



# Type 3 COPV Inspection Manual

Version 1.0

**AST** ADVANCED  
STRUCTURAL  
TECHNOLOGIES, INC.

Ladies and Gentlemen:

We appreciate having you as our valued customer.

Please review the **Type 3 COPV Inspection Manual** for general inspection and handling procedure.

Please contact us with any cylinder inspection questions or concerns you may have that may not be covered in the **Type 3 COPV Inspection Manual**.

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## **SCOPE**

This document provides sufficient details for an experienced, certified inspector to guide them to examine, assess, repair and approve AST composite overwrapped pressure vessel (COPV) products for continued service. This document cannot cover all aspects of COPV inspection. In the event an issue is encountered that is not covered in this guideline or the other applicable documents referenced herein, please forward your questions to:

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## **APPLICABLE DOCUMENTS AND SPECIFICATIONS**

***ANSI NGV 2 (latest revision)*** - American National Standard for Compressed Natural Gas Vehicle Fuel Containers

***FMVSS 304 (latest revision)*** - Federal Motor Vehicle Safety Standards for Compressed Natural Gas Containers

***CSA B51 (latest revision)*** - Canadian Standards Association High Pressure Cylinders for On-Board Storage of Natural Gas as a Fuel for Automotive Vehicles

***ANSI/NFPA 52 (latest revision)*** - CNG Vehicular Fuel Systems

***CGA C-2 (latest revision)*** - Compressed Gas Association Recommendation for Disposition of Unserviceable Cylinders

***CGA C-6.4 (latest revision)*** - Methods of Visual Inspection of NGV Containers and Installations

**DEFINITION OF TERMS**

<b>IMPACT:</b>	Damage caused by dropping or an impact to the cylinder by another object
<b>BLUNT IMPACT:</b>	High energy localized impact that does not gouge, cut or perceptibly indent the cylinder. This type of damage may not be easily identified during visual inspection and caution must be used during inspection. Vehicle/cylinder history should be reviewed prior to inspection.
<b>ABRASION:</b>	Friction damage caused by wearing, grinding or rubbing away of the composite material.
<b>CRAZE CRACKING:</b>	Hairline cracking of the composite material.
<b>DELAMINATION:</b>	Separation of the composite layers.
<b>CUT DAMAGE:</b>	Damage caused by a "knife like" object.
<b>COMPOSITE MATERIAL:</b>	Structural material composed of load bearing fibers imbedded in a protective resin matrix.
<b>RESIN:</b>	Plastic material in the composite overwrap that bonds the fiber in place and distributes load
<b>LINER:</b>	Aluminum inner portion of the cylinder that is seamless, leak tight and is the mandrel for the composite material.
<b>PORT (BOSS):</b>	The threaded opening(s) for the valve, PRD or blank plug.
<b>SERVICE PRESSURE:</b>	The settled pressure at 70 F gas temperature in which the cylinder is considered full. This pressure is indicated on the cylinder label.
<b>OVERPRESSURIZATION:</b>	Pressure that exceeds the settled service pressure.
<b>CONDEMNED:</b>	Cylinders that have been over pressurized, damaged beyond repair limits or have reached their end of service life.

## **DAMAGE LEVELS**

- LEVEL 1:** The damage is minor and considered normal "wear and tear". Such damage will have no effect on the safety of the cylinder and its continued use.
- LEVEL 2:** May be abrasion, severed fibers, cuts or gouges that are deeper or longer than those in Level 1 (see Table 1, page 4). Additional rework and inspection is required before placing in service.
- LEVEL 3:** The damage is such that it cannot be reworked and the cylinder is no longer acceptable for continued service.

## **INSPECTION GUIDELINES**

**Preparation:** Surfaces shall be cleaned, shields removed and straps loosened to allow visual inspection. If cylinder(s) need to be vented to allow for internal inspection, the depressurization shall be performed by qualified personnel only. Venting shall be performed in an open area to allow the gas to disperse and to limit the possibility of fire or explosion.

**Service History and owner input:** Prior to performing the inspection the service history shall be reviewed and the owner (if present) shall be questioned about any vehicle/cylinder incidents.

**Visual inspection:** Primary method to detect cylinder/valve/prd damage. Inspector shall be certified by an accredited agency. Inspector shall look for but not be limited to the following: dents, cuts, abrasion, heat or fire damage, discoloration, chemical damage, unraveling or broken fiber and any other suspicious anomaly. Verify the cylinder(s) has not exceeded its life. *Please note: if an observation looks different than normal it is cause for further investigation. CGA pamphlet C-6.4 shall be used a supplement to this guideline.*

**Coin tap test:** Potential impact damage shall be further evaluated by performing a coin tap test. This test can aid the inspector to determine if the impact damage is excessive and requires the cylinder to be removed from service. Using a coin, tap the suspect area and listen to the sound variation. If the tapping changes from a solid to a deadened or hollow sound the cylinder shall be removed from service. The inspector shall contact AST for additional information.

**TABLE 1 - DAMAGE LEVELS**

<b>Damage Levels:</b>	<b>Scratch/Cuts/Abrasion</b>	<b>Rework</b>
<b>Level 1</b>	0.010" max depth	none
	3.00" max. length	none
<b>Level 2</b>	0.011 - 0.036" max depth	inspector rework - see below
	3.01" - 5.00" max length	inspector rework - see below
<b>Level 3</b>	over 0.036" depth	remove from service and condemn
	over 5.00" length	remove from service and condemn

a) Use a two-part room curing epoxy for repairs. Loose fibers may be removed prior to repair as long as defect limits are not exceeded. Verify acceptability of repair(s) prior to returning the cylinder(s) to service.

**Impact damage:**

Impact damage may cause severe structural damage and become a safety hazard. Impact damage may cause damage within the wall and not be readily visible from the surface of the cylinder. Known impact areas should be marked and evaluated using the coin tap test. Those cylinders that exhibit a sound variation shall be removed from service and condemned.

**Chemical damage:**

Chemical damage will alter the composite surface by: blistering, swelling, softening, etching, and discoloring or by removing resin. Minor discoloration or etching of the surface is acceptable as long as the source has been identified and eliminated. Clean the affected area prior to returning to service. All other levels of chemical attack require the cylinder to be removed from service and condemned.

**Gas leakage:**

Cylinders and attachments shall be tested for gas leakage on a periodic basis and any time there is evidence of leakage. If a cylinder is suspected of or exhibiting leakage it shall be immediately removed from service. Contact AST to report the condition and request additional information.

**Fire and heat damage:**

180 F is the maximum operating temperature of our cylinders. Cylinders that see short duration temperatures (less than 5 minutes and not more than 200 F) exceeding this temperature are acceptable for service. Cylinder shall be not installed next to the exhaust system or any other heat generating source. Cylinders that have experienced excessive heat or fire damage are to be removed from service and condemned.

**Non-structural anomalies:**

Resin crazing, resin bubbles, excessive resin, cracking noise when filling and fiber gaps on the dome surfaces are some of the anomalies that are non-structural and will have no effect on the cylinder's integrity. If other anomalies are detected during inspection and are not covered in this or other associated literature, please contact AST for disposition.

**Condemned cylinder destruction:**

Purge the cylinder with an inert gas prior to drilling as residual compressed natural gas may still be in the cylinder and be a potential safety hazard. Drill two or more 1/2" holes through the cylinder sidewall. Dispose of the cylinder adhering to the environmental, safety and health guidelines.

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