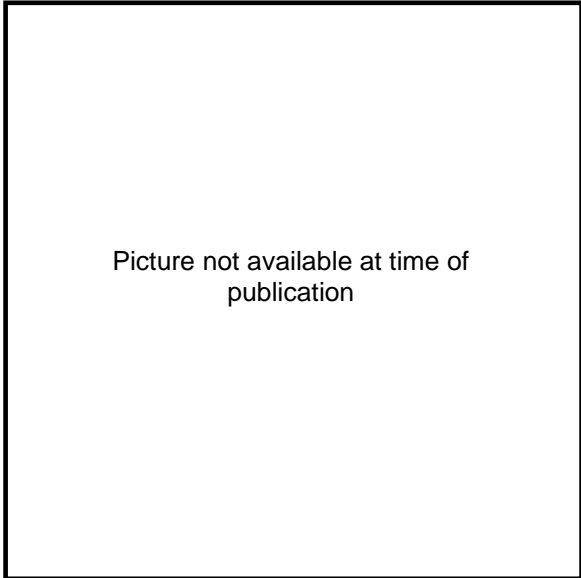
⚠ WARNING

While all cylinder inspection items are somewhat subjective, the following inspections require an inspector with a higher level of experience. If there is any doubt as to the severity of the damage, return the cylinder to Quantum Technologies for a thorough inspection and test. Failure to properly identify cylinder damage may result in serious injury or death.

Impact damage differs from cuts or abrasions. More severe damage may occur within the wall of the cylinder and may not be readily apparent on the surface. A cylinder with localized surface deformation up to 12.7 mm diameter (1/2 inch) or fiber breakage 6.35 mm wide (1/4 inch) that does not exceed 0.25 mm (0.010 in) in depth are acceptable. Return the tank to Quantum Technologies for through inspection and test if there is any doubt as to the level of damage

Cylinder damage can be determined by the following methods:

- Permanent deformation of the cylinder surface resembling denting that exceeds 0.89 mm (0.035 in) in depth.
- Softness or deflection of the cylinder wall. The cylinder wall should be rigid and not easily deformable.
- Localized areas of surface cracking. The cracks will have a localized circular, oval or linear pattern.



If exposure to impact damage is suspected and cylinder condition cannot be determined, the cylinder must be removed from service. The “Tap Test” outlined below can be an aid in determining cylinder condition:

1. Tap the surface of the cylinder with a small metal object such as a large coin.

Important: The tap test can only be performed in the cylindrical portion of the cylinder. The dome ends of the cylinder (spherical) cannot be tested by sound.

2. Compare the sound emitted in the suspect area to the sound emitted in an area where impact is not suspected.
3. Damage is present when the suspect area emits a sound that is different than other portions of the cylinder.
4. Remove from service any cylinder with suspected impact damage.

Mounting Bracket Inspection Procedure

1. Verify that the rubber isolator is properly seated on the cylinder brackets and straps.
2. Inspect the rubber isolator for cracks, deterioration, or other damage.

Important: Do not verify the cylinder strap nut torque on a charged cylinder. A composite cylinder will expand and contract as the internal pressure increases and decreases. In order to compensate for expansion and contraction the cylinder strap rubber isolator is designed to deform slightly. The rubber isolators will eventually settle somewhat causing cylinder strap nut torque to vary from factory installed torque.

3. Replace the rubber isolators whenever the cylinder straps are removed or loosened.
4. Inspect the cylinder brackets, straps, mounting frame, and mounting hardware for cracks, corrosion, deformation, or other damage.
5. Replace any parts that are suspect or found to be damaged or defective.

Regulatory Inspection and Requalification

Certain regulations require that the cylinders be periodically re-qualified through visual inspection:

- In the US, every three years (DOT FMVSS304)
- In Canada, every four years (CSA B51)

In addition, re-qualification is recommended when:

- A cylinder without test records is to be transferred to a vehicle
- A cylinder is transferred from one vehicle to another vehicle. (Example: OEM to retrofit vehicle)
- A cylinder is involved in a motor vehicle accident

Valve/PRD Replacement

DANGER

A malfunctioning valve may result in incomplete depressurization of the cylinder. Removing a valve or PRD from a pressurized cylinder may propel the valve being removed. Verify that there is no pressure present in the cylinder before removing the valve or PRD. Failure to do so may result in death or serious injury.

WARNING

Failure to use approved valve and PRD may cause cylinder rupture. Only use valves and PRDs that are approved for use in your cylinder. Failure to do so may result in serious injury or death.

CAUTION

Do not remove or replace factory-installed valves without prior approval from Quantum Technologies, Inc. Failure to do so may result in damage to cylinder.

NOTICE

Unauthorized removal of the valve and/or the regulator will void the warranty.

Certain models of the Quantum cylinders are supplied with factory-installed valves or in-cylinder regulators.

Regulatory approvals require that valve/PRD/cylinder combinations be tested in standard bonfire tests. It is critical that each cylinder be fitted with the tested and approved valve and PRD (Pressure Relief Device).

For cylinders supplied without a valve, follow the valve manufacturer's instructions for installation.

Only install Quantum-approved valves and PRD(s). Contact Quantum for a list of approved components for your cylinder(s).

Removing Cylinders from Service

WARNING

Failure to remove traces of flammable vapor or gas may lead to dangerous explosions of disposed cylinders. Cylinders must be purged of flammable vapors before disposal. Failure to do so may result in serious injury or death.

WARNING

Cylinders that have been damaged, or exceed the lifespan indicated on the cylinder label, may be at risk of gas leakage. These cylinders must be removed from service and disposed of according to applicable laws and regulations. Failure to do so may result in serious injury or death.

Removal Procedure

The CNG fuel cylinder has a predetermined service life from the date of manufacture. The fuel cylinder "DO NOT USE AFTER DATE" appears on a label on the cylinder. The fuel cylinder expiration date is also located on the fill area label.

Any fuel cylinder in service beyond the date indicated on the cylinder label or that exhibits level 3 damage or greater must be removed from service with the following procedure:

1. Vent and purge the cylinder. Refer to [Purge Instructions](#) in this manual.
2. Clearly mark the cylinder as "CONDEMNED".
3. Disconnect the vent hose.
4. Remove the cylinder from the vehicle. Refer to the latest service procedures.
5. Place the cylinder outside in a well ventilated area.
6. Allow the cylinder to stand for 24 hours with the cylinder valve manually held open.
7. With a non-electric drill and with the cylinder valve removed, drill a hole with a 1/2 inch diameter or greater completely through the cylinder wall and inner liner at the end of the cylinder serial number. Do not drill through and destroy the serial number.
8. Dispose of the cylinder in a safe and approved manner. A properly decommissioned cylinder is considered solid waste by most authorities. If in doubt, contact your local disposal regulatory agency for disposal requirements.

Other Available Specifications and Information

ANSI/NFPA 52 Compressed Natural Gas Vehicular Fuel Systems

Canadian Gas Association CGA B146.4 - M1991-NGV Installation Code

FMVSS/CMVSS 303/304

NGV2

Warranty and Limitation of Liability

Limited Warranty

Products of Quantum Technologies, Inc. are guaranteed against defects in material and workmanship for a period of twenty four (24) months from date of shipment from our plant. This warranty is limited to replacing or repairing F.O.B. factory, any material which upon our inspection on our premises we find to be defective. Transportation charges on material returned must be prepaid. This warranty is null and void if, upon examination of the returned product, it is determined that the failure or defect has been caused by misuse, neglect, improper installation, repair, alteration or accident.

Dimensions and specifications of catalogued items are standard, and we shall adhere to these standards whenever possible, reserving however the right to make changes without notice.

EXCEPT AS EXPRESSLY STATED ABOVE, SELLER MAKES NO WARRANTY, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE, ON ANY PRODUCT, OR ON ANY PARTS OR LABOR FURNISHED DURING THE SALE, DELIVERY OR SERVICING OF ANY PRODUCT.

Limitation of Liability

Seller shall not be liable to Buyer or to any third party for any indirect, incidental, exemplary or consequential loss, damage or injury arising out of any breach of warranty or other default relating to Buyer's order or to any product or services provided to Buyer, or any third party, even if any such loss, damage or injury is caused by Seller's negligence and even if Seller was notified of the possibility of such damages. The correction of defects as provided in the warranty statement above shall constitute Seller's full obligation and Buyer's and third party's exclusive remedy with respect to all claims and Seller's liability shall in no event exceed the unit purchasing price of the product in question.

Any lawsuit or other action based upon breach of contract or upon any other claim arising out of this sale (other than an action by Seller for any amount due to Seller by Buyer) must be commenced within one year from the date of the tender of delivery by Seller or, in the case of a cause of action based upon alleged Breach of Warranty, within one year from the date within the warranty period on which the defect is or should have been discovered by the Buyer or third party.

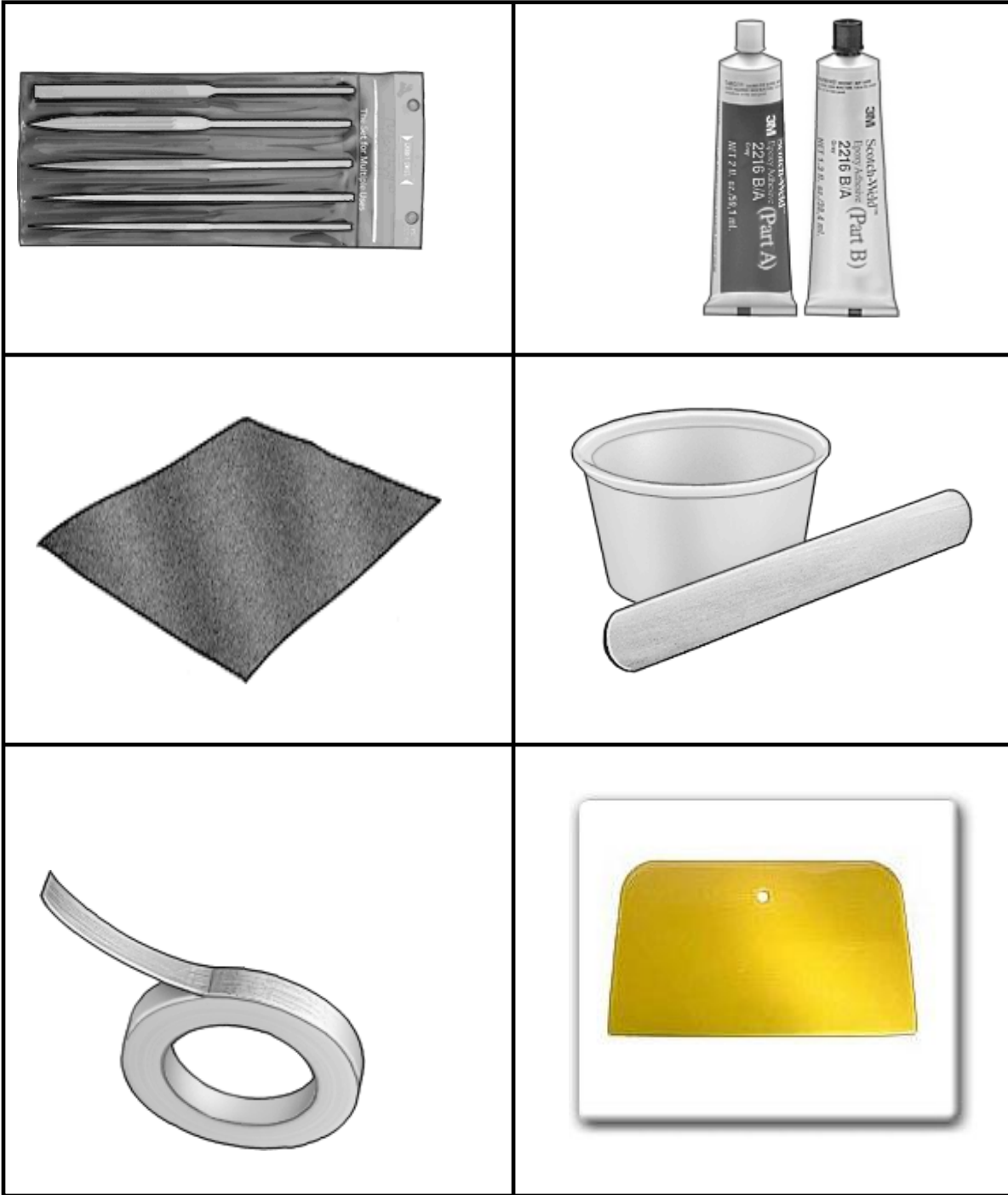
All sales, warranties and liabilities shall be governed by the laws of the State of California, U.S.A and application of the U.N. Convention on Contracts for the International Sale of Goods is expressly waived.

No person or entity shall have the authority to alter the terms set forth above unless in writing and signed by an authorized representative of Quantum Technologies Worldwide, Inc.

TECHNICAL SUPPORT
Technical telephone support is available by calling
1-949-399-4500

Appendix A – Typical Inspection and Repair Equipment





Appendix B - Sample Inspection Form

Vehicle Year: _____ Vehicle Make: _____

Vehicle Model: _____ Mileage: _____

Cylinder #	1	2	3	4
Manufacturer				
Serial Number				
Location (position)				

P = Pass X= Fail C = Correction made (see notes)

Cylinder Inspection Point	1	2	3	4
Verify cylinder installation is compliant with NFPA and MVSS regulations.				
Verify cylinder and mounting bracket are clean.				
Verify cylinder strap isolators are in place and in good condition.				
Verify cylinder mounting bracket and attachment points are in good condition.				
Verify cylinder labeling is in place and legible.				
Verify cylinder expiration dates have not been exceeded.				
Inspect for any signs of fire or extreme heat exposure are evident.				
Inspect for signs of physical damage to the cylinder bracket or adjacent area.				
Inspect for signs of corrosion or chemical damage to the cylinder bracket.				
Inspect for signs of chemical or physical damage to the cylinder.				
Verify the correct PRD and Valve are installed in the cylinder.				
Inspect for wear or damage to the PRD or tank valve assemblies.				
Inspect any vent system for proper installation or damage				

Inspection results: Cylinder(s) returned to service

Cylinder(s) repaired or removed from service. Explain Below

Explanation of cylinder repairs or disposition (use back if more space is needed)

Date: _____

Inspector name (print): _____

Inspector Signature: _____

Appendix C - Sample Cylinder Inspection Record Form



Tank Serial Number _____ Tank Expiration Date _____

Vehicle VIN _____

Inspection Interval (Mileage or Years)	Inspection Date	Inspector	Inspector Initials	Type of Repair*
20 Years	N/A	N/A	N/A	Tank Exchanged

*Record the type of repair as None, Level1, Level2, or Exchanged. See "Cylinder Inspection" in the *Type 4 Compressed Natural Gas (CNG) Cylinder Installation and Maintenance Guide* (available at WWW.QTWW.COM/QUALITY) for the inspection criteria.

Revision History

Revision A, 10/4/2011 Initial Release



Quantum Technologies Worldwide, Inc.
17872 Cartwright Road
Irvine, CA 92614
Tel: (949) 399-4500 Fax: (949) 399-4600
www.qtw.com
info@qtw.com