

FOREWORD

THE INSTRUCTIONS PRESENTED HERE ARE ORIENTED TO USERS OF CNG CYLINDERS AS WELL AS TO TECHNICIANS IN CHARGE OF THEIR INSTALLATION

CAUTION! READ THIS BEFORE

This guide only has the objective of providing information on the handling and care of GNC cylinders. It sets some basic safety recommendations to be followed. It is not intended to replace maintenance manuals, technical specifications or guides for CNG high-pressure cylinders.

Further information related to maintenance manuals and/or user's guides should be requested from your CNG cylinders supplier.

The information presented here is not intended to replace any local authority rule and/or regulation. Contact your local authority for further information.

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General Information for end users
and/or installation workshops
and qualified registered personnel

Introduction

The information in this paper can prevent you from serious injury. It could even contribute to protecting your life, provided you follow the guidelines presented here.

The most important thing you can do is to understand that handling and care of high pressure cylinders for the on-board storage of compressed natural gas is serious business.

There is a right way to deal with these cylinders and many wrong ways, most of which can develop into serious consequences.

Ignorance can be dangerous.

THE SECOND MOST IMPORTANT THING TO REMEMBER IS THAT NOT KNOWING CAN BE DANGEROUS.

- ✗ Unless you have received training in the handling and care of these cylinders, do not assume that you know everything about how to deal with them.
- ✓ Always seek and follow the guidance and recommendations of the cylinder and/or vehicle manufacturer.



- ✓ In case any doubt about procedures arises, contact either the workshop's Technical Manager or the Local Authority.
- ✗ The information presented in this paper does **NOT** replace the guidelines and/or regulations issued by the cylinder or vehicle manufacturer, or local authority.

THE INTENTION OF THIS PAPER IS TO PROVIDE SOME KEY INFORMATION IN THE HOPE THAT IT WILL PROVE HELPFUL TO MAKE USERS AWARE OF PROCEDURES.

Knowing what type of cylinder you have

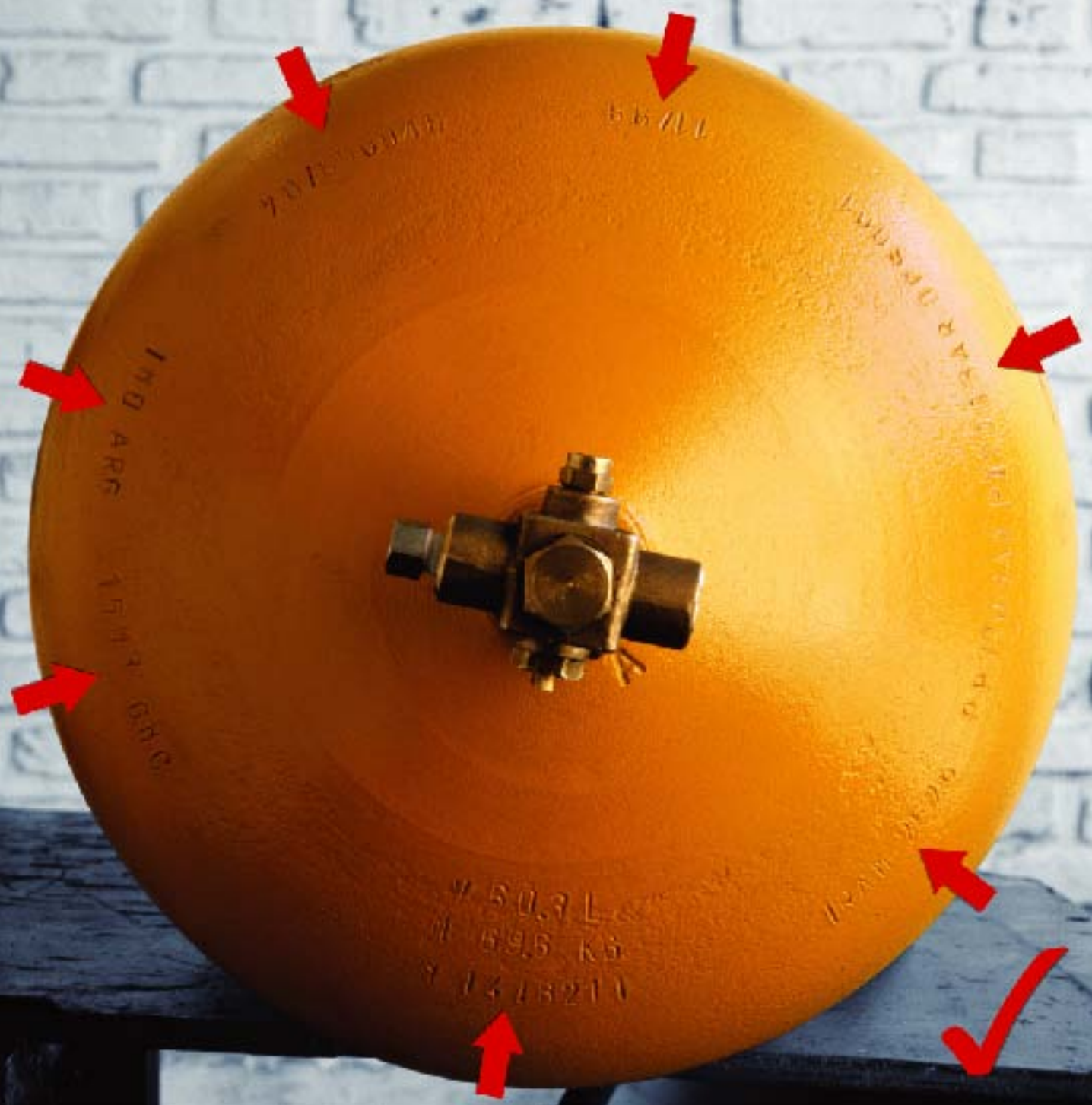
There are several different types of cylinders. Each has its own characteristics. Each requires different care and handling. What is safe for one type of cylinder can result in serious personal injury, or even death if applied inadequately to some other type.

- ✓ The easiest way to determine what kind of cylinder you are dealing with is to look at the label or marking.
- ✓ Read the label carefully. Respect what it says.
- ✓ Be sure that has the marking standard number and the approval seal duly stamped.
- ✗ For example, if the label or marking says the cylinder is for natural gas, **Do NOT** fill it with anything else.
- ✓ If the cylinder has no label, contact either the workshop's Technical Manager or Local Authority or Cylinders' Manufacturer.
- ✗ **Do NOT**, under any kind of circumstances, attempt to do anything to a cylinder with no label or marking.
- ✓ **Do NOT** forget that every single type of cylinder requires different treatment.

THERE ARE FOUR TYPES OF CYLINDERS FOR COMPRESSED NATURAL GAS IN USE:

- **TYPE 1:** This is an all metal cylinder made of steel or aluminum. There is no covering other than paint on the outside of the cylinder. This is the most common type of cylinder and has a marking instead of a label.
- **TYPE 2:** This is a metallic cylinder with a partial wrapping that goes around the cylinder. The wrapping is usually made of glass fiber, aramid fiber or carbon fiber, embedded in an epoxy or polyester resin.
- **TYPE 3:** This type of cylinder is fully wrapped with the same kind of materials used for the partial wrapping of a Type 2 cylinder. This type of cylinder has a metallic liner.
- **TYPE 4:** This type of cylinder is fully wrapped with the same kind of materials used for the partial wrapping of a Type 2 cylinder. This type of cylinder has a plastic liner.

READ THE LABEL OR MARKING. KNOW THE TYPE OF CYLINDER YOU ARE DEALING WITH.



- Be sure that the cylinder has the marking standard number and the approval seal duly stamped. ✓

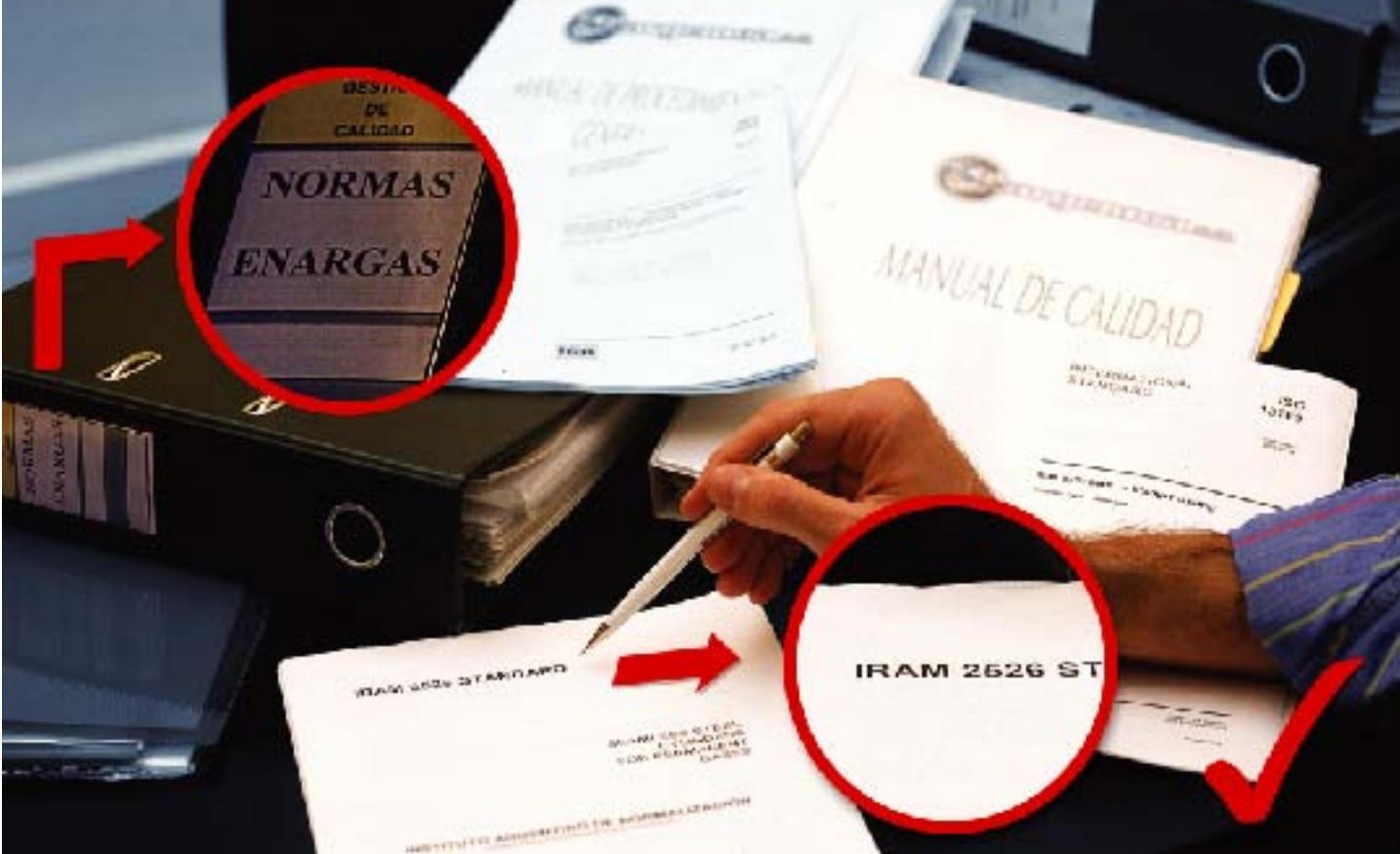
Getting to know your cylinder

Cylinder Inspection

YOU CHECK YOUR CAR TIRES FROM TIME TO TIME BECAUSE YOU KNOW THAT YOUR SAFETY DEPENDS ON THEM. THE SAME APPLIES TO HIGH-PRESSURE CNG CYLINDERS. THERE ARE LOTS OF IMPORTANT THINGS THAT A GENERAL VISUAL INSPECTION CAN REVEAL.

- Regular checks are recommended to see if there is any sign of damage.
- In addition, a thorough detailed inspection should be performed periodically by qualified registered technicians, following the manufacturer's specifications and local regulations.
- It is mandatory to submit the CNG cylinder to periodical tests to meet official regulations at each country.
- It is suggested as well, to make a visual inspection of the CNG cylinder and the CNG fuel system annually.
- Besides, it is essential to do a complete inspection of the cylinder including a hydraulic test every five (5) years for cylinders Type I.
- However if you have a CNG cylinder type II, III or IV you should contact your Local Authority or the manufacturer.
- In all cases local authority regulations prevail


YOUR SAFETY DEPENDS ON THE PER IODIC TEST OF THE CNG CYLINDERS.



- In all cases local authority regulations prevail. ✓



- A thorough detailed inspection should be performed periodically by qualified registered technicians. ✓

The background of the slide is a dense, repeating pattern of blue, spherical objects, likely balls or marbles, arranged in a grid-like fashion. Each ball has a small, circular white sticker with the text "O.K. C" printed on it. The lighting creates highlights and shadows on the surfaces of the balls, giving them a three-dimensional appearance. The overall color scheme is a monochromatic blue.

Recommendations
only for qualified registered
workshops/technicians

Cylinder Inspection

HERE'S WHAT YOU SHOULD DO:

1. If the cylinder is installed under the vehicle, use a hydraulic elevator, being careful to hook up/ place the hoist away from the cylinder(s).
2. Remove the shielding that protects the cylinder.
3. Clean the cylinder and mounting device.
4. Check the label or marking. Ensure that the cylinder is still within its service life limit.
5. Make records of the cylinder's working pressure and never fill it beyond this.
6. In the records include information such as: manufacturer, cylinder manufacturer's serial number, manufacturing date, cylinder's water capacity, latest visual inspection or hydrostatic test, manufacturing standard number, type of gas.
7. Inspect the mounting brackets and gaskets, the pressure relief device (PRD), valves, piping and hoses.
8. Inspect the cylinder to detect:
 - Scratches, abrasions or cuts (if wrapped).
 - Corrosion
 - Impact damage – dents, gouges.
 - Gas leaks using only a soap solution all over critical joints under pressure or a gas leak detector.
 - Cylinder inspection must be performed away from any fire/flame source.
 - Cracks (be aware of any increase of cracks compared to previous inspection).
 - Fire or heat damage.

IN CASE ANY DOUBT REGARDING YOUR CYLINDER SAFETY ARISES, INFORM EITHER THE WORKSHOP'S TECHNICAL MANAGER IN CHARGE OF INSTALLATION OR LOCAL AUTHORITY OR THE CYLINDERS' MANUFACTURER. REPORT ANY DAMAGE TO YOUR SUPERVISOR OR TECHNICAL MANAGER.

Handling and Storage

HIGH PRESSURE CNG CYLINDERS REQUIRE CAUTIOUS HANDLING. THE SIMPLE RULE OF THE THUMB IS TO USE COMMON SENSE.

✗ **Don't** let the cylinders drop. Lower them gently down to their place of storage.

Be particularly careful when handling an empty Type-4 cylinder as they are extremely fragile.

✗ **Don't** use the pressure relief device (PRD) and/or valve as a handle.

✗ **Don't** drag or roll a cylinder along the ground.

✓ Be careful when using forklifts.

✓ Protect them from the environment (including UV exposure). This is important for all types of cylinders, but it is specially important for wrapped cylinders (Types 2, 3 and 4).

✗ Avoid unstable stacking which can result in cylinders falling.

HANDLE AND STORE HIGH-PRESSURE CYLINDERS WITH CARE.



• Corrosion. ✗ Report any damage to your supervisor. ✓



• Impact damage. ✗ Report any damage to your supervisor. ✓



• Use a shock absorber element to unload high pressure cylinders. ✓



- Don't let the cylinders drop. ❌ Lower them gently down to their place of storage. ✅



- Avoid unstable stacking which can result in cylinders falling. ❌

Mounting cylinders on a vehicle

Cylinders can be mounted in different locations on a vehicle, for example: underneath the vehicle (provided there is adequate clearance), on top of it (provided this does not make the vehicle too high and unstable – for parking garages, underpasses, etc) or in the trunk or bed of a truck.

WHATEVER THE LOCATION, THERE ARE A NUMBER OF IMPORTANT SAFETY CONSIDERATIONS:

1. Use the manufacturer's recommended brackets and shielding.
2. Use approved rubber gaskets between the brackets and cylinder.
3. Locate the cylinder at a place where road and collision damage can be minimized. Provide adequate ground clearance. (Minimum clearance should be adequate for the conditions of average country roads and regulations of local authority)
4. Allow at least 8 in. clearance from exhausting pipes, otherwise a heat shielding must be installed
5. Ensure that the cylinder's PRD vents to the outside of the vehicle.
6. Ensure that the label is visible once the cylinder is installed.
7. If the cylinder is installed in the trunk or bed of a vehicle:
 - Consider cargo placement, specially batteries which can spill acid.
(Corrosive fluids, such as battery acid, are extremely harmful for wrapped cylinders (Type 2 to 4))
 - Protect wrapped cylinders from the sun (Sunlight can degrade the materials used and weaken them.)

SAFETY SHOULD BE THE FIRST CONSIDERATION WHEN DETERMINING WHERE TO MOUNT A HIGH-PRESSURE CYLINDER.



- Locate the cylinder at a place where damage can be minimized. ✓

If the valve is supplied already installed by the cylinder manufacturer verify its pressure relief device (PRD) before installing the cylinder and check if the valve has been previously tested by the cylinders' manufacturer according to manufacturing standards (e.g: ISO 11439, ISO 4705, IRAM 2526, NZS 5454, etc).

If the cylinder has been supplied by the manufacturer without the valve and this is provided by the installation workshop, care should be taken regarding type of valve and thread characteristics and the corresponding homologation by local authority

The valve installation on the cylinder must be made following the manufacturer's instructions and the regulations of the local authority.

IF YOU HAVE ANY DOUBT, CONTACT THE LOCAL AUTHORITY OR CYLINDERS' MANUFACTURER.

Protective Shieldings for cylinders

CYLINDERS SHIELDS ARE ESSENTIAL FOR EQUIPMENT SAFETY.
ACCORDING TO THE LOCATION OF THE CYLINDER, SHIELDS PROTECT THEM FROM:

1. Road debris
2. Exhaust pipes
3. Heat Sunlight
4. Cargo

THERE ARE SEVERAL IMPORTANT SAFETY CONSIDERATIONS REGARDING THE INSTALLATION OF SHIELDS AND THE TYPE OF MATERIAL THEY ARE MADE OF.

- ✗ Shields must **not** contact the cylinder. A shield should be located at least 3/8th of an inch from the cylinder. Metal-to-metal cylinder contact (as could occur with a type 1 or 2) can lead to galvanic corrosion, damaging the cylinder. If a metal shield contacts a fully-wrapped cylinder (Types 2, 3 & 4) the wrapping can be damaged and thus weaken the cylinder.
- ✗ Shields must **not** trap liquids, stones or other debris. For shielding a cylinder mounted underneath a vehicle, a good choice of material is expanded metal.
- ✓ Shields must be designed to avoid the impact of stones and debris as well as consequences of a a salty environment.

PROPER SHIELDS ARE ESSENTIAL TO PROTECT HIGH-PRESSURE CYLINDERS.



- Protect cylinders. ✓

- Use protection. ✓

Maintenance

WHEN PERFORMING MAINTENANCE ON THE VEHICLE OR ON THE MOUNTING ASSEMBLY FOR THE CYLINDER(S), THERE ARE SEVERAL THINGS TO KEEP IN MIND:

- ✗ Do not use welding equipment near cylinders.
- ✗ Do not hit cylinders with tools or other objects.

IF DOING CYLINDER MAINTENANCE:

- ✓ Be cautious when venting high-pressure gas. Always use grounding cables to prevent static electricity from generating sparks.
- ✗ Handle cylinders with care. Do not let cylinders drop or drag.
- ✓ When re-mounting a cylinder to the vehicle, put everything back to its original place
- ✗ Do not vent type 4 cylinders. That operation should be performed by technical personnel only.
- ✓ Be sure to align the brackets, use the gaskets, and torque the mounting bolts according to manufacturer's specifications.

USE COMMON SENSE WHEN MAINTAINING HIGH-PRESSURE CYLINDERS.



- Do not use welding equipment near cylinders. ✗
- Use grounding cables. ✓



- Handle cylinders with care. Do not let cylinders drag. ✗ Use a handcar. ✓

Disposal

The objective of disposal is to render the cylinder obviously unserviceable so that nobody will try to fill it again even though the cylinder may still appear to be serviceable.

THE FOLLOWING STEPS SHOULD BE TAKEN:

1. Purge all gas (It is essential to properly ground the tank before releasing the gas). Purging should be performed in a well vented area away from all sources of spark, such as electrical switches or motors.
2. Once the cylinder is completely vented:
 - Fill it with inert gas such as Nitrogen (N₂) at low pressure to scavenge any CNG remainders.
 - Make sure that the cylinder has no residual pressure before removing the valve once the scavenge is made.
 - Remove valves and fittings.
 - Cut up or drill a large hole in the cylinder to avoid refilling.
 - Scrap the cylinder.

CYLINDERS REQUIRE CAREFUL ATTENTION ALL THROUGHOUT THEIR OPERATIONAL LIFE TIME. CAREFUL DISPOSAL IS ESSENTIAL.





- Cut up or drill a large hole in the cylinder to avoid refilling. ✓

REFERENCES:

The following does not pretend to be a complete bibliography but a basic list of international reference literature:

- ISO 11439 – High Pressure Cylinders for the On-board storage of Natural Gas as a Fuel for automotive vehicles
- ISO WD 19078 – Gas Cylinders Inspection for requalification of high pressure cylinders and their installation
- American Gas Association – ANSI/AGA NGV 2
 - Basic requirements for Compressed Natural Gas Vehicle Fuel Container
- US National Fire protection Association – NFPA 52 – Standard for vehicular CNG Fuel Containers
- Canadian Standards Association – B51 – 95
 - High Pressure Cylinders for the on-board Storage of Natural Gas as a Fuel for Automotive Vehicles
- Compressed Gas Association – GCA C-6.4
 - Methods for External Visual Inspection of Natural Gas Vehicles and their installations
- US Federal Motor Vehicle Safety Standards – FMVSS 304
 - Compressed Natural Gas Fuel Container Integrity
- Gas Research Institute/NGC (US) – Natural Gas Cylinder Care and Handling Handbook
- Instituto Argentino de Racionalización de Materiales IRAM 2526
 - Seamless steel cylinders for permanent gases
- NAG 444: 1991 – Technical specification . Periodical revision of CNG seamless steel cylinders