

DOT Cylinder testing Certification and Approval requirements

- 1- DOT (PHMSA) expectations
- 2- Title 49 – CFR 172.700 & 180.205 (Training & Laws)
 - 3- Operator responsibilities/calibration criteria
 - 4- Using Title 49, CGA pamphlets and exemption/special permit testing of cylinders
- 5- Application process for DOT once training and compliance has been proven

#1 DOT Expectations

- **The first step to the approval of DOT certification is the application.**

Let us see what is involved.

The application from the PHMSA website

1. Name and Title of Responsible Person:

Facility Manager:

Company Name:

Facility Address:

(Where testing is performed) (Street Address) City, State, Zip Code

Mailing Address: (if different than above) City State Zip Code

Designated U.S. Agent Information: (Name of Company or Individual, U.S. mailing address with Zip Code, email, phone and fax)

2. Business Telephone () Fax () Email:

3. Check One: Headquarters _____ Division _____ Branch _____

If Division or Branch, Headquarters Location

List Other Facilities Operated:

If applicable, current Hydrostatic Retest I.D. Number:

4. Applicant intends doing business as:

Individual _____ Partnership _____ Corporation _____

State of Incorporation: Date of Incorporation:

5. What DOT specification/DOT exemption cylinders will be tested?

6. Estimated number of cylinders to be tested annually under this registration:

7. Will cylinders be tested by water jacket volumetric expansion method?

Yes _____ No _____

a. If no, state other method used:

Direct Expansion _____ Modified Hydrostatic _____

Pressure Recession _____ Other:

8. Describe briefly your equipment and facilities for drying cylinders after test:

9. Testing Equipment Inventory:

(a) Manufacturer _____

(b) Model and serial number _____

(c) Inside diameter and length of test jacket(s) _____

(d) Is a copy of manufacturer's operation manual for the equipment

(h) Pressure Gauge(s): _____

(1) Percent accuracy? _____

(2) Method for certifying test gauge calibration: _____

a. Outside agency _____ b. Second calibration cylinder _____

c. Master gauge _____ d. Deadweight tester _____

e. Other _____

Frequency: _____

Performed by: _____

Increments and range? _____

(2)

(i) Test Burettes:

(1) Number _____

(2) Percent accuracy _____

(3) Range _____ Increments _____

(List for each burette)

(4) Method of leveling _____

(5) At eye level when reading? _____

(j) Calibrated cylinder:

(1) Manufacturer and serial number? _____

(2) Is calibration chart available? _____

(3) Frequency of use? _____

I certify that I am familiar with all applicable Federal regulations relating to functions I will perform, and that all statements made by me on this application are to the best of my knowledge true and correct.

I understand that any duly authorized employee of the US Department of Transportation may enter, examine and inspect any premises, building, room, establishment, and all records relating to the reinspection and retesting of DOT specification and DOT exemption cylinders to determine compliance with applicable regulations.

(Date)

(Signature) (Title)

Requirements needed before certification

- Your company must provide training for cylinder re-qualifier with records
- Test equipment needs to meet DOT standards
- Testing facility must have all documents and calibration certificates required
- Test facility needs to demonstrate proper inspection, safe cylinder handling and drying techniques

#2 Overview of Training & Cylinder laws (DOT) CFR 49

- Section 172.700 – 172.704 covers training requirements
- Section 180.205 – 180.213 covers cylinder testing requirements

Section 172.700 Training

- Hazmat cylinder training to be provided by employer or company
- Information informing the employee about hazards and avoiding accidents

Section 172.702 Training

- Training materials to be supplied by employer or Training company
- Training is proven by testing employee and records retained
- Training shall meet requirements in section 172.704

172.704 Training Requirement

- **General Awareness**
- **Function Specific**
- **Safety Training**
- **Security Awareness (Everyone)**
- **In depth Security plan (large company)**

Section 180.205 Testing

- Visual inspection of cylinders
- Requalification requirements for cylinders
- Specifications for cylinder testing
- Pressure & expansion device regulations

180.209 Cylinder testing

- DOT test pressure specifications including retest interval (5 year or more)
- Criteria for 110% fill and 10 year test
- Visual eddy specification pertaining to criteria for 6351 alloy aluminum (prior to 1990 manufacture date)

180.213 Cylinder marking

- A cylinder requalified in September 2006, and approved by a person who has been issued RIN “A123”, would be marked plainly and permanently into the metal of the cylinder in accordance with location requirements of the cylinder specification or on a metal plate permanently secured to the cylinder in accordance with paragraph (b) of this section. An example of the markings prescribed in this paragraph (d) is as follows:

180.213 continued

A1
9 32 06 X

Where:

“9” is the month of requalification

“A123” is the RIN

“06” is the year of requalification, and

“X” represents the symbols described in paragraphs (f)(2) through (f)(8) of this section.

What is the RIN?

- **R- Rester**
- **I- Identification**
- **N- Number**
- **Each test facility receives this RIN number to stamp on cylinders once that facility has been DOT certified**

DOT/PHMSA ?

- Department of Transportation
- Pipeline and Hazardous Materials Safety Administration
- To Locate Regulations visit website-
www.phmsa.dot.gov/regulations
Under Hazmat Safety click on:
Federal Regulations
Title 49 CFR Parts 100-185

#3 Test procedure/calibrate

- Following the regulations to calibrate each day of testing
- Test equipment must be calibrated within + or – 500 PSI of test pressure at or above 3000 PSI
- Calibration cylinder should operate within + or - 1% expansion as shown on certificate

Test procedure (continued)

- Calibration cylinder is always tested before testing cylinders each day
- Master gauge should be calibrated once per year and used to verify system at least every 6 months
- Verify expansion scale with 50 grams weights to prove scale accuracy
- Record results of calibration each day

Visual Inspection required CFR 49, section 180.205 (f).

- (1) The visual inspection must be performed in accordance with the following CGA Pamphlets: C-6 for steel and nickel cylinders (IBR, see §171.7 of this subchapter); C-6.1 for seamless aluminum cylinders (IBR, see §171.7 of this subchapter); C-6.2 for fiber reinforced composite special permit cylinders (IBR, see §171.7 of this subchapter); C-6.3 for low pressure aluminum cylinders (IBR, see §171.7 of this subchapter); C-8 for DOT 3HT cylinders (IBR, see §171.7 of this subchapter); and C-13 for DOT 8 series cylinders (IBR, see §171.7 of this subchapter).
- (2) For each cylinder with a coating or attachments that would inhibit inspection of the cylinder, the coating or attachments must be removed before performing the visual inspection.
- (3) Each cylinder subject to visual inspection must be approved, rejected, or condemned according to the criteria in the applicable CGA pamphlet.

Visual Inspection

- Use CGA pamphlet for applicable cylinder type (steel, aluminum & composite)
- CGA C-6, Steel
- CGA C-6.1, Aluminum
- CGA C-6.2, Composite
- CGA C-1 Methods of testing
- Other CGA's as applicable

CGA C-6—2001

CGA C-1—2004
METHODS FOR
HYDROSTATIC TESTING
OF COMPRESSED
GAS CYLINDERS
EIGHTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.

STANDARDS FOR
VISUAL INSPECTION
OF STEEL
PRESSURE
CYLINDERS

COMPRESSED GAS
ASSOCIATION, INC.

CGA C-6—2005
STANDARDS FOR VISUAL
INSPECTION OF STEEL
COMPRESSED
GAS CYLINDERS
NINTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.

CGA C-6.2—2005
GUIDELINES FOR
VISUAL INSPECTION AND
REQUALIFICATION OF
FIBER REINFORCED
HIGH PRESSURE
CYLINDERS
FIFTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.

CGA C-5—2005
WALL STRESS
REQUALIFICATION CRITERIA
FOR HIGH PRESSURE
SEAMLESS STEEL CYLINDERS
EIGHTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.

TRANSFILLING OF
LIQUID OXYGEN
TO BE USED
FOR RESPIRATION

COMPRESSED GAS
ASSOCIATION, INC.

CGA C-6.3—1999
GUIDELINES FOR VISUAL
INSPECTION AND
REQUALIFICATION OF
LOW PRESSURE
ALUMINUM COMPRESSED
GAS CYLINDERS
SECOND EDITION
REVISED 2001

COMPRESSED GAS
ASSOCIATION, INC.



CGA C-8—2005
STANDARD FOR
REQUALIFICATION OF
DOT-3HT, CTC-3HT, AND
TC-3HTM SEAMLESS
STEEL CYLINDERS
SEVENTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.



CGA C-6.1—2002
STANDARDS FOR
VISUAL INSPECTION
OF HIGH PRESSURE
ALUMINUM COMPRESSED
GAS CYLINDERS
FOURTH EDITION

COMPRESSED GAS
ASSOCIATION, INC.



Organize your cylinders before testing



CGA C-6.1 High pressure Aluminum

CGA C-6.1—2006

STANDARDS FOR
VISUAL INSPECTION
OF HIGH PRESSURE
ALUMINUM COMPRESSED
GAS CYLINDERS

FIFTH EDITION



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1 Introduction

The U.S. Department of Transportation (DOT) and Transport Canada (TC) require that cylinders used for the transportation of compressed gases be requalified periodically by visual inspection followed by hydrostatic testing if they are to remain in service (CGA C-1, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*) [1].¹ However, a cylinder that was charged or filled before the requalification became due may remain in service until it has been emptied. U.S. regulations in Part 180 Subpart C of Title 49 of the *Code of Federal Regulation* (49 CFR) and equivalent Canadian regulations in Section 24 of CSA B339, *Cylinders, Spheres, and Tubes for the Transportation of Dangerous Goods*, identify the inspection and hydrostatic testing requirements for most cylinders [2, 3]. Cylinders fabricated in accordance with DOT, TC, or the former Canadian Transport Commission (CTC) permits or exemptions/special permits shall be requalified as specified in the exemption/special permit or permit. These documents can be obtained from DOT, TC, or the manufacturer.

The approval of the 3AL specification in 49 CFR 178.46 (July 2, 1982) consolidated the majority of the exemptions and special permits for aluminum cylinders into one manufacturing regulation [2]. The Canadian Specification TC-3ALM also consolidates specification CTC-3AL and permits for aluminum cylinders into their regulations [3, 4].

Both DOT and TC have provisions in their regulations for introduction of new cylinder designs, materials, and fabrication techniques. Aluminum cylinders, before implementation of CTC/DOT specification 3AL and TC specification 3ALM, had been manufactured under special permits and/or exemptions E 6498, E 7042, E 8107, E 8364, E 8422, or CTC SP 890 or SP 922. Permit or exemption numbers are stamped on the shoulder of the cylinder. These cylinders may be continued in use in Canada. In the United States, these cylinders with the exception of CTC SP 922 may be continued in use but shall be remarked in compliance with 49 CFR 173.23 at the time of the first retest following July 2, 1982 [1]. Care should be exercised that other exemption number cylinders should not be remarked.

In the United States, DOT exemptions E 6498, E 7042, E 8107, E 8364, and E 8422 were previously issued that identified the manufacturing, usage, and inspection requirements of these cylinders. These exemptions have been superseded by DOT specification 3AL, and copies of the exemptions are no longer required. Cylinders marked with S.P. preceding the previously noted exemption numbers, designating special permits, also are covered by the DOT specification 3AL. Some cylinders with the previously noted markings might be preceded by CTC indicating compliance with the CTC requirements, for example, CTC/DOT E 6498-1800. Exemption and special permit cylinders shall be remarked at the time of the first hydrostatic testing occurring since July 2, 1982. Requirements for remarking can be found in 49 CFR 173.23(c), which states that after July 2, 1982, a seamless aluminum cylinder manufactured in conformance with and for use under DOT exemption E 6498, E 7042, E 8107, E 8364, or E 8422 may be continued in use if marked before or at the time of the next retest with the specification identification 3AL immediately above the exemption number, or if the DOT mark (i.e., DOT-3AL 1800) is added in proximity to the exemption marking [2]. See Figures 1 and 2 for examples of exemption marked cylinders.

Experience in the inspection of cylinders is an important factor in determining the acceptability of a given cylinder for continued service. Users lacking this experience or having questionable cylinders should consult the manufacturer or other knowledgeable sources.

- CGA C-6, *Standards for Visual Inspection of Steel Compressed Gas Cylinders* [6];
- CGA C-6.2, *Guidelines for Visual Inspection and Requalification of Composite High Pressure Cylinders* [7]; and
- CGA C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders* [8].

Since there has been little or no experience with aluminum cylinders in the pressure range from 900 psig to 1800 psig (6200 kPa to 12 410 kPa), this publication is directed at cylinders with a service pressure of 1800 psig (12 410 kPa) or greater. CGA C-6.3 is available for cylinders with lower service pressure [8].



Note—It is recommended that existing exemption markings remain intact.

Figure 1—Exemption marked cylinder



Internal & External visual inspection required before Hydrostatic test

VISUAL INSPECTION, CFR TITLE 49, SECTION 180.205

(f) *Visual inspection.* Except as otherwise provided in this subpart, each time a cylinder is pressure tested, it must be given an internal and external visual inspection.

(1) The visual inspection must be performed in accordance with the following CGA Pamphlets: C-6 for steel and nickel cylinders (IBR, see §171.7 of this subchapter); C-6.1 for seamless aluminum cylinders (IBR, see §171.7 of this subchapter); C-6.2 for fiber reinforced composite special permit cylinders (IBR, see §171.7 of this subchapter); C-6.3 for low pressure aluminum cylinders (IBR, see §171.7 of this subchapter); C-8 for DOT 3HT cylinders (IBR, see §171.7 of this subchapter); and C-13 for DOT 8 series cylinders (IBR, see §171.7 of this subchapter).

(2) For each cylinder with a coating or attachments that would inhibit inspection of the cylinder, the coating or attachments must be removed before performing the visual inspection.

(3) Each cylinder subject to visual inspection must be approved, rejected, or condemned according to the criteria in the applicable CGA pamphlet.

(4) In addition to other requirements prescribed in this paragraph (f), each specification cylinder manufactured of aluminum alloy 6351-T6 and used in self-contained underwater breathing apparatus (SCUBA), self-contained breathing apparatus (SCBA), or oxygen service must be inspected for sustained load cracking in accordance with Appendix C of this part at the first scheduled 5-year requalification period after January 1, 2007, and every five years thereafter.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Bow

Cylinder manufactured with a curve in it like a banana shape.

3.2 Bulge

Visible swelling of the container.

3.3 Condemned

No longer fit for service; the cylinder is required to be removed from service.

3.4 Corrosion

Loss of metal thickness by some corrosive media and is usually apparent from a general loss of wall thickness or pitting.

NOTE—Corrosion of aluminum appears as a roughened and discolored area with a white deposit sometimes associated with the corrosion.

3.4.1 General corrosion

Somewhat uniform loss of metal in a relatively large area.

NOTE—General corrosion might be difficult to see unless it is very pronounced.

3.4.2 Line corrosion

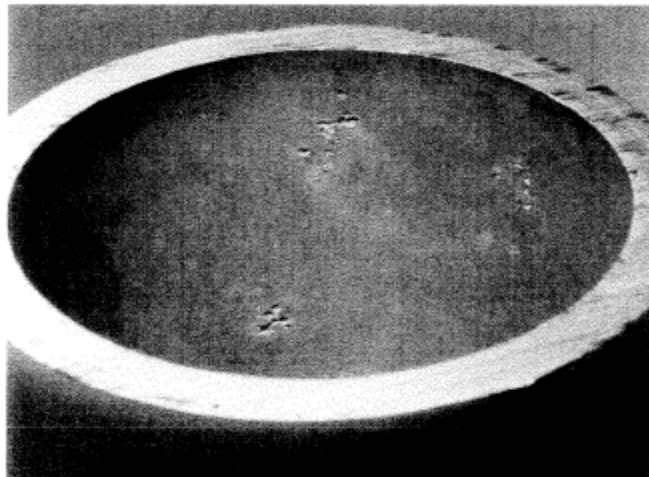
Series of pits closely spaced as to appear to be in a line.

NOTE—This condition is considered more serious than isolated pitting.

3.4.3 Pitting corrosion

Most common form of attack on aluminum; pits can be small and localized or larger and scattered.

NOTE—Small, isolated pits have very little effect on the strength of the cylinder, but the degree of pitting and concentration of the pits determine if the cylinder can be continued in service (see Figure 3).



3.5 Crack

Split or rift in the metal.

3.6 Cuts, digs, and gouges

Defects that are indicated by removed or upset metal.

NOTE—They are associated with some loss of wall thickness and are usually caused by a sharp object (see Figure 4).

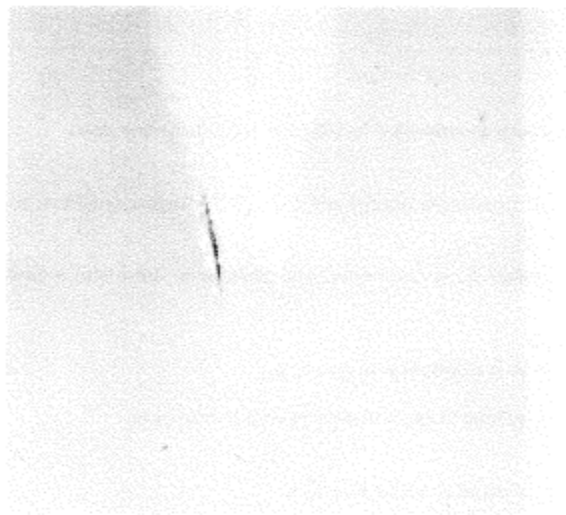


Figure 4—Gouged cylinder

3.7 Dent

Deformations of the cylinder caused by a blunt object so that the metal is relocated and the wall thickness is not reduced.

NOTE—See Figure 5.



3.8 Fold

Sharp visual groove along the length of the cylinder usually in the crown area.

NOTE—See Figure 6.

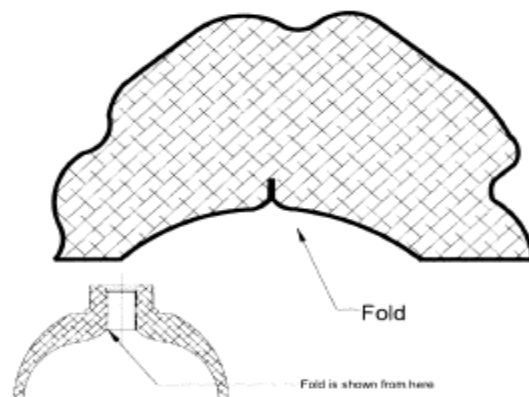


Figure 6—Fold

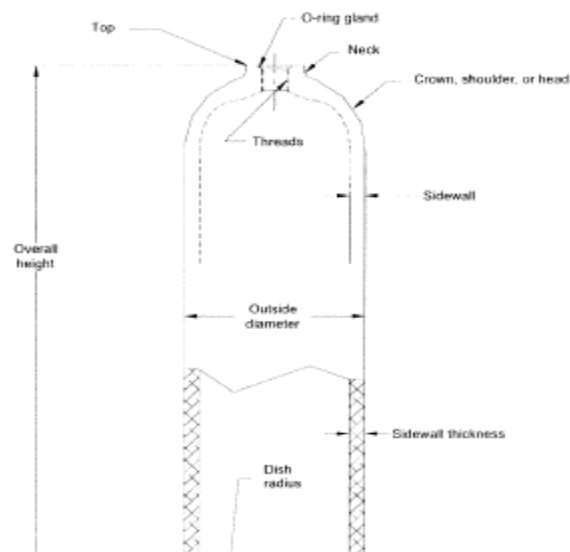
3.9 High pressure

1800 psig (12 410 kPa) or greater.

3.10 High pressure aluminum cylinders

Aluminum cylinders manufactured in accordance with DOT-3AL, CTC-3AL, and TC-3ALM specifications.

NOTE—See Figure 7.



3.11 Minimum design wall thickness

Minimum wall thickness as established by the cylinder manufacturer.

NOTE—Consult the manufacturer for specific minimum design wall thickness.

3.12 Valley

Shallow and smooth elongated depression usually found in the crown area.

NOTE—Compare this to “fold” (see Figure 8).

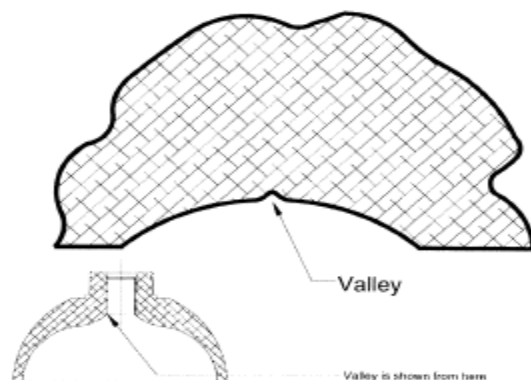


Figure 8—Valley

4 Preparation for inspection and hydrostatic testing

4.1 Inspection equipment

4.1.1 Depth gauges, scales, and straightedges

Exterior corrosion, denting, bulging, gouges, or digs normally are measured by simple direct measurement with straightedges and depth gauges or scales. In brief, a rigid straightedge of sufficient length is placed over the defect and a scale is used to measure the distance from the bottom of the straightedge to the bottom of the defect. Also available are commercial depth gauges that are especially suitable for measuring the depth of small cuts or pits. It is important when measuring such defects to use a scale that spans the entire affected area. When measuring cuts, the upset metal should be removed or compensated for so that only actual depth of metal removed from the cylinder wall is measured.

4.1.2 Inspection light

One of the most useful tools for the internal inspection of cylinders is a high intensity light probe (see Figure 9).

4.1.3 Inspection mirror

A 1/2-in (13 mm) diameter 2X dental mirror is commonly used to aid a visual inspection of internal neck and crown surfaces (see Figure 9).

4.1.4 Penetrant inspection

Dye penetrant materials are available that show surface faults not readily visible to the unaided eye.

4.1.5 Other devices

Other inspection methods such as ultrasonic and eddy current are available and can be used to detect subsurface faults, neck defects, and to measure thickness (see Appendix A).

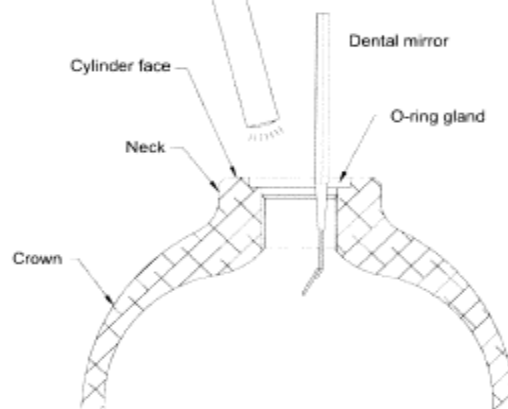


Figure 9—Light and mirror used to inspect threads and crown

4.2 Venting

CAUTION: Venting unknown gases from cylinders by improper methods may result in injury or death.

If there is any question about the safe venting of a cylinder, the cylinder owner should be contacted to make safe disposition of the cylinder and contents.

4.3 Aluminum cylinder identification

Aluminum cylinders can be identified by DOT, TC, or CTC markings found on the shoulder of the cylinder. Some of the exemption and special permit numbers of high pressure aluminum cylinders are listed in Section 1. Additional information can be obtained from the DOT, TC, or the cylinder manufacturer.

4.4 Cleaning

Judgment is required to determine the extent of cleaning required and whether removal of paint is necessary. Remove all attachments that could conceal corrosion or other defects before inspection. If internal/external cleaning is performed in conjunction with periodic hydrostatic retest, cleaning should be accomplished before hydrostatic testing.

4.4.1 External cleaning

Paint stripping should be performed only with products recommended for aluminum. *Do not use* solutions of strong alkali (caustic), acid, or heat sources such as furnaces or blow torches.

Abrasive shot blasting or cleaning methods that remove or might remove cylinder material shall not be used. Recommendations from manufacturers or equipment suppliers should be followed. Threads should be protected and all abrasive materials removed from the cylinder.

4.4.2 Internal cleaning

Tumble cleaning, if required, should be with a watery slurry of aluminum oxide pellets, ceramic chips, or other inert media. After tumbling, a thorough flushing is required to remove loose materials and cleaning media, followed by thorough drying. *Do not use* solutions of strong alkali (caustic) or acid for internal cleaning (see 4.4.1).

Inspection tools include - Light, mirrors, depth gauge and depth reference gauge





4.4.3 Other

Other cleaning methods (e.g., media blasting, vapor honing, etc.) may be used for cleaning. Methods, procedures, or chemical cleaning that removes or might remove cylinder material shall comply with the requirements in 5.3.3. Recommendations from cylinder manufacturers should be followed. Threads shall be protected during cleaning processes. The cleaned cylinder shall be free of all media, by-products, and materials (see 4.4.2).

5 Inspection criteria for aluminum high pressure cylinders

5.1 Markings

Specification-required cylinder markings shall be legible and complete.

5.1.1 Stampings prohibited

The plus (+) stamp mark is *not allowed* on aluminum cylinders. The plus stamp signifies the qualification of a steel cylinder for filling to a settled pressure 10% in excess of the stamped service pressure. With aluminum cylinders, the full settled pressure shall not exceed the service pressure limit stamped on the cylinder.

5.1.2 Retest dates

The regulations of 49 CFR 180.213 require that the requalifier's identification number (RIN) be stamped between the month and year of retest [1]. The current practice is to place RIN marks near the original hydrostatic test date. Canadian *Transportation of Dangerous Goods Regulations* also require that the retester's registered mark be stamped on the cylinder as prescribed in Section 24.6.3 of CSA B-339 [3].

5.2 Corrosion limits

It is not practical to identify corrosion limits for all types, designs, and sizes of cylinders and include them in a standard. The following general descriptions provide guidelines for the acceptability of aluminum cylinders for service. The allowable corrosion depths specified are for high pressure cylinders with a wall thickness of 3/16 in (0.187 in; 4.762 mm) or greater.

5.2.1 General corrosion limits

If the wall thickness is unknown, the allowable corrosion depth is 1/32 in (0.031 in; 0.787 mm). If the wall thickness is known, the maximum allowable corrosion depth is 15% of the minimum design wall thickness. The area of corrosion shall not extend over 25% of the external or internal surface area.

5.2.2 Isolated pit limits

If the wall thickness is unknown, the allowable depth of pitting is 1/16 in (0.062 in; 1.575 mm). If the wall thickness is known, the allowable depth of pitting is 30% of the minimum design wall thickness.

As an example, for a known wall thickness of 0.345 in (8.763 mm) the allowable pit depth is 0.345 in x .30 = 0.103 in (2.616 mm). The pitting shown in Figure 3 measured 0.086 in (2.184 mm). This is more than the allowable pit depth for a cylinder with an unknown design wall thickness, but is less than the allowable pit depth for a cylinder with a known design wall thickness of 0.345 in (8.763 mm).

5.2.3 Line corrosion

If the wall thickness is unknown, the allowable line corrosion depth is 1/32 in (0.031 in; 0.787 mm). If the wall thickness is known, the allowable line corrosion depth is 15% of the minimum design wall thickness. The length of the line corrosion shall be less than 6 in (152.4 mm).

5.3 Cuts, digs, and gouges

5.3.1 Measurement

Cuts, digs, and gouges may be measured with suitable depth gauges or with a pipe pit gauge. Any upset metal shall be smoothed to allow true measurements without causing further damage to the cylinder.

5.3.2 Limits

If the wall thickness is unknown, the allowable cut, dig, or gouge is 1/32 in (0.031 in [0.787 mm]). If the wall thickness is known, the allowable cut, dig, or gouge is 15% of the minimum design wall thickness. The length of the cut, dig, or gouge shall be less than 6 in (152.4 mm). Condemn any cylinder with a cut, dig, or gouge 6 inches or more in length.

As an example, for a gouged cylinder of known design wall thickness of 0.380 in (9.652 mm), the allowable gouge depth is $0.380 \times 0.15 = 0.057$ in (1.447 mm). The gouge in the cylinder in Figure 4 measured 0.060 in (1.524 mm). This is more than the allowable gouge depth (0.031 in [0.787 mm]) for a cylinder with an unknown design wall thickness, and also more than the allowable gouge depth (0.057 in [1.447 mm]) for a cylinder with a known design wall thickness of 0.380 in (9.652 mm).

5.3.3 Wall loss

Most surface (internal or external) treatment processes have the potential to remove material from the sidewall of the cylinder. Therefore, it is essential that these processes are performed before the final requalification test. The wall thickness shall be determined after any metal removal process, regardless of the quantity of material loss that has occurred. Any reconditioning process used to clean, alter, or improve the finish of a cylinder after it has entered the market shall not reduce the wall thickness below 85% of the minimum design wall thickness in any isolated locations as described in 5.2 through 5.2.3 and 5.3.2. Cylinders with greater wall loss than this shall be condemned.

If the cylindrical portion is to be reconditioned beyond isolated locations described in 5.2 through 5.2.3 and 5.3.2, then the cylinder wall thickness may not be reduced below the minimum design wall thickness. Cylinders with greater wall loss than this shall be condemned. The criteria for isolated defects subsequent to such reconditioning remain applicable.

Processes that can produce loss of wall include:

- cleaning internal or external surfaces (see 4.4);
- cutting, grinding, trimming, or shaving metal from the internal or external surfaces; and
- application of chemicals that dissolve or react with aluminum.

5.4 Dents

In general, dents that do not reduce the wall thickness can be tolerated. However, current practice is to accept dents up to 1/16-in (0.062-in [1.575-mm]) in depth when the major diameter of the dent is 2 in (50.8 mm) or greater (see Figure 5). Cylinders with one or more dents that are smaller than 2 in (50.8 mm) in diameter shall be condemned.

5.5 Leaks and holes

5.5.1 Detection

Leaks and holes can be found or suspected in a cylinder by different means. A close visual inspection of the exterior and interior surfaces is strongly recommended. Use of a dye or penetrant can be helpful (see 4.1.4). A cylinder that is leaking or that might have a hole could rupture if it is pressurized, so checking for leaks with a soap solution or immersion in water is not recommended. Holes can be concealed with construction material and then painted, or attempts at plugging holes might be seen. If the cylinder owner has identified a time when the cylinder lost pressure for unknown reasons, a leak or hole might be suspected.

NOTE—Hydrostatic testing might identify a cylinder with a leak. Do not pressurize a cylinder that is suspected of having a leak or hole outside a test jacket capable of safely containing or relieving the pressure released from a catastrophic failure.

5.5.2 Limits

Cylinders with leaks through the metal shall be condemned. Cylinders found with holes (plugged or not plugged) shall be condemned. Repair of aluminum cylinders with leaks or holes is not allowed.

5.6 Bulges

Cylinders are manufactured with a reasonably symmetrical shape. Those with definite visible bulges shall be condemned.

5.7 Fire and thermal damage

5.7.1 Fire damage

Aluminum cylinders subjected to the action of fire (e.g., in a fire) shall be condemned. In 49 CFR, DOT requires that aluminum cylinders be condemned that have been or show signs of overheating (the cylinder material has exceeded 350 °F [176.7 °C]).

5.7.2 Thermal damage

Aluminum cylinders can be permanently damaged by exposure to elevated temperatures. Cylinders heated to metal temperatures in excess of 350 °F (176.7 °C) shall be condemned (see Appendix C). If there is a doubt about the temperature a cylinder might have reached, the cylinder shall successfully pass the hydrostatic retest (see 5.7.4).

Processes that can produce metal temperatures in excess of 350 °F (176.7 °C) include:

- paint baking, curing, or drying;
- oven drying;
- vinyl coating;
- heat stripping of paint; and
- application of heat to assist the mixing of gases in cylinders containing gas mixtures.

Follow the cylinder manufacturer's recommendations regarding the painting or refurbishing of cylinders.

5.7.3 Arc burns

Cylinders with arc burns shall be condemned.

5.7.4 Inspection for fire and thermal damage

Direct and indirect evidence of a cylinder being subjected to the action of fire or evidence of exposure to elevated temperatures includes:

- charring or blistering of the paint or other protective coating;
- melting, cratering, or scarfing of the metal;
- adding of welding metal, weld marks, and arc burns;
- distorting (e.g., bulging) of the cylinder;
- melting, scorching, or deformation of the valve handwheel or valve protector;
- charring, blistering, distortion, or discoloration of labels or attachments;
- activating a pressure release device (e.g., a ruptured burst disk or melted fuse plug(s)); and
- increases in total or permanent expansion from hydrostatic testing.

CAUTION: Do not conceal fire or thermal damage by painting or other means.



5.8 Neck defects

Cylinder necks shall be examined for cracks, folds, and other flaws.

5.8.1 Neck cracks

All aluminum cylinders shall be internally inspected for cracks in the neck region. The inspection shall be visual but may be confirmed using an electronic nondestructive testing device (see Appendix A). Cylinders with cracks shall be condemned. Repair of neck cracks is not allowed (see Figure 10).

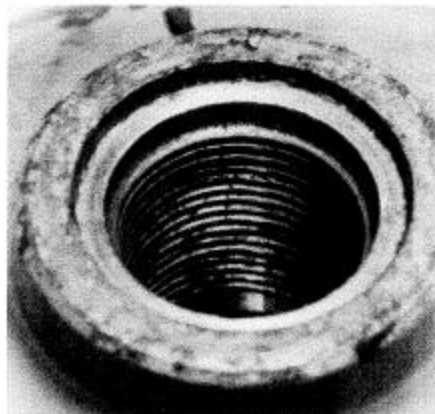


Figure 10—Neck crack

A neck with a tool stop mark is to be distinguished from a neck crack. Cylinders with a tool stop mark are acceptable for use (see Figure 11).

Aluminum cylinders manufactured from 6351 alloy might exhibit sustained load cracking (SLC) growing over several years of use. Such cylinders should be given diligent and proper inspections at the time of requalification (see Appendix B).

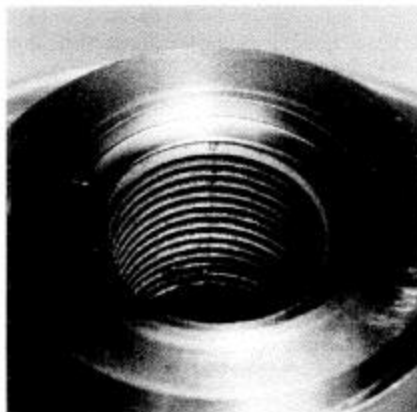


Figure 11—Tool stop mark

5.8.2 Folds

Folds found in the crown region that extend into the base of the neck can appear to be a crack, by the internal visual inspection of the neck. Condemn all cylinders with folds that enter into more than one continuous full neck thread (see Figure 6).

5.8.3 Valleys

Cylinders with one or more valleys are acceptable for use provided the valley(s) does not enter into the minimum number of required threads (see 5.9 and Figure 8).

5.9 Threads and valving

Cylinder neck threads should be examined whenever the valve is removed from the cylinder. Cylinders have a specified number of full threads of proper form as required in applicable thread standards. Cylinders shall be rejected if the required numbers of effective threads are materially reduced so that a gas-tight seal cannot be obtained by reasonable valving methods. Thread defects include threads that are galled, worn, corroded, broken, cracked, nicked, and "double threaded" (from forcing an incorrect valve into the threads).

5.9.1 O-ring gland

Many aluminum cylinders have an O-ring gland and straight threads. Both the O-ring and lubricant, if used, should be compatible with the lading. Where the cylinder is part of a certified assembly such as in the self-contained breathing apparatus (SCBA) unit used by firefighters and emergency responders the only O-ring used shall be the O-ring type originally certified with the assembly. In the case of cylinders used in SCBA service, any replacement O-ring shall be obtained from the SCBA unit manufacturer. O-rings should be clean and smooth. Replace damaged O-rings.

5.9.2 Valving/devalving

When valving, note the thread configuration (straight versus tapered). In some cases, a valve with tapered threads (3/4-in NGT) will fit into a cylinder with straight threads (3/4-in NGS) and damage to the cylinder or valve could result. A thread gauge can be used to verify the size and type of threads.

The installation of valves shall follow CGA V-11, *General Guidelines for the Installation of Valves into High Pressure Aluminum Alloy Cylinders* [9]. The devalving or valve removal shall follow the guidelines in CGA P-38, *Guidelines for Devalving Cylinders* [10].

5.9.3 Gas service

DOT specifies the use of specific thread types for certain gas service. Refer to 49 CFR 173.302(b)(2) [2]. Refer to CSA B340 for equivalent Canadian requirements [4].

5.10 Bow

A cylinder with a bow is an acceptable condition.

6 Condemning a cylinder

When visual inspection detects a defect requiring that the cylinder be condemned (see Section 5), the cylinder shall be removed from service. In addition, the cylinder shall have a series of Xs stamped through the specification number and marked service pressure or the word CONDEMNED stamped on the shoulder, top head, or neck using a steel stamp. Alternately the cylinder may be rendered unable to contain gas under pressure with permission of the cylinder owner. When a cylinder has been condemned, the cylinder owner shall be notified in writing that the cylinder is condemned and may not be filled with hazardous material for transportation in commerce where use of a specification packaging is required.



- Poor manufacturing, folds & cracks



CGA incorporated by law 171.7

Compressed Gas Association, Inc., 4221 Walney Road, 5th Floor,
Chantilly, Virginia 20151:

CGA Pamphlet C-3, Standards for Welding on Thin-Walled Steel Cylinders, 1994	178.47; 178.50; 178.51; 178.53; 178.55; 178.56; 178.57; 178.58; 178.59; 178.60; 178.61; 178.65; 178.68; 180.211.
CGA C-5, Cylinder Service Life—Seamless Steel High Pressure Cylinders, 1991 (reaffirmed 1995)	173.302a.
CGA Pamphlet C-6, Standards for Visual Inspection of Steel Compressed Gas Cylinders, 1993	173.3, 173.198, 180.205, 180.209, 180.211, 180.411, 180.519.
CGA Pamphlet C-6.1, Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders, 2002, Fourth Edition	180.205; 180.209
CGA Pamphlet C-6.2, Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders, 1996, Third Edition	180.205.
CGA Pamphlet C-6.3, Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders, 1991	180.205; 180.209.
CGA C-7, Guide to Preparation of Precautionary Labeling and Marking of Compressed Gas Containers, Appendix A, issued 2004 (8th Edition)	172.400a.
CGA Pamphlet C-8, Standard for Requalification of DOT-3HT Cylinder Design, 1985	180.205; 180.209.
CGA Pamphlet C-11, Recommended Practices for Inspection of Compressed Gas Cylinders at Time of Manufacture, 2001, Third Edition	178.35.
CGA Pamphlet C-12, Qualification Procedure for Acetylene Cylinder Design, 1994	173.301; 173.303; 178.59; 178.60.
CGA Pamphlet C-13, Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders, 2000, Fourth Edition	173.303; 180.205; 180.209.
CGA Pamphlet C-14, Procedures for Fire Testing of DOT Cylinder Pressure Relief Device Systems, 1979	173.301; 173.323.
CGA Pamphlet G-2.2 Tentative Standard Method for Determining Minimum of 0.2% Water in Anhydrous Ammonia, 1985	173.315.

IBR? What is this?

- Incorporated By Reference
- The CGA pamphlets are part of the CFR 49 when referenced by this incorporation.
- Located at 171.7 (references)

After Visual Inspection comes the Hydrostatic water jacket test

- After visual inspection perform hydrostatic test
- Fill cylinders with water and allow time to stabilize
- Perform test, record results of test
- Dry cylinder and inspect cylinder for dryness

CFR 49 section 180.209 (m), (6351 regulation)

- Requalification and Inspection of DOT-??? Cylinders Made of Aluminum Alloy 6351-T6
- **Requalification requirement Examination procedure 1 Sustained Load Cracking**
Condemnation Criteria 2 Requalification period (years) Eddy current examination combined with visual inspection Eddy current—In accordance with Appendix C of this part
Visual inspection—In accordance with CGA Pamphlet C-6.1 (IBR; see §171.7 of this subchapter)
Any crack in the neck or shoulder of 2 thread lengths or more

CGA C-1 – Methods of testing

5 Water jacket method

5.1 Scope

The water jacket method is the preferred method for testing cylinders in the compressed gas industry. This method consists of suspending or supporting a cylinder filled with water inside a container filled with water (water jacket). See Figure 1 for a typical schematic diagram of a water jacket test apparatus. The cylinder shall be free to expand in all directions. The water jacket shall be sealed, and the expansion indicating device (EID) shall be zeroed (see Figure 2). The cylinder is then pressurized to the appropriate test pressure. As the cylinder expands under pressure, the surrounding water in the water jacket is displaced, and forced out of the water jacket into the EID. This displaced volume of water represents the total expansion of the cylinder (see Figure 3). The cylinder shall maintain test pressure for at least 30 seconds, and as much longer as may be necessary to ensure its complete expansion, as evidenced by the stabilization of the pressure and expansion readings. The total expansion and test pressure are then recorded. The pressure is then released, and as the cylinder contracts, the displaced water returns to the water jacket from the EID. The permanent expansion is then recorded.

CGA pamphlets are incorporated into CFR 49 (ref. IBR- Incorporated By Reference)

- CGA Pamphlet C-3, Standards for Welding on Thin-Walled Steel Cylinders, 1994178.47; 178.50; 178.51; 178.53; 178.55; 178.56; 178.57; 178.58; 178.59; 178.60; 178.61; 178.65; 178.68; 180.211.CGA C-5, Cylinder Service Life—Seamless Steel High Pressure Cylinders, 1991 (reaffirmed 1995)173.302a.CGA Pamphlet C-6, Standards for Visual Inspection of Steel Compressed Gas Cylinders, 1993173.3, 173.198, 180.205, 180.209, 180.211, 180.411, 180.519.CGA Pamphlet C-6.1, Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders, 2002, Fourth Edition180.205; 180.209CGA Pamphlet C-6.2, Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders, 1996, Third Edition180.205.CGA Pamphlet C-6.3, Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders, 1991180.205; 180.209.CGA C-7, Guide to Preparation of Precautionary Labeling and Marking of Compressed Gas Containers, Appendix A, issued 2004 (8th Edition)172.400a.CGA Pamphlet C-8, Standard for Requalification of DOT-3HT Cylinder Design, 1985180.205; 180.209.CGA Pamphlet C-11, Recommended Practices for Inspection of Compressed Gas Cylinders at Time of Manufacture, 2001, Third Edition178.35.CGA Pamphlet C-12, Qualification Procedure for Acetylene Cylinder Design, 1994173.301; 173.303; 178.59; 178.60.CGA Pamphlet C-13, Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders, 2000, Fourth Edition173.303; 180.205; 180.209.

Pre 1990 cylinders made from 6351 aluminum.

- (4) In addition to other requirements prescribed in this paragraph (f), each specification cylinder manufactured of aluminum alloy 6351–T6 and used in self-contained underwater breathing apparatus (SCUBA), self-contained breathing apparatus (SCBA), or oxygen service must be inspected for sustained load cracking in accordance with Appendix C of this part at the first scheduled 5-year requalification period after January 1, 2007, and every five years thereafter.

Follow CFR title 49, section 180.205 part (g)

- (g) *Pressure test.* (1) Unless otherwise provided, each cylinder required to be retested under this subpart must be retested by means suitable for measuring the expansion of the cylinder under pressure. Bands and other removable attachments must be loosened or removed before testing so that the cylinder is free to expand in all directions.
- (2) The pressure indicating device of the testing apparatus must permit reading of pressures to within 1% of the minimum prescribed test pressure of each cylinder tested, except that for an analog device, interpolation to 1/2 of the marked gauge divisions is acceptable. The expansion-indicating device of the testing apparatus must also permit incremental reading of the cylinder expansion to 1% of the total expansion of each cylinder tested or 0.1 cc, whichever is larger. Midpoint visual interpolation is permitted.
- (3) Each day before retesting, the retester shall confirm, by using a calibrated cylinder or other method authorized in writing by the Associate Administrator, that:
 - (i) The pressure-indicating device, as part of the retest apparatus, is accurate within $\pm 1.0\%$ of the prescribed test pressure of any cylinder tested that day. The pressure indicating device, itself, must be certified as having an accuracy of $\pm 0.5\%$, or better, of its full range, and must permit readings of pressure from 90%-110% of the minimum prescribed test pressure of the cylinder to be tested. The accuracy of the pressure indicating device within the test system can be demonstrated at any point within 500 psig of the actual test pressure for test pressures at or above 3000 psig, or 10% of the actual test pressure for test pressures below 3000 psig.

CFR 49, section 180.205 (continued)

- (ii) The expansion-indicating device, as part of the retest apparatus, gives a stable reading of expansion and is accurate to $\pm 1.0\%$ of the total expansion of any cylinder tested. (ii) The expansion-indicating device, as part of the retest apparatus, gives a stable reading of expansion and is accurate to 0.1 cc, whichever is larger. The expansion-indicating device itself must have an accuracy of $\pm 0.5\%$, or better, of its full scale.
- (4) The test equipment must be verified to be accurate within $\pm 1.0\%$ of the calibrated cylinder's pressure and corresponding expansion values. This may be accomplished by bringing the pressure to a value shown on the calibration certificate for the calibrated cylinder used and verifying that the resulting total expansion is within $\pm 1.0\%$ of the total expansion shown on the calibration certificate. Alternatively, calibration may be demonstrated by bringing the total expansion to a known value on the calibration certificate for the calibrated cylinder used and verifying that the resulting pressure is within $\pm 1.0\%$ of the pressure shown on the calibration certificate. The calibrated cylinder must show no permanent expansion. The retester must demonstrate calibration in conformance with this paragraph (g) to an authorized inspector on any day that it retests cylinders. A retester must maintain calibrated cylinder certificates in conformance with §180.215(b)(4).
- (5) Minimum test pressure must be maintained for at least 30 seconds, and as long as necessary for complete expansion of the cylinder. A system check may be performed at or below 90% of test pressure prior to the retest. In the case of a malfunction of the test equipment, the test may be repeated at a pressure increased by 10% or 100 psig, whichever is less. This paragraph (g) does not authorize retest of a cylinder otherwise required to be condemned under paragraph (i) of this section.

CFR 49 section 180.209

- **Table 1—Requalification of Cylinders**

1 Specification under which cylinder was made	2 Requalification period (years)
DOT 33000 psig	5
DOT 3A, 3AA	5/3 times service pressure, except noncorrosive service (see §180.209(g))
5, 10, or 12	(see §180.209(b), (f), (h), and (j))
DOT 3AL	5/3 times service pressure 5 or 12 (see §180.209(j) and §180.209(m))
3).DOT 3AX, 3AAX	5/3 times service pressure
53B, 3BN	2 times service pressure (see §180.209(g))
5 or 10	(see §180.209(f))
3E	Test not required
3HT	5/3 times service pressure
3	(see §§180.209(k) and 180.213(c))
3T	5/3 times service pressure
54AA	4802 times service pressure (see §180.209(g))
5 or 10	(see §180.209(h))
4B, 4BA, 4BW, 4B–240E	T2 times service pressure, except non-corrosive service (see §180.209(g))
5, 10, or 12	(see §180.209(e), (f), and (j))
4D, 4DA, 4DS	2 times service
5DOT 4E	2 times service pressure, except non-corrosive (see §180.209(g))
54L	Test not required
8, 8AL	10 or 20 (see §180.209(i))
Exemption or special permit cylinder	
See current exemption or special permit	
See current exemption or special permit	
Foreign cylinder (see §173.301(j) of this subchapter for restrictions on use) As marked on cylinder, but not less than 5/3 of any service or working pressure marking	
5	(see §§180.209(l) and 180.213(d)(2))

Typical Test pressures

- Refer to 180.209
- 3A, 3AA, 3AL and others listed have test pressures of $5/3$ service pressure
- Typical 5 year retest period
- 10 % permanent expansion as rejection criteria

Locate cylinders to be tested



Record/input cylinder information to record or computer



Fill cylinders with water and allow time to stabilize temperature...



Test cylinders using Hydrostatic test machine



EID Expansion Indicating Device and PID (pressure) need to be .5% accurate or better of its full range



Scale is utilized to read cylinder expansions



Pass/fail computation (C-1)

The remaining displaced volume of water above zero, if any, represents the permanent expansion of the cylinder (see Figure 4). The ratio of permanent expansion to total expansion is calculated by dividing the permanent expansion by the total expansion. The ratio may then be converted to percent by multiplying by 100. The difference between the total expansion and the permanent expansion represents the elastic expansion of the cylinder. All expansion values are measured in cubic centimeters (cc). See Appendix D for a sample test record form.

$$\frac{\text{Permanent expansion}}{\text{Total expansion}} \times 100 = \% \text{ permanent expansion}$$

$$\text{Example : } \frac{2 \text{ cc}}{100 \text{ cc}} \times 100 = 2\%$$

$$\text{Total expansion} - \text{Permanent expansion} = \text{Elastic expansion}$$

$$\text{Example: } 100 \text{ cc} - 2 \text{ cc} = 98 \text{ cc}$$

NOTES

- 1 Test pressure, retest period, and all expansion rejection criteria for DOT and TC specification, exemption/special permit, or permit cylinders are cited in 49 CFR, CSA B339, and current exemptions/special permits or permits [1, 2].
- 2 Any internal pressure applied to a cylinder prior to the test pressure shall not exceed 90% of the minimum prescribed test pressure.
- 3 When test pressure cannot be achieved or maintained due to test apparatus failure or operator error, and when applied pressure has exceeded 90% of minimum prescribed test pressure, the test may be repeated at a pressure increased by 10%, or 100 psi, whichever is the lower value. If repeated, the cumulative increase shall be limited to no more than 10% of minimum prescribed test pressure.
- 4 An increase in elastic expansion indicates a reduction in the average wall thickness or reduced yield strength of the cylinder material (possibly due to overheating of the cylinder). A cylinder shall no longer qualify for service at 110% of rated pressure (i.e., +), when the elastic expansion exceeds the limit established by Table 2 in CGA C-5, *Wall Stress Requalification Criteria for High Pressure Seamless Steel Cylinders*, as marked on the cylinder, or when the wall stress at service pressure exceeds the limits established in 49 CFR 173.302a(b) [10, 1].

Remove cylinders from test and dry after test procedure.



Why do we test cylinders in water jacket?



CFR 49 section 180.209 (m), (6351 regulation)

- Requalification and Inspection of DOT–3AL Cylinders Made of Aluminum Alloy 6351–T6
- **Requalification requirement Examination procedure 1 Sustained Load Cracking**
Condemnation Criteria 2 Requalification period (years) Eddy current examination combined with visual inspection Eddy current—In accordance with Appendix C of this part
Visual inspection—In accordance with CGA Pamphlet C–6.1 (IBR; see §171.7 of this subchapter)
Any crack in the neck or shoulder of 2 thread lengths or more

CGA 6.1 Appendix A- Eddy current devices

Appendix A—Eddy current devices (Informative)

Besides visual inspections (for material loss and defects), there are nondestructive testing techniques that are less likely to miss defects than the human eye.

Some of these testing techniques use eddy current. Eddy current devices are especially suitable to detect neck defects (see 5.8). For more information regarding eddy current and its application to cylinder inspection, see CGA TB-19, *Uses of Eddy Current on Refillable High Pressure Vessels to Detect Imperfections* [11].

There are commercially available testing units that easily identify neck cracks and thread defects in cylinders. Contact the cylinder manufacturer for testing recommendations.

CGA C-6.1 Appendix B- Sustained Load Cracking

Appendix B—Sustained load cracking (Informative)

This appendix provides additional information regarding SLC in aluminum cylinders.

As the name implies, the SLC process in a cylinder is where cracking occurs in the metal when the cylinder is pressurized (filled). Cracking begins and grows in the head region of a pressurized cylinder. The process requires stress and certain components in the metal alloy, but SLC does not always occur.

Over the years, all-metal aluminum gas cylinders and some composite cylinders with aluminum liners have been manufactured from different aluminum alloys. Some of those alloys were found to exhibit a characteristic later named SLC. In the United States, the commonly used aluminum alloy that might exhibit SLC is identified by the Aluminum Association alloy number 6351. It is referred to as the 6351 alloy, and cylinders manufactured using this alloy are generally referred to as 6351 alloy cylinders or 6351 cylinders.

Today, the most commonly used aluminum alloy in North America manufactured to DOT specification 3AL and specification TC-3ALM uses the Aluminum Association alloy number of "6061." Straight threaded, high pressure aluminum cylinders manufactured from 6061 alloy do not develop SLC.

B1 Is the aluminum cylinder made from 6351 alloy?

Cliff Impact, a division of Parker Hannifan, manufactured cylinders from 6351 alloy before July 1990.

Justice Cylinders produced all-aluminum cylinders manufactured from 6351 alloy. They primarily manufactured medical cylinders during the two-year period from 1984 to 1985.

Luxfer USA, now known as Luxfer Gas Cylinders, produced 6351 alloy cylinders in the United States to DOT and CTC specifications before June 1988. Cylinders from Luxfer USA with a first hydrostatic test date of 5/88 or earlier are manufactured from 6351 alloy. Some cylinders before 5/88 were manufactured from the 6061 aluminum alloy. If the cylinder being tested is dated between December 1987 and June 1988, contact Luxfer Gas Cylinders to find out what aluminum alloy was used.

The Walter Kidde 6351 alloy cylinder was no longer produced in the United States to DOT and CTC specifications after 1989. Cylinders from Walter Kidde with a first hydrostatic test date of 12/98 or earlier are manufactured from 6351 alloy. Some Walter Kidde cylinders manufactured during 1989 were manufactured from both the 6061 and 6351 alloys. If the cylinder being tested is originally marked in 1989, contact Walter Kidde to find out what aluminum alloy was used. Walter Kidde ceased to manufacture high pressure aluminum cylinders in January 1990.

Aluminum alloy cylinders manufactured by Catalina Cylinders and Cliff Division of Catalina Cylinders have never been manufactured with 6351 alloy.

The composite cylinders that were manufactured using 6351 alloy (as liners) are near or have passed their life limit of 15 years. Because of their age, composite cylinders manufactured using 6351 alloy are no longer eligible for another requalification.

B2 Additional information

Not all 6351 cylinders will exhibit SLC. Some 6351 cylinders have been in service for 30 years without showing signs of SLC. Some will never exhibit cracking from SLC. In addition, low pressure cylinders are less likely to develop SLC.

SLC has been closely studied since before 1980. One or more cracks might develop in a cylinder. The conditions needed to crack the metal are that the metal is under a sustained load or, in the case of gas cylinders, the metal is under pressure. A full or nearly full high pressure 6351 aluminum alloy cylinder might crack slowly in the head and neck region.

Evidence and actual experience has shown that SLC takes many years to develop into a large crack or leaking cylinder. If an attempt is made to fill a leaking cylinder, a rupture can occur, which might lead to injury, death, or

Sustained load cracking (continued)

property damage. The 3-year periodic requalification for composites and the 5-year periodic requalification for all-metal 6351 aluminum alloy cylinders provides ample opportunity to discover neck cracks before they lead to leaks. Some cylinder manufacturers, regulatory authorities, or industries might recommend a different frequency of visual inspection. For example, the SCUBA industry recommends an annual visual inspection of all SCUBA cylinders regardless of make, model, or material. Recommendations are not required to be performed.

What is most important is that the visual inspection be performed accurately and with diligence. More frequent poor quality inspections will not discover cylinder imperfections. Diligent, properly performed inspections at the current required frequency do find cylinder defects before they can lead to catastrophic failure.

As stipulated in this publication, any aluminum cylinder with a crack(s) shall be condemned. Likewise, any cylinder that is leaking shall be condemned.

When should the eddy current test be done?



Identify “older” 6351 versus “newer” 6061 aluminum cylinders

- 6351 aluminum made 1990 or before
- 6061 aluminum made after 1990

#4 Refer to CFR 49 & special permits as needed

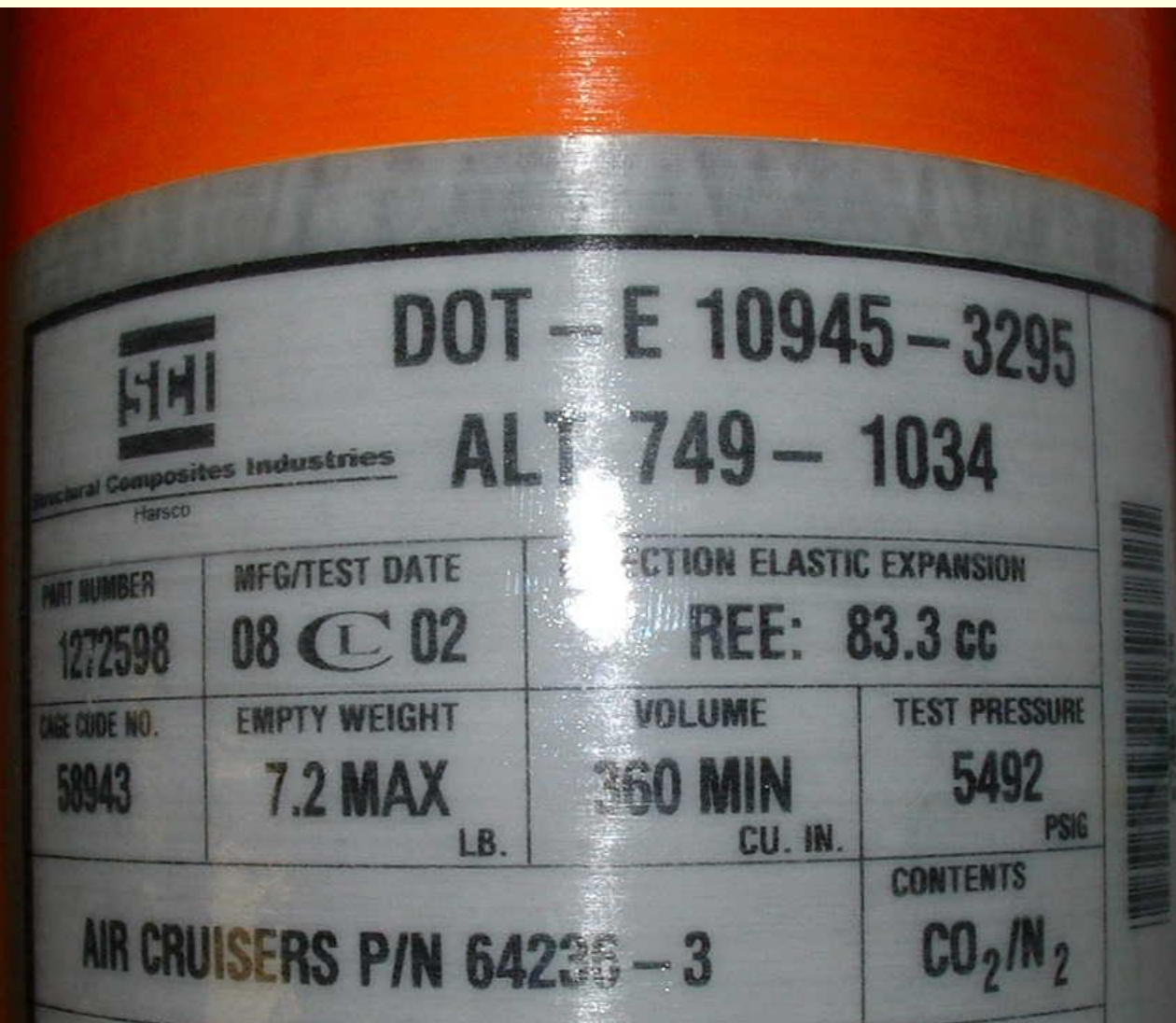
- Exemption/special permit cylinders
- Follow special permit information to test these cylinders
- Use the following website to find special permit information

phmsa.dot.gov/hazmat/regs/sp-a/special-permits/search

Composite cylinders will have visual inspection using CGA C-6.1 and C-6.2

- **Composite cylinders require special attention**
- **See CGA C 6.2 for more information**
- **Reference Special permit for testing criteria**
- **Reference CGA 6.1 & 6.2 for testing information**

Typical Composite cylinders.....



“Aluminum lined” Composite cylinder

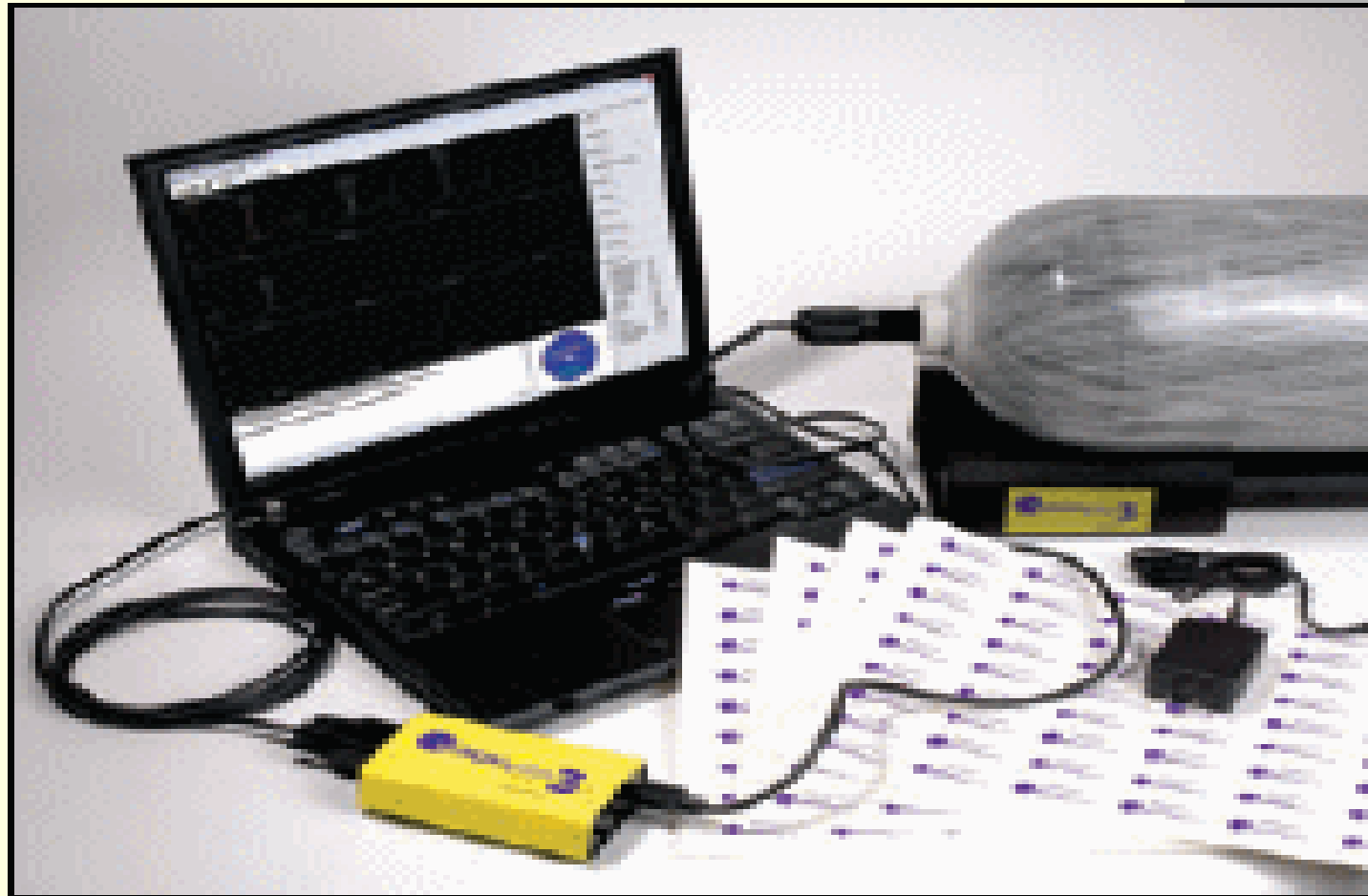




Visual Eddy Products (mark V shown) -stand alone operation or computer



Visual Plus 3 (eddy current device) computer required



Eddy current Manufacturer information

- Visual Eddy products

www.visualeddy.com

phone- 630/736-7075

email- visualeddy@ix.netcom.com

Visual plus (by Advanced Inspection Tech.)

www.visualplus.net

phone- 951/776-9994

email- visualplus@aol.com

Questions before continuing?

- **Reference CFR Title 49 section 180.205**
- **Use CGA pamphlets as needed**
- **Practice safe cylinder handling procedures per your companies' safety standards**

#5 Application process to become DOT certified

- Make sure testers are trained
- Make sure test equipment meets DOT standard
- Complete application and submit to the DOT to schedule inspection
- Must have certificates for calibration cylinder and master gauge

Application for Foreign country certification

■ APPLICATION FOR APPROVAL OF FOREIGN DOT CYLINDER

REQUALIFICATION FACILITY

➤ LOCATED OUTSIDE OF THE UNITED STATES (NON-US)

1. Name and Title of Responsible Person:

Facility Manager:

Company Name:

Facility Address:

(Where testing is performed) (Street Address) City, State, Zip Code

Mailing Address: (if different than above) City State Zip Code

Designated U.S. Agent Information: (Name of Company or Individual, U.S. mailing

address with Zip Code, email, phone and fax)

Application (continued)

2. Business Telephone () Fax () Email:

3. Check One: Headquarters _____ Division
Branch _____

If Division or Branch, Headquarters Location

List Other Facilities Operated:

If applicable, current Hydrostatic Retest I.D. Number:

4. Applicant intends doing business as:

Individual _____ Partnership _____ Corporation State
of Incorporation: Date of Incorporation:

5. What DOT specification/DOT exemption cylinders will
be tested?

Application (continued)

6. Estimated number of cylinders to be tested annually under this registration _____

7. Will cylinders be tested by water jacket volumetric expansion method?

Yes _____ No _____

a. If no, state other method used:

Direct Expansion _____ Modified Hydrostatic _____ Pressure Recession _____

Other: _____

8. Describe briefly your equipment and facilities for drying cylinders after test _____

9. Testing Equipment Inventory:

(a) Manufacturer _____

(b) Model and serial number _____

(c) Inside diameter and length of test jacket(s) _____

(d) Is a copy of manufacturer's operation manual for the equipment on file at the facility? _____

(e) Is an optional pressure recorder part of the test unit? _____

(f) Does the test jacket have an explosion port: if so, what size _____

Application (continued)

Rupture disc and of what material is it made? _____

(g) Is the test unit equipped with a pressure snubber to prevent excessive surges and vibration?

(h) Pressure Gauge(s):

(1) Percent accuracy?

(2) Method for certifying test gauge calibration:

a. Outside agency _____ b. Second calibration cylinder _____

c. Master gauge _____ d. deadweight tester _____

e. Other _____

Frequency: _____

Performed by: _____

Increments and range? _____

Application (continued)

(2)

(i) Test Burettes:

(1) Number _____

(2) Percent accuracy _____

(3) Range _____ Increments _____

(List for each burette)

(4) Method of leveling _____

(5) At eye level when reading? _____

(j) Calibrated cylinder:

(1) Manufacturer and serial number?

(2) Is calibration chart available? _____

(3) Frequency of use? _____

Application (continued)

I certify that I am familiar with all applicable Federal regulations relating to functions I will perform, and that all statements made by me on this application are to the best of my knowledge true and correct.

I understand that any duly authorized employee of the US Department of Transportation may enter, examine and inspect any premises, building, room, establishment, and all records relating to the reinspection and retesting of DOT specification and DOT exemption cylinders to determine compliance with applicable regulations.

(Date) _____

Office of Hazardous Materials Safety



U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration

HMS111408

Website: hazmat.dot.gov

NATIONAL RESPONSE CENTER
 For Immediate Notification of
 Hazardous Materials Incidents
 1-800-424-8802
 202-267-2675

HAZARDOUS MATERIALS
INFORMATION CENTER
 (800) HMR49-22
 (800) 467-4922
 202-366-4488 (local)
 Fax 202-366-3753
 FAX-ON-DEMAND
 (800) 467-4922 X 2

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EXECUTIVE DIRECTOR
 PHH-1
 Tonya Schreiber
 202-366-1634

E21-318
PHMSA FOIA OFFICER
 PHH-2
 Marilyn Burke
 202-366-6119

E21-325
ADMINISTRATIVE OFFICER
 PHH-3
 Dell Sdbury
 202-366-4470

E21-316
ASSOCIATE ADMINISTRATOR
 PHH-1
 Ted Wilkie
 202-366-0656

E23-314
DEPUTY ASSOCIATE ADMINISTRATOR
 PHH-2
 Bob Riehard
 202-366-0656

Fax: 202-366-5713

E24-314
OFFICE OF
HAZARDOUS MATERIALS
STANDARDS
 PHH-10
 202-366-6553
 Fax 202-366-7435

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 Ben Supko, Sr. Tr. Reg. Spec.
 Deborah Boothe, Jr. Reg. Spec.
 Kurt Eichenlaub, Jr. Reg. Spec.
 Kevin Leary, Jr. Reg. Spec.
 Dirk Der Kinderen, Tr. Reg. Spec.
 Agnes Trolia, Admin. Assistant

REGULATORY REVIEW
AND REINVENTION
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Thank you for your attention!!

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