

CHAPTER 13 - PART 173

GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGING

General Requirements

The shipper has the overall responsibility for ensuring that the packaging meets the requirements of the Hazardous Materials Regulations, including the specifications for manufacturing and marking of containers. (Although a shipper may accept a container manufacturer's certification, specification, approval or exemption marking (§173.22), he may be held accountable if he has reason to know that the markings are fraudulent or applied in error.)

Two or more materials may not be mixed in the same container if the mixture will result in an unsafe condition, such as an explosion, fire, excessive pressure or heat, or the release of toxic vapors. No product may be loaded that will have an adverse effect on the container's integrity so as to produce an unsafe condition. Containers that are overdue for requalification or retesting may not be charged with hazardous materials for transportation.

Cylinders must not be filled in excess of their capacity or beyond the container design pressure and temperature range specifications, or filled with materials that may corrode or react with the container material during transportation. Air pressure must not be used to load or unload materials from a container if there is a danger of creating an air-enhanced mixture within the flammability range of the materials in the vapor space of the container. Container loading and unloading pressure, and the lading pressure for transport must also meet the container's specifications.

Use and Qualification of Cylinders

49 CFR, §180 establishes the requirements for the use and qualification of cylinders. A company may not charge a cylinder that is out of test, leaks, has a bulge, has defective valves or pressure relief devices, shows evidence of physical abuse, fire or heat damage, or shows evidence of detrimental rusting or corrosion.

Cylinders must be legibly marked with the service **pressure and retest dates**. **Additional** information may be required, such as symbols indicating the type of test performed. Optional information may also be placed on the cylinder if it does not affect the required markings and is not indented into the sidewall of the cylinder.

With few exceptions, all cylinders must be equipped with pressure relief devices, in accordance with CGA Pamphlet S-1.1. The devices must be capable of preventing a cylinder from rupturing during a fire or other sources of overpressurization. These devices must be tested for leaks before a charged cylinder is shipped, and should be examined for evidence of damage or plugging prior to a cylinder being charged.

Periodic retesting for each cylinder must be performed at a certain minimum retest pressure. Details for the requalification testing of cylinders is contained in §180. Certain low pressure cylinders,

dedicated to non-corrosive lading, may receive a modified hydrostatic test that doesn't require the measurement of cylinder expansion, or alternatively, can receive a visual examination in lieu of hydrostatic testing in accordance with CGA Pamphlet C-6 (includes C-6.1, C-6.2, or C-6.3, as required).

Acetylene cylinders must undergo periodic shell examinations and a porous filler examination in accordance with CGA-1 3, "Guidelines for Periodic Visual Inspection and Requalification of Acetylene Cylinders."

Requirements for Filling and Shipping

Requirements for shipping compressed gases are contained in Subpart G of Part 173. Definitions for compressed gases are contained in 49 CFR, §173.115. An abstracted summary of important definitions is as follows:

- Nonflammable Gas (Division 2.2): Any material, which exerts an absolute pressure of 41 psia or more at 20°C (68 F).
- Flammable Gas (Division 2.1): A material which is a gas at 20°C (68°F) and atmospheric pressure, which is ignitable when in a mixture of 13% or less by volume with air; or has a flammable range with air of at least 12% by volume, regardless of the lower limit.
- Poisonous by Inhalation (Division 2.3): A material which is a gas at 20°C (68°F) and atmospheric pressure and which:
 - a. Is known to be so toxic to humans as to pose a hazard to health during transportation, or
 - b. Has an LC50 value of not more than **5000** ppm when tested with laboratory animals.

§173.302 covers requirements for filling of cylinders with nonliquefied compressed gases. The specifications of containers that are allowed are given, as well as special filling instructions and specific conditions for filling carbon monoxide, fluorine, diborane, and diborane mixtures.

§173.303 covers the filling requirements for acetylene cylinders, including requirements for filler materials, solvent, and acetylene maximum filling pressure.

§173.304 covers liquefied gas filling. Liquefied gases are normally filled by weight, although there are allowed exceptions. Cylinders are permitted to be filled to a limit defined as a "filling density." Filling density is the percent ratio of the weight of a gas in a container to the weight of water that the container will hold at 60°F. (1 lb. water 27.737 cubic inches at 60°F).

Other Filling Requirements

- §173.314 Compressed gases in tank cars.
- §173.315 Compressed gases in cargo tanks and portable tanks.
- §173.316 Cryogenic liquids in cylinders.
- §173.318 Cryogenic liquids in cargo tanks.
- §173.319 Cryogenic liquids in tank cars.

Cylinder Ownership

A container charged with a compressed gas must not be shipped unless it was charged by or with the consent of the owner of the container (§173.301 (e)).

Manifolding

Manifolding of cylinders in transportation may be done in accordance with § 173.301 (g). Specific rules are given for support of the cylinders during transportation, as well as for individual cylinders to be equipped with pressure relief devices.

Filling Pressure

The pressure in a container at 70°F must not exceed the service pressure for which the container is marked or designated. Nonflammable, nonpoisonous, other than liquefied or dissolved gases may be shipped 10% in excess of the container service pressure under certain conditions. There is a pressure limit at 130°F, which requires that the pressure in a cylinder not exceed 5/4 the service pressure, except for cylinders in acetylene, liquefied carbon dioxide, or liquefied nitrous oxide service (§173.304 and 173.304a).

Valve Protection

Cylinders charged with flammable, corrosive or noxious gases must have their valves protected during transportation by one of the following methods (§173.301 (g)):

1. By equipping the containers with securely attached metal caps of sufficient strength to protect the valves from injury during transit.
2. By boxing or crating the containers so as to give proper protection to the valves.
3. By so constructing the container that the valve is recessed into the container or otherwise protected so that it will not be subjected to a blow when the container is dropped on a flat surface.
4. By loading the containers compactly in an upright position and securely bracing in cars or motor vehicles, when loaded by the consignor and to be unloaded by the consignee.
5. By equipping with valves strong enough to avoid damage during transit for containers containing non-liquefied gas under pressure not exceeding 300 psig at 70°F.

CYLINDER RETESTING / REQUALIFICATION §180

Requirements

Cylinders may not be filled for transportation unless all required inspections or tests and markings have been performed. (However, a cylinder may be transported "out of date", provided it was within the required test date when filled.)

Registration

Generally, no requalification function may be performed with requires pressurizing and stamping a cylinder unless the person or company has first registered with DOT, Research and Special Programs Administration (RSPA) and obtained a registration number. Except for acetylene requalification, if only a visual inspection is performed, registration is not required.

Registration numbers will not be granted unless the company has first received an inspection and satisfactory review from an approved Independent Inspection Agency. The Agency will negotiate it's own fee for this service. After completing a satisfactory review, the agency will provide a letter of recommendation.

Personnel must be able to demonstrate to the independent inspector their knowledge of test equipment and procedures, Title 49 CFR, §180, required CGA Pamphlets, and any exemptions, which will be referenced. Prior to the inspection, distributors should have all materials, tools, equipment, etc., necessary for testing. For hydrostatic testing, the following should be ready:

1. Copies of:
 - 49 CFR, §180
 - CGA Pamphlet C-5
 - CGA Pamphlet C-6
 - CGA Pamphlet C-6.1, as applicable
 - CGA Pamphlet C-6.2, as applicable
 - CGA Pamphlet C-6.3, as applicable
 - CGA Pamphlet S-1.1
 - Any exemptions which may be applicable
2. Certificate of calibration for the test gauge(s) through its operating range, which verifies a calibration accuracy of 0.5%.
3. Calibration cylinder and chart showing the cylinder's expansions at various test pressures.
4. Hydrostatic test equipment capable of producing an accuracy of 1%.
5. Equipment necessary for visual inspections (test light, mirror, wire brush, pit gauge(s), etc.)
6. Sample of the facility recordkeeping form.

After the inspection, the Independent Agency will give you a letter of recommendation and a copy of the inspection report. This must be filed, along with a completed application form, to:

Approvals, DHM-32 Office of Hazardous Materials Exemptions and Approvals U.S. Department of Transportation 400 7th Street, N.W. Washington, DC 20590

Registration is valid for five years. Renewal requires another visit by an Independent Inspection Agency.

If you are already a registered retester and wish to retest / requalify other cylinder types for which approval has not been granted, write a letter to RSPA requesting approval of the additional cylinder type(s). Include supporting information (training documents, policy statements, etc.) to convince RSPA that you are competent to retest the cylinders applied for. However, acetylene requalification always requires a separate application and independent agency approval.

If the request is denied, RSPA will include information describing the reason for the denial and what you must do to receive a favorable response. Otherwise, a letter will be issued granting approval for the additional cylinder types.

Independent Inspection Agencies

(Current as of January, 1997)

Note: The following agencies are authorized by DOT to act as Independent Inspection Agencies for high pressure cylinders. Some agencies, however, may not be authorized for acetylene requalification. **GAWDA does not recommend or endorse any particular agency.**

Steigerwalt Associates
1121 South 24th Street
Allentown, PA 18103
(610) 437-1704

Authorized Testing
2522 Kansas Avenue
Riverside, CA 92507
(909) 682-4110

Arrowhead Industrial Services, Inc.
18 Colonial Woods Drive
West Orange, NJ 07052
(201) 731-2145
(910) 578-2777

Cylinder Services, Inc.
15270 Westover Road
P.O. Box 52
Elm Grove, Wisconsin 53122
(414) 827-0422

T. H. Cochrane Laboratories, Ltd.
5803 West National Avenue
Milwaukee, Wisconsin 53214-3491
(414) 476-2500

Robert W. Hunt Company
580 Waters Edge,
Oak Creek Center
Lombard, IL 60148
(708) 691-4333

Professional Services Inc.
Pittsburgh Testing Lab. Div.
850 Poplar Street
Pittsburgh, PA 15222
(412) 922-4000

"Failed" Cylinders

Cylinders fail requalification when they fail either (a) visual internal or external examinations or (b) hydrostatic test. Both tests carry equal weight. Therefore, if a cylinder fails the visual examination, hydrostatic testing is unnecessary. Cylinders fail visual inspection when they fail to meet the inspection criteria outlined in the CGA Pamphlet C-6 series. These pamphlets discuss maximum allow pit depths, fire and thermal damage, corrosion, and other critical inspection details.

Cylinders fail hydrostatic test when they indicate excessive permanent expansion or leak. In the case of DOT 3HT cylinders, excessive elastic expansion may also be cause for failure. Cylinders subject to the terms of an exemption must meet the criteria outlined in the exemption.

Cylinder Condemnation

If a cylinder must be condemned, the retester must either (a) stamp a series of "Xs" (XXXX) over the DOT specification number and the marked service pressure or (b) stamp, "CONDEMNED" on the shoulder, top head, or neck using a steel stamp. The word, "condemned", may not be abbreviated. It is important that retesters follow one (or both) of these two stamping options for condemned cylinders.

The owner of the cylinder may wish to have the cylinder made incapable of holding product. However, if the cylinder is customer-owned, do not destroy the cylinder without the owner's permission (preferably in writing). In addition to stamping cylinders, the retester must notify the cylinder owner, in writing, that the cylinder is condemned and may not be filled with hazardous material for transportation in commerce where a specification packaging is required.

Sample letter:

Dear

You have asked us to retest compressed gas cylinder (serial number) Unfortunately, this cylinder did not qualify for continued service and is condemned according to criteria established by the U.S. Department of Transportation. The cylinder may not be filled with hazardous material for transportation in commerce where use of a specification packaging is required under the terms of Title 49, Code of Federal Regulations. In compliance with 49 CFR, §180.205, we have stamped a series of Xs through the DOT specification and service pressure marking.

Sincerely,

10% Overfill §172.302a (b)

A compressed gas other than liquefied, dissolved, poisonous, or flammable may be filled to 10% in excess of the marked service pressure, provided that all the following conditions are met:

- The cylinder must be a DOT 3A, DOT 3AX, DOT 3AA, DOT 3AAX, or DOT 3T;
- Valves must be equipped with a frangible disc pressure relief device (without fusible metal backing) having a burst pressure not greater than the minimum test pressure.
- Average or maximum wall stress must not exceed allowable limits, or alternatively, CGA Pamphlet C-5 must be used to determine elastic expansion rejection limits.
- External and internal visual examinations must show that the cylinder is free from excessive corrosion, pitting, or dangerous defects.
- A "plus" sign (+) must be stamped on the cylinder following the test date.

10-Year Retest §180.209 (b)

Cylinders may be retested at 10-year intervals provided all of the following conditions are met:

- The cylinders must be DOT 3A or DOT 3AA, not exceeding 125 pounds water capacity,
- The cylinders must be removed from any cluster, bank, group, rack, or vehicle each time they are filled,
- Cylinders must have been manufactured after December 31, 1945,
- Cylinders must be used exclusively (see note below) for: air, argon, cyclopropane, ethylene, helium, hydrogen, krypton, neon, nitrogen, nitrous oxide, oxygen, sulfur hexafluoride, xenon, or mixtures of these gases with up to 30% carbon dioxide. Also, mixtures of these gases are allowed provided they are not capable of combining chemically with each other or with the cylinder so as to endanger its serviceability,
- Gases must have a dewpoint at or below -520F @ 1 atmosphere,
- Prior to each refill, cylinders must pass a hammer test,
- Each cylinder must be stamped with a 5-point "star" (tz) at least ¼ inch high following the test date.
- Cylinders must be dried immediately following hydrostatic testing to remove all traces of water.
- Cylinders must not be used for underwater breathing.

Note: If a cylinder has not been maintained in exclusive service, it may be retested in accordance with 10% overfilling rules (§173.302a (b)) and 10 year retest rules, and put into 10-year service.

Common Citations Levied Against Retesters

1. Failure to calibrate at the highest test pressure to be used.

2. Failure to retest at 10% over the test pressure or 100 psi, whichever is lower, if an accurate test cannot be made due to equipment failure.
3. Not using wall stress calculations or, alternatively, not using CGA Pamphlet C-5 to determine the elastic expansion rejection limit in hydrostatic testing for 10% overfill.
4. Not holding the test pressure for at least 30 seconds, or until a cylinder has time to completely expand, to determine total expansion.
5. Not performing necessary visual inspections.
6. Marking cylinders with the test date and tester's ID number prior to running the hydrostatic test.
7. Failure to properly record test results, as well as results of internal and external visual inspections.
8. Marking the cylinder with a star although it has not been used exclusively in an approved gas service as required.
9. Failure to periodically use a calibrated cylinder to assure accuracy of the testing equipment.
10. Inadequate training records.

REMINDER: Hydrostatic Testing is a "hazmat" job and retester's MUST BE appropriately trained. Retraining is required at least every three years.

PRESSURE RELIEF DEVICES §180.205; CGA Pamphlet S-1.1

Types of Devices:

With very few exceptions, cylinders must be equipped with pressure relief devices as described in CGA Pamphlet S-1.1 relief devices are expressly prohibited on cylinders charged with fluorine and with Division 2.3, Hazard Zone "A" gases. Types of relief devices are as follows:

- CG-1 (Rupture Disks): Used with a rated bursting pressure not exceeding the minimum required test pressure of the cylinder with which the disk is used. This disk must be used with 10% overfilled cylinders. When actuated, it will completely release the contents of the cylinder.
- CG-2 (Fusible Plug): Usually used with lower pressure liquefied gases. This is a thermally operated device and may not protect against an overpressurized cylinder. When actuated, it will release the entire contents of the cylinder.
- CG-4, CG-5 (Combination Rupture Disk / Fusible Metal): Used with some higher pressure liquefied gases, with gases (i.e., hydrogen) where premature failure would be considered a greater hazard, and with corrosive gases. This device does not protect against an overpressurized cylinder. When actuated, it will release the entire contents of the cylinder.

- CG-7 (Pressure Relief Valve): Designed to release excessive pressure until pressure reduces to a set rating. It will only release enough pressure to prevent excessive build-up. Since it will retain pressure in the cylinder at a preset value, it may not prevent rupture of a vessel weakened by heat.

Inspection

"Care shall [also] be exercised to avoid plugging of pressure relief device channels and parts by paint or other foreign matter which could interfere with the functioning of the device. Only trained personnel shall be allowed to service pressure relief devices. Only assemblies of original manufacturer's parts shall be **used** in the repair of pressure relief devices unless the interchange of parts has been proven by suitable test."

Relief devices for high pressure gases are designed to equalize the forces of a discharge so that the cylinder will not be knocked over or go into a spin; however, the blockage of one or more of the discharge ports will create an unbalance in the discharge which may cause the cylinder to topple and spin.

Each time a compressed gas cylinder is received for refilling, all pressure relief devices must be examined externally for corrosion, damage, rust, plugging of external pressure relief device channels, and other defects. This examination does not apply to DOT4L cylinders. If there is any doubt regarding the suitability of the pressure relief device for service, the cylinder shall not be filled until it is equipped with a suitable device.

A "backed" rupture disk will eventually rupture if it is subjected to its burst pressure, even though the fusible metal has not been subjected to heat. Significant extrusion of the fuse metal could be a sign that the rupture disk is, or has been, exposed to pressures at or near its burst pressure; it may, in fact, have already burst. Trained workers should look for signs of extruding fuse metal or leakage.

Repair

Proper pressure rating of the disk and temperature rating of fusible metal is essential.

The safety way to repair a relief device is by replacement of the entire assembly. Cylinder failures have occurred when two or more disks have inadvertently been placed into an assembly. Additionally, leakage will occur if the proper gasket is not included.

Fusible metal and spring loaded pressure relief valve devices (types CG-2, CG-3 and CG-7) "...shall not be reconditioned except for external cleaning. No attempt should be made to replace or refill the fusible metal in devices that have been in service. No attempt should be made to replace parts in, or adjust the pressure setting on, CG-7 (pressure relief valve type) devices once they have been set by the manufacturer."

Used Valves

When transferring valves to cylinders of different pressure ratings which require either an unbacked or backed rupture disk, it is important to change to a properly rated disk. When converting to cylinders

with a lower pressure rating, the former disk will burst above the minimum test pressure of the cylinder and not adequately protect it. Converting to a higher pressure cylinder will expose the device to the burst pressure of the former disk and may cause premature disk rupture, even if it is a backed device.

ACETYLENE CYLINDER REQUALIFICATION §180.209; CGA Pamphlet C-13

Requirements

There are two requalifications of an acetylene cylinder:

1. Shell Requalification. Requalify the shell by external visual inspection every ten (10) years. The focus is on damage such as cuts, dents, corrosion, bulges, and pressed-on footrings. Particular emphasis must be placed on cylinder bottoms.
2. Porous Filler. Requalify the porous mass filler material using internal visual inspection with tests, checking the clearance and looking for voids and deterioration once in the lifetime of the cylinder. The focus is on clearances with respect to the shell and mass.

Inspection Schedule

MFG. DATE	SHELL		FILLER	
	INITIAL REQUAL.	NEXT REQUAL.	INITIAL REQUAL.	NEXT REQUAL.
Before Jan. 1, 1991	Before Jan. 1, 2001	10 yrs. from 1st requal.	Before Jan. 1, 2011	not required
Since Jan. 1, 1991	10 yrs. From mfg. date	10 yrs. from 1 st. requal.	5 - 20 yrs from mfg. date	not required

All cylinders which have not been inspected by the appropriate due dates **must be withdrawn from service** until the inspections have been performed and the cylinders properly marked in accordance with inspection criteria in CGA Pamphlet C-13. C-13 is available from the Compressed Gas Association

Registration

Some distributors want to perform shell inspections and have another facility perform the filler inspections; this is acceptable, provided both facilities are registered with the DOT.

Periodic requalification of acetylene cylinders may only be performed by registered inspectors, *specifically approved for acetylene*. The approvals process is very similar to that of hydrostatic testing: after acquiring the proper tools and equipment and training employees, the distributor must engage an independent "third party" inspector to audit their procedures . After visiting the facility, the inspector will write a letter of recommendation which, together with a written "request for approval" (application) must be forwarded to DOT. Upon receipt and examination of these documents, DOT will issue a retester's number.

Marking

Cylinders successfully passing requalification must be stamped with the retester's number, date of requalification, and the letter "S" for shell requalification, "F" for filler requalification, or "SF" for both shell and filler requalification (e.g., "xxx-97SF").

Special Considerations

- Cylinders in current inventory may contain a porous filler consisting of some asbestos fibers. When the valve, screen and packing are removed, fibers will probably be released and a special vacuum system suitable for capture of asbestos fibers should be used. The waste captured by the vacuum must be specially handled as a hazardous waste. This involves **packaging, labeling, manifesting, and sending by a licensed carrier** to an approved disposal location.
- Persons required to wear respiratory protection, to protect against exposure to asbestos fibers, during a filler inspection, will have to be qualified to use such respiratory protection. The GAWDA Compliance Manual, OSHA Section, TAB 32, contains a sample Respirator Program.
- Degassing cylinders can be a problem due to the flammable gas hazard. In addition to adequate ventilation, the facility should be designed in accordance with the appropriate electrical and building codes. Additionally, the use of non-sparking tools must be considered.

NOTICE: The following Codes are the sections used in the preceding Tab. These Code sections do not necessarily include all sections that may be pertinent to your operation. A complete copy of the code of Federal Regulations, Title 49, parts 105 to 180 may be ordered from any U.S. Government Printing Office Bookstore. They are also available on-line at: <http://hazmat.dot.gov/rules.htm>

173.22a	Use of packagings authorized under exemptions
173.23	Previously authorized packaging
173.301	General requirements for shipment of compressed gases in cylinders and spherical pressure vessels
173.302	Charging of cylinders with non-liquefied compressed gases
173.302a	Additional requirements for shipment of liquefied compressed gases in specification cylinders.
173.303	Charging of cylinders with compressed gas in solution (acetylene)
173.304	Charging of cylinders with liquefied compressed gas
173.316.1	Cryogenic liquids in cylinders
180	Qualification maintenance and use of cylinders