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RR-C-901D
21 February 2003
SUPERSEDING
(see Section 6)

FEDERAL SPECIFICATION

CYLINDERS, COMPRESSED GAS: SEAMLESS SHATTERPROOF, HIGH PRESSURE DOT 3AA STEEL, AND 3AL ALUMINUM

The General Services Administration has authorized the use or this federal specification by all federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification provides the acquisition requirements for the purchase of empty compressed gas cylinders to be used for storage, transportation and distribution of high pressure liquefied and gaseous industrial and medical compressed gases including air, argon, carbon dioxide, helium, hydrogen, nitrogen, oxygen, sulfur-hexafluoride, and other gases.

1.2 Classification. The cylinders shall be of the following types, intended gas service, sizes, and valve designation (see 6.2).

Type I - DOT 3AA steel
II - Non-shatterable steel
III - Aluminum

Intended gas service - See table I

Size - See tables II and III

Valve designation - See table IV

Beneficial comments, recommendations, additions, deletions clarifications, etc. and any data that may improve this document should be sent to: Defense Supply Center Richmond, ATTN: DSCR-VBD, 8000 Jefferson Davis Highway, Richmond, VA 23297-5610.

AMSC N/A FSC 8120

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1.3 International standardization agreement code numbers.

QSTAG 236 (see 6.9)
STANAG 2121 (see 6.9)
STANAG 7146 (see 6.9)

2. APPLICABLE DOCUMENTS

2.1 Government publications. The issues of the following documents, in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Commercial Item Description

A-A-59503 - Nitrogen, Technical.

(Activities outside the federal government may obtain copies of federal specifications, standards, and commercial item descriptions as specified in the General Information section of the Index of Federal Specifications, Standards and Commercial Item Descriptions. The index is for sale on a subscription basis from the General Services Administration, Federal Supply Service, Specification Section, East 470 L'Enfant Plaza SW, Suite 8100, Washington, DC 20407.)

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the federal government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service, Specification Section, East 470 L'Enfant Plaza SW, Suite 8100, Washington, DC 20407.)

(Federal government activities may obtain copies of federal standardization documents and the Index of Federal Specifications, Standards and Commercial Item Descriptions from established distribution points in their agencies.)

Military Specifications

MIL-C-17376 - Caps and Flanges, Compressed-Gas Cylinder, General Specification for.
MIL-C-17376/1 - Caps and Flanges, Compressed-Gas Cylinder: Caps.
MIL-C-17376/3 - Caps and Flanges, Compressed-Gas Cylinder: Flange, High Pressure.
MIL-DTL-2 - Valves, Cylinder, Gas (for Compressed or Liquefied Gases) General Specification for.

Military Standard

MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders.

(Copies of military specifications and standards required by contractors in connection with specific procurement functions are obtained from the Standardization Document Order

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Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Electronic copies of specifications and standards may be obtained from http://assist.daps.dla.mil/quicksearch/.)

Code of Federal Regulations (CFR)

49 CFR 173, subpart G	- Gases; Preparation and Packaging.
49 CFR 178, subpart C	- Specifications for Cylinders.
49 CFR 178.37	- Specification 3AA and 3AAX Seamless Steel Cylinders.
49 CFR 178.46	- Specification 3AL Seamless Aluminum Cylinders.

(The CFR is for sale on a subscription basis from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. When indicated, reprints of certain regulations may be obtained from the federal agency responsible for issuing them. Electronic copies may be obtained from http://www.access.gpo.gov/.)

National Aeronautics and Space Administration (NASA)

NASA-STD-6001	- Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion.

(Application for copies should be addressed to NASA Technical Standards, EL01 MSFC, AL 35801 (Phone: 205-544-2448). Electronic copies may be obtained from http://standards.nasa.gov/.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

ASTM International

ASTM A 370	- Standard Test Methods and Definitions for Mechanical Testing of Steel Products (DoD adopted).
ASTM E 23	- Standard Test Methods for Notched Bar Impact Testing of Metallic Materials (DoD adopted).

(Application for copies should be addressed to ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. Electronic copies may be obtained from http://www.astm.org/.)

Compressed Gas Association (CGA)

CGA G-10.1	- Commodity Specification for Nitrogen.
CGA S-1.1	- Pressure Relief Device Standards Part 1 – Cylinders for Compressed Gases.
CGA TB-15	- Tare Weights, Requirements for Marking Cylinders (Post Manufacture).

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Compressed Gas Association (CGA) (continued)

CGA TB-17 - Test Methods for Evaluating Paints and Coatings on Refillable Steel Compressed Gas Cylinders.

(Application for copies should be addressed to the Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923. Electronic copies of CGA standards may be obtained from http://www.cganet.com/.)

3. REQUIREMENTS

3.1 Material, design, and construction. All cylinders shall conform to the specifications found in 49 CFR 178, subpart C. The seamless steel cylinders shall conform to Department of Transportation (DOT) specification 3AA, type 4130X steel of 49 CFR 178.37. The aluminum cylinders shall conform to DOT specification 3AL, 49 CFR 178.46. The physical characteristics, accessories and special requirements shall be as specified herein and in the acquisition document. The cylinder shall be newly fabricated within one year of the date of the contract or acquisition order.

3.2 Construction.

3.2.1 Stability. Cylinders shall be true to form and shall be stable in the upright position.

3.2.2 Fragmentation resistance (non-shatterability). The fragment resistance or non-shatterability (shatterproof) characteristics of the cylinder shall be determined by either the resultant wall stress value of the cylinder at the minimum designated test pressure or by the performance of the specified gunfire test (see 4.3.4). Cylinders manufactured to DOT specification 3AA of 4130X steel that are greater than four inches in outside diameter shall have a maximum wall stress of 70,000 psig as stated in 49 CFR 178.37. Cylinders manufactured to DOT specification 3AA of 4130X steel that are less than four inches in diameter shall have a maximum wall stress of 60,000 psig. Cylinders meeting these requirements shall be acceptable as non-shatterable cylinders and shall be steel stamped "NONSHAT". Cylinders manufactured to DOT specification 3AA of 4130X steel that are less than four inches in diameter and have a resultant wall stress value greater than 60,000 psig must pass the gunfire test to be acceptable as shatterproof cylinders. Steel cylinders manufactured of other than 4130X steel to DOT specification 3AA and all aluminum cylinders must pass the gunfire test to be acceptable as shatterproof cylinders.

3.2.3 Impact resistance. When impact resistance is specified (see 6.2), samples of each heat of steel represented in a lot of cylinders shall have a minimum lateral expansion of 0.015 inches or greater than 50 percent fibrous fracture at a temperature not higher than -58 ºF (-50 ºC) in accordance with ASTM E 23. Sub-sized samples from a cylinder wall may be used or a sample from a cylinder wall of greater thickness may be used if the source, processing, and heat treatment of the steel parallels the source, processing, and heat treatment of the cylinders under consideration.

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3.3 Cylinder processing.

3.3.1 Preconditioning and internal preservation. After hydrostatic and any other testing, the cylinder internal surface shall be cleaned and dried to be free of moisture, oil, grease, grit, machining products, loose scale, slag, or other foreign materials. Rust bloom or particulate matter (approximately 1.0 to 1.5 grams) generated subsequent to inspection as a result of handling and shipping is acceptable. Cleaning agents used shall be compatible with the cylinder materials and the intended gas service.

3.3.2 Oil and hydrocarbon residue. Residual oil and other hydrocarbons resulting from the manufacture of the cylinder shall be removed to a level not greater than 2.5 milligrams (mg) per square foot of internal surface area, but shall not exceed 20 mg per cylinder regardless of the size of the cylinder. Trailer tubes shall not contain more than 40 mg of oil or residual hydrocarbons. Verification of cleanliness shall be measured by gravimetric or infrared analysis or any equivalent chemical analysis method.

3.3.3 Moisture content. Cylinders tested hydrostatically and/or internally flushed for cleaning, or cylinders that were tested or flushed with moisture laden air, shall be immediately dried with hot filtered air or nitrogen to insure the effluent air or gas has a dew point lower than 30 ºF (-1 ºC). Immediately after internal drying, the cylinder shall be closed with the designated valve or plug.

3.3.4 Internal cylinder preparation. When specified (see 6.2) or as needed, the internal surface of steel cylinders shall be cleared of all mill scale, rust, and oxidation to the reduced metal level by use of an abrasive process such as shot or bead blasting. Aluminum cylinders shall be cleaned free of residue by vapor degreasing or equivalent process.

3.3.5 Internal cylinder preservation. When specified (see 6.2), cylinders closed with a valve shall be pressurized to approximately 5 psig with dry oil free nitrogen, type I, grade A or B, class 1 in accordance with A-A-59503 or type I, grade L or better in accordance with CGA G-10.1. The cylinder shall then be tagged at the valve with "PRESERVED WITH NITROGEN GAS".

3.4 Tare weight. The cylinder's maximum tare weight shall be as specified in tables II or III and shall be stamped into the shoulder of the cylinder in a position other than in sequence with another DOT permanent marking (see 3.6.2.2). The marking shall be displayed as required by CGA TB-15. The marking shall represent the tare weight of the cylinder and valve with an accuracy of 1 percent and shall be displayed in pounds (lb.) and ounces (oz.) unless otherwise specified.

3.5 Delivery date. The cylinders shall be newly fabricated and delivered within less than one year from the date of manufacture.

3.6 Cylinder identification. Unless otherwise specified herein, markings shall not be less than 1/4 inch (6.350 millimeters (mm)) high. On cylinders 6 inches (152.4 mm) in outside diameter or larger, the markings shall be 3/8 inch (9.525 mm) high.

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3.6.1 Standard permanent markings. The standard permanent markings as required by the appropriate DOT specification shall be plainly and permanently marked by stamping into the shoulder or the neck of each cylinder.

3.6.2 Additional special permanent markings. The following permanent markings shall be stamped into the shoulder or neck of the cylinder as they are specified or as they apply to the cylinder being manufactured or its dedicated application:

3.6.2.1 Ownership markings. All cylinders being purchased by a U.S. Government agency shall be stamped with "US GOVT" to indicate government ownership. Cylinders over four inches in diameter shall be marked with 3/8-inch characters. Cylinders under four inches in diameter shall be stamped with 1/4-inch characters. The symbols shall be stamped directly below or offset 90 degrees from the DOT permanent markings.

3.6.2.2 Tare weight. All cylinders being used in liquefied gas application shall have the tare weight applied to the cylinder (see 3.4).

3.6.2.3 Impact resistance. All cylinders tested and designated impact resistant shall have the designation of "-50 ºC" applied to the cylinder.

3.6.2.4 Shatterproof. All cylinders meeting the shatterproof characteristics of this specification shall be stamped "NONSHAT".

3.6.3 Special markings. The following special markings shall be applied as specified in the acquisition order (see 6.2) when required:

3.6.3.1 Special cylinder applications. When specified, cylinders designated for aviators breathing oxygen (ABO), nitrogen, and compressed air used in aircraft servicing shall be stenciled with the equivalent service pressure in kilopascals.

3.6.3.2 Specific gas applications. All cylinders that have been designated for a specific gas application shall be color coded and stenciled in accordance with MIL-STD-101.

3.6.3.3 Medical gas cylinders. All government medical cylinders, both government-owned and vender-owned, shall be color coded and stenciled in accordance with MIL-STD-101. All materials provided in the cylinder package shall pass tests specified in NASA-STD-6001.

3.6.3.3.1 Medical services tag. A military medical services tag shall be used on filled medical cylinders when they are purchased as part of a medical gas commodity contract. The tag shall be attached to each cylinder and the markings shall include the national stock number, the name of the specified gas, cylinder size, cylinder capacity in gallons, lot number, contract number, cylinder serial number, contractor's name or registered trademark, and necessary precautionary markings. The statement, "CAUTION: Federal Law Prohibits Dispensing Without Prescription.", shall appear on the tag, if it does not appear on the cylinder. In addition, tags for nitrous oxide cylinders shall bear the markings for total gross weight of the cylinder, tare weight, and net weight (weight of nitrous oxide liquid). These markings shall allow weights to be

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indicated in pounds and ounces. The tags shall be furnished with a metal eyelet and stringing wire. The wire shall be tinned, annealed, or galvanized, and be not less than 23 gage.

Tag colors shall be as follows:

Background - Same color as cylinders
Print - Black

OR

Background - White
Print - Same color as cylinders

The bottom of the tag shall be designed with a three part legend marked on both sides with perforated lines between the legends for easy removal as follows:

"EMPTY"
"IN USE"
"FULL"

3.6.3.3.2 Marking for medical cylinders. Medical cylinders shall be permanently marked. The markings shall be not less than 3/16 inch (4.760 mm) high for cylinders less than 6 inches in outside diameter and not less than 3/8 inch (9.520 mm) high for cylinders more than 6 inches in outside diameter as follows:

a. The capacity in gallons shall be marked on the shoulder of each cylinder. (Capacities shall be at 15 ºC (59 ºF) and 760 mm Hg (29.9213 in. Hg).)

b. To the right of the manufacturer's symbol, the letters "MED" shall be added either horizontally or vertically.

c. Name of gas abbreviated as follows:

Gas	Stamped	Stenciled
Oxygen	O_2	OXYGEN - U.S.P.
Nitrous oxide	N_2O	NITROUS OXIDE - U.S.P.

3.7 Treatment and painting. The treatment and painting of cylinders shall be by any method or system that will provide a finish that meets the requirements of CGA TB-17, tests 1, 3, 5, 6, and 8. The cylinder shall be color coded and stenciled in accordance with MIL-STD-101 for the dedicated gas for which the cylinder is designated. When required, treatment and painting (finish) for aluminum cylinders shall be as specified in the acquisition order (see 6.2).

3.8 Intended gas service. The intended gas service shall be selected from table I. Cylinder compatibility with the intended gas or liquid contents shall comply with the requirements of 49 CFR 173, subpart G.

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TABLE I. Intended gas service.

Class code	Item name code[1]	Gas product
A1	49516	Air, breathing
B1	49517	Air, technical
C1	49448	Argon-carbon dioxide
D1	49449	Argon-carbon dioxide-oxygen
E1	49451	Argon-methane
F1	49452	Argon, technical
G1	49452	Argon-oxygen
H1	49454	Boron trifluoride
J1	49458	Calibrating gas mixture
K1	49459	Carbon dioxide-helium-oxygen-nitrogen
L1	49460	Carbon dioxide-nitrogen-oxygen
M1	49461	Carbon dioxide-oxygen
N1	49462	Carbon dioxide, technical
P1	49463	Carbon dioxide, USP[2]
R1	49464	Carbon monoxide
S1	49471	Ethane, technical
T1	49473	Ethylene oxide-carbon dioxide
U1	49475	Ethylene, technical
V1	49478	Helium-argon
W1	49479	Helium-butane
X1	49480	Helium-isobutane
Y1	49481	Helium-methane
Z1	49482	Helium-nitrogen
A2	49483	Helium-oxygen
B2	49484	Helium, technical
C2	49485	Helium, USP
D2	49486	Hexafluoroethane
E2	49487	Hydrogen-argon
F2	49488	Hydrogen chloride, anhydrous
G2	49490	Hydrogen, technical
H2	49492	Methane, technical
I2	49477	Natural, dry
J2	49495	Neon, technical
K2	49496	Nitrogen-carbon dioxide
L2	49497	Nitrogen-hydrogen
M2	49498	Nitrogen, technical
N2	49499	Nitrogen, USP
O2	49500	Nitrous oxide, technical
P2	49501	Nitrous oxide, USP
Q2	49502	Oxygen, aviator's breathing
R2	49504	Oxygen-nitrogen
S2	49505	Oxygen, technical
T2	49506	Oxygen, USP
U2	49509	Sulfur hexafluoride, technical

[1]The above identification codes are the item name codes for each one of the above listed cylinders found in the Federal Item Identification Guide T162.
[2]United States Pharmacopoeia (USP).

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3.9 Physical characteristics. The cylinder service (operating) pressure and its physical characteristics shall be selected from tables II or III. The dimensional tolerances shall be ±1/4 inch for the diameter and 1 inch for the height.

TABLE II. Cylinder sizes: high pressure industrial and medical gases, steel (DOT specification 3AA).

Size code	Diameter[1] (inches)	Height[2] (inches)	Maximum tare weight (lbs.)	Water capacity[3] (lbs.)	Volume (cubic inches)
1800 psig carbon dioxide					
AA	3.6	14.6	5.25	3.9	110
AB	5.5	14	10.75	7.9	220
AC	7.0	17.75	23.5	17.6	490
AD	7.75	23.3	54.0	29.5	820
AE	8.75	45.5	109	110.2	3058
AF	9.0	56	142	110.2	3058
2015 psig carbon dioxide					
AG	8.5	51	101	83.6	2320
AH	9.0	45	104	81.8	2270
2300 psig carbon dioxide					
AI	9.25	56	138	110.3	3060
AJ	10.625	58	190	147.0	4080
2015 psig medical gases					
AK	3.3	13.25	5.25	3.0	84
AL	4.2	16.75	7.9	6.3	175
AM	4.2	25.25	11.25	10.3	285
AN	7.0	43.0	58.0	47.6	1320
AO	9.0	51.0	113.0	95.1	2640
2015 psig industrial gases					
AP	5.25	14.0	11.0	7.9	220
AQ	7.0	18.0	25.0	17.6	490
AR	7.0	23.0	31.0	23.7	660
AS	7.0	32.0	46.5	47.5	1320
AT	7.25	46.0	70.0	58.7	1630
AU	9.0	51.0	116	95.1	2640
2265 psig industrial gases					
AV	7.0	43.0	62	47.5	1320
AW	9.0	51.0	117	95.1	2640
2400 psig industrial gases					
AX	9.25	55.0	140	107.4	2980
AY	10.5	56.0	191	133.0	3690
3500 psig industrial gases					
AZ	9.25	51.0	188	95.1	2640
3600 psig industrial gases					
BA	9.25	51.0	188	95.1	2640
6000 psig industrial gases					
BB	9.25	51.0	267	82.3	2285

[1]Diameter represents the outside diameter.
[2]Height represents the measured distance from the bottom to the base of valve.
[3]The product capacity shall be determined by the cylinder application.
NOTE: Unless otherwise specified, the cylinder inlet threads shall be 3/4 - 14 National Gas Taper (NGT).

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TABLE III. Cylinder sizes: high pressure industrial and medical gases, aluminum (DOT specification 3AL).

Size code	Diameter (inches)	Height (inches)	Maximum tare weight (lbs.)	Water capacity (lbs.)	Volume (cubic inches)	Cylinder inlet thread size
1800 psig carbon dioxide						
BC	3.2	9.5	1.6	1.8	51	0.750-16 UNF[1]
BD	3.2	11.5	1.8	2.3	63	0.750-16 UNF
BE	4.4	9.0	3.0	3.0	82	0.875-14 UNF
BF	4.4	10.4	3.4	3.6	102	0.750-16 UNF
BG	5.3	14.2	6.3	7.4	205	1.125-12 UNF
BH	6.9	16.6	12.9	14.7	408	1.125-12 UNF
BI	6.9	23.2	17.0	22.1	612	1.125-12 UNF
BJ	8.0	23.3	23.0	29.4	816	1.125-12 UNF
BK	8.0	36.0	34.7	51.5	1429	1.125-12 UNF
BL	8.6	46.3	48.5	73.6	2040	1.125-12 UNF
2015 psig medical						
BM	4.4	7.894	3.1	2.6	71	0.750-14 UNF
BN "B"	4.4	9.18	3.4	3.1	87	0.750-14 UNF
BO	4.4	10.87	3.8	3.7	103	0.750-14 UNF
BP "D"	4.4	16.5	5.4	6.2	172	0.750-14 UNF
BQ "E"	4.4	25.63	8.1	10.2	283	0.750-14 UNF
2216 psig medical						
BR	3.2	9.000	1.9	1.6	43	0.750-14 UNF
BS	3.2	11.77	2.3	2.3	62	
BT	5.3	14.00	7.7	7.0	193	0.750-16 UNF
BU	5.3	17.06	8.9	8.8	244	0.750-16 UNF
BV	7.3	23.5	22.3	23.4	650	0.750-16 UNF
BW	8.0	36.3	39.7	46.9	1302	1.125-12 UNF
BX	9.8	51.93	87.4	102.0	2831	1.125-12 UNF
1800 psig industrial						
BY	8.6	46.1	49.5	73.6	2040	0.750-14 NGT or 1.125-12 UNF as requested
2015 psig industrial						
BZ	4.4	9.2	3.0	3.1	87	1.125-12 UNF
CA	4.4	10.5	3.5	3.7	103	1.125-12 UNF
CB	8.0	47.8	47.5	65	1800	0.750-14 NGT or 1.125-12 UNF as requested
2216 psig industrial						
CC	3.2	9.0	1.9	1.5	43	1.125-12 UNF
CD	3.2	11.7	2.3	2.2	62	1.125-12 UNF
CE	5.3	17.1	8.7	8.8	244	1.125-12 UNF
CF	5.9	15.6	15.2	13.0	130	0.750-14 NGT or 1.125-12 UNF as requested
CG	7.3	23.5	22.5	23.4	650	0.750-14 NGT or 1.125-12 UNF as requested
CH	7.3	32.9	30.0	34.6	960	0.750-14 NGT or 1.125-12 UNF as requested
CI	8.0	36.3	40.1	47.0	1302	0.750-14 NGT or 1.125-12 UNF as requested
CJ	9.8	51.9	89.6	102.1	2831	0.750-14 NGT or 1.125-12 UNF as requested

[1]United Fine Thread Series (UNF).

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3.10 Components. Each industrial gas cylinder with capacity of 625 cubic inches or greater and all medical cylinders with a capacity of 300 cubic inches or greater shall be fitted with a neck flange in accordance with MIL-C-17376/3 with a mating valve protection cap in accordance with MIL-C-17376/1. Fire extinguisher and industrial gas cylinders with a capacity under 625 cubic inches, and D and E size medical cylinders shall be supplied without caps and flanges.

3.10.1 Neck flange. The cylinder neck flange shall be pressed on or peened tight around the neck and onto the shoulder of the cylinder. It shall be visibly free of defects (cracks, pits, scale, etc.) or foreign materials (sand, flux, etc.). The flange threads shall be clean cut and free of any damage.

3.10.2 Valve protection cap. The cylinder neck flange shall mate with a valve protection cap of the size and thread designated in MIL-C-17376/1. The cap shall turn smoothly and freely on its threads to full thread engagement. The cap shall be free of any cracks or dents and shall be painted the same color and with the same quality as the shoulder of the cylinder.

3.10.3 Pressure relief device. The cylinder and valve assembly shall be furnished with a pressure relief device that is rated for the service pressure of the cylinder, and as stipulated in the designated valve specification type designator. All pressure relief devices shall be selected and tested in accordance with the CGA S-1.1 as required by 49 CFR 173.34.

3.10.4 Closure (valve or plug). The cylinder shall be furnished with a designated valve in accordance with MIL-DTL-2 (see table IV) when specified. The valve shall meet all of the requirements of MIL-DTL-2 and its associated specification sheet as referenced by the type designator. When a valve is not designated, the cylinder shall be closed with a brass plug (hex wrenching flats) and Teflon tape to afford proper sealing and easy removal.

TABLE IV. Valve identification designation.

Valve identification	Detail specification number	Type designation	Service pressure	Gas service
001	MIL-DTL-2/1	V1-510-0		Acetylene
001	MIL-DTL-2/2	V2-510-0		Acetylene
003	MIL-DTL-2/3	V3-200-1		Acetylene
004	MIL-DTL-2/5	V5-346-2	1800 through 2400	Air for human respiration
005		V5-346-3	1800	
006		V5-346-4	2015	
007		V5-346-5	2265	
008		V5-346-6	2400	
009	MIL-DTL-2/6	V6-590-2	1800 through 2400	Air, industrial
010		V6-590-3	1800	
011		V6-590-4	2015	
012		V6-590-5	2265	
013		V6-590-6	2400	
014	MIL-DTL-2/7	V7-240-0		Anhydrous ammonia
015	MIL-DTL-2/8	V8-240-0		Anhydrous ammonia
016	MIL-DTL-2/9	V9-240-0		Anhydrous ammonia

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TABLE IV. Valve identification designation - Continued.

Valve identification	Detail specification number	Type designation	Service pressure	Gas service
017	MIL-DTL-2/10	V10-240-0		Anhydrous ammonia
018	MIL-DTL-2/11	V11-580-2	1800 through 2400	Argon, helium, nitrogen, neon, or xenon
019		V11-580-3	1800	
020		V11-580-4	2015	
021		V11-580-5	2265	
022		V11-580-6	2400	
023	MIL-DTL-2/14	V14-510-14	240	Butane, propane, butane/propane mixture, MAPP gas, or propylene
024		V14-510-15	260	
025	MIL-DTL-2/15	V15-320-3	1800	Carbon dioxide
026		V15-320-4	2015	
027	MIL-DTL-2/16	V16-320-4		Carbon dioxide
028	MIL-DTL-2/17	V17-940-4		Carbon dioxide
029	MIL-DTL-2/18	V18-350-2		Carbon monoxide
030	MIL-DTL-2/19	V19-350-3	1800	Ethylene oxide/carbon dioxide mixture
031		V19-350-4	2015	
032		V19-350-5	2265	
033	MIL-DTL-2/20	V20-820-1		Chlorine
034	MIL-DTL-2/21	V21-820-0		Chlorine
035	MIL-DTL-2/22	V22-660-13	225	R-11 trichlorofluoromethane R-12 dichlorodifluoromethane R-13 chlorotrifluoromethane R-22 chlorodifluoromethane R-23 trifluoromethane R-31 chlorofluoromethane R-32 difluoromethane R-113 trichlorotrifluoroethane R-114 dichlorotetrafluoroethane R-115 chloropentafluoroethane R-123 dichlorotrifluoroethane R-124 chlorotetrafluoroethane R-125 pentafluoroethane R-134a tetrafluoroethane R-143a trifluoroethane R-152a difluoroethane R-290 propane R-401A (R-22/R-125/R-124)(53/13/34) R-401B (R-22/R-152a/R-124)(61/28/11) R-402A (R-22/R-125/R-290)(38/60/2) R-402B (R-22/R-125/R-290)(60/38/2) R-404A (R-125/R-143a/R-134a)(44/52/4) R-500 (R-12/R-152a) (73.8/26.2) R-501 (R-22/R-12) (75.0/25.0) R-502 (R-22/R-115) (48.8/51.2) R-503 (R-23/R-13) (40.1/59.9) R-504 (R-32/R-115) (48.2/51.8) R-505 (R-12/R-31) (78.0/22.0) R-506 (R-31/R-114) (55.1/44.9)
036		V22-660-14	240	
037		V22-660-15	260	
038		V22-660-16	300	
039		V22-660-17	400	
040		V22-660-18	300	
041		V22-660-19	400	
042		V22-660-20	240	
043		V22-660-21	300	
044		V22-660-22	400	
045	MIL-DTL-2/23	V23-300-1		Ethyl chloride

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TABLE IV. Valve identification designation - Continued.

Valve identification	Detail specification number	Type designation	Service pressure	Gas service
046	MIL-DTL-2/24	V24-510-1		Ethylene oxide
047	MIL-DTL-2/26	V26-590-2	1800 through 2400	Helium or nitrogen
048		V26-590-3	1800	
049		V26-590-4	2015	
050		V26-590-5	2265	
051		V26-590-6	2400	
052	MIL-DTL-2/27	V27-280-2		Oxygen/helium mixture
053	MIL-DTL-2/28	V28-890-2		Oxygen/helium mixture
054	MIL-DTL-2/29	V29-350-2		Hydrogen
055	MIL-DTL-2/37	V37-326-4		Nitrous oxide
056	MIL-DTL-2/38	V38-910-4		Nitrous oxide
057	MIL-DTL-2/39	V39-540-2	1800 through 2400	Oxygen
058		V39-540-3	1800	
059		V39-540-4	2015	
060		V39-540-5	2265	
061		V39-540-6	2400	
062	MIL-DTL-2/41	V41-540-2		Oxygen
063	MIL-DTL-2/42	V42-870-2		Oxygen
064	MIL-DTL-2/43	V43-660-12		Phosgene
065	MIL-DTL-2/44	V44-510-14	240	Butane, propane, butane/propane mixture, MAPP gas, or propylene
066		V44-510-15	260	
067	MIL-DTL-2/46	V46-590-2	1800 through 2400	Sulfur hexafluoride
068		V46-590-3	1800	
069		V46-590-4	2015	
070		V46-590-5	2265	
071		V46-590-6	2400	
072	MIL-DTL-2/47	V47-950-2		Air for human respiration
073	MIL-DTL-2/48	V48-346-2		Air for human respiration
074	MIL-DTL-2/49	V49-920-2		Cyclopropane
075	MIL-DTL-2/50	V50-330-12		Methyl bromide
076	MIL-DTL-2/51	V51-677-9		Argon, helium, nitrogen, neon, xenon or krypton
077	MIL-DTL-2/52	V52-660-14	240	Halon Halon-1202 (dibromodifluoromethane) Halon-1211 (bromochlorodifluoromethane) Halon-1301 (bromotrifluoromethane) Halon-2402 (dibromotetrafluoroethane)
078		V52-660-16	300	
079		V52-660-17	400	
080		V52-660-18	300	
081		V52-660-19	400	
082	MIL-DTL-2/53	V53-660-2	1800 through 2400	Hexafluoroethane
083		V53-660-3	1800	
084		V53-660-4	2015	
085		V53-660-5	2265	
086	MIL-DTL-2/54	V54-660-1		Sulfur dioxide

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TABLE IV. Valve identification designation - Continued.

Valve identification	Detail specification number	Type designation	Service pressure	Gas service
087	MIL-DTL-2/55	V55-540-2	1800 through 2400	Oxygen
088		V55-540-3	1800	
089		V55-540-4	2015	
090		V55-540-5	2265	
091		V55-540-6	2400	
092	MIL-DTL-2/56	V56-680-8	3500 through 3600	Argon, helium, neon, nitrogen, xenon, or krypton
093		V56-680-10	4000	
094		V56-680-11	4500	
095	MIL-DTL-2/57	V57-621-8	3500 through 3600	Helium and nitrogen
096		V57-621-10	4000	
097		V57-621-11	4500	
098	MIL-DTL-2/58	V58-677-9		Argon, helium, neon, nitrogen, xenon, or krypton
099	MIL-DTL-2/59	V59-347-8	3500 through 3600	Air
100		V59-347-10	4000	
101		V59-347-11	4500	
102	MIL-DTL-2/60	V60-500-2		Oxygen/helium mixture
103	MIL-DTL-2/61	V61-930-2		Oxygen/helium mixture
104	MIL-DTL-2/62	V62-350-2		Methane
105	MIL-DTL-2/63	V63-350-2		Natural gas
106	MIL-DTL-2/64	V64-330-2		Hydrogen chloride
107	MIL-DTL-2/65	V65-330-2		Hydrogen sulfide
108	MIL-DTL-2/66	V66-590-2	1800 through 2400	Mildly oxidizing mixtures
109		V66-590-3	1800	
110		V66-590-4	2015	
111		V66-590-5	2265	
112		V66-590-6	2400	
113	MIL-DTL-2/67	V67-510-1		Low pressure flammable
114	MIL-DTL-2/68	V68-580-2	1800 through 2400	Inert-oil free mixtures
115		V68-580-3	1800	
116		V68-580-4	2015	
117		V68-580-5	2265	
118		V68-580-6	2400	
119	MIL-DTL-2/69	V69-330-12		Corrosive (acidic) mixtures
120	MIL-DTL-2/70	V70-350-2		High pressure, flammable or toxic mixtures
121	MIL-DTL-2/71	V71-660-2	1800 through 2400	High pressure, toxic and oxidizing mixtures
122		V71-660-3	1800	
123		V71-660-4	2015	
124		V71-660-5	2265	
125		V71-660-6	2400	
126	MIL-DTL-2/72	V72-670-12		Fluorinating compound mixtures
127	MIL-DTL-2/73	V73-705-0		Corrosive (basic) mixtures
128	MIL-DTL-2/74	V74-660-1		Low pressure, toxic and oxidizing mixtures
129	MIL-DTL-2/75	V75-577-8	3500 through 3600	Oxygen
130		V75-577-10	4000	

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TABLE IV. Valve identification designation - Continued.

131	MIL-DTL-2/76	V76-296-2	1800 through 2400	Oxidizing mixtures
132		V76-296-3	1800	
133		V76-296-4	2015	
134		V76-296-5	2265	
135		V76-296-6	2400	
136	MIL-DTL-2/77	V77-660-13	225	Methyl chloride
137		V77-660-14	240	
138		V77-660-16	300	
999	None	Plug		

3.10.4.1 Medical service cylinders. All cylinders fabricated for medical services shall be supplied with a medical valve as specified. Each medical cylinder shall be equipped with a flange and a valve protection cap unless otherwise specified.

3.11 Workmanship. Cylinders, valves, plugs, flanges, and caps shall be cleaned and free from grit, fins, pits, and loose scale. Edges shall be rounded and chamfered. Cylinders shall be cleaned and free of dents, scratches, and any other surface defects detrimental to the intended use.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or acquisition order (see 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or acquisition order (see 6.2), the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Quality conformance inspection.

4.2.1 Lot. A lot shall consist of not more than 200 cylinders offered for delivery at the same time.

4.2.2 Sampling.

4.2.2.1 For examination. Sampling for examination shall be in accordance with 49 CFR 178.37.

4.2.2.2 Oil content. Unless otherwise specified in the contract or acquisition order (see 6.2), the testing for hydrocarbons shall be 1 in 200 cylinders.

4.2.2.3 Impact resistance. Charpy impact samples shall be prepared from each heat of steel represented in a lot of cylinders. The sample plate shall be taken from a fabricated cylinder representative of the heat of steel and the lot of cylinders to be tested and prepared in accordance with ASTM E 23. Sub-size samples are acceptable. The sample plate shall be of a length, width, and thickness to provide six Charpy impact test specimens.

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4.2.3 Examination. The sample cylinders shall be examined as specified in 4.2 for the characteristics in table V.

TABLE V. Cylinder defects.

Defect	Major	Minor
Dimensions not as specified	101	
Construction not as specified	102	
Cleaning not as specified	103	
Markings not as specified		201
Delivery date not within one year of the test date		202
Treatment and painting not as specified		203
Workmanship not as specified		204

4.3 Tests.

4.3.1 Leakage. Cylinders with a valve threaded into the cylinder shall be charged to the indicated service pressure with oil-free air or nitrogen. The cylinder shall be immersed in water covering the valve and neck of the cylinder and observed for bubbles for two minutes. Any bubbles shall constitute failure of the test. Leakage occurring around the valve stem may be corrected and the cylinder retested.

4.3.2 Oil and hydrocarbon residue. Place a clean plug, cork, or rubber stopper in the cylinder neck, clean the area around it thoroughly with heptafluorocyclopentane (HFCPA) solvent, and wipe dry with a clean cloth. For cylinders with less than three square feet of internal surface area, remove the plug and pour in 300 milliliters (ml) of the solvent. For larger cylinders, add an additional 100 ml for each square foot of internal area over 3 square feet. Replace the plug and lay the cylinder on its side. Roll or rotate through 360 degrees on a level surface or level rolling/tumbling machine for a minimum of 10 minutes to assure all the internal surfaces have been thoroughly wetted with solvent. Remove the solvent extract into a clean beaker. Any undissolved liquid floating on the surface of the solvent would indicate the presence of water or glycerin. The solvent extract shall be analyzed for hydrocarbons by one of the following methods:

4.3.2.1 Evaporation method. Evaporate the extract to dryness at slightly below the boiling point and finish the drying in an oven at 221 ºF (105 ºC) ± 1.8 ºF (1ºC) for 15 minutes. Cool, weigh, and report as milligrams of extracted oil. All traces of solvent shall be removed from the cylinder upon completion of this test. Nonconformance to the requirements paragraph 3.3.2 shall constitute failure of this test.

4.3.2.2 Infrared spectrophotometer. A sample of the solvent extract shall be analyzed against a reference standard of the base solvent with a known hydrocarbon level of 2.5 mg per 100 ml. A response in fractional range displaying a greater contamination of hydrocarbons in the solvent extract than found in the reference standard of 2.5 mg per 100 ml shall constitute failure of this test. All traces of solvent shall be removed from the cylinder upon completion of this test.

4.3.2.3 In case of dispute. In case of dispute, final determination shall be made by the evaporation method.

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4.3.3 Charpy impact test. The samples selected in accordance with 4.2.2.1 shall be tested in accordance with ASTM E 23. Impact energy values shall be great enough to produce cleavage of the test samples. Cleavage shall result in not less than 50 percent fibrous fracture with a transitional temperature not higher than -58 ºF (-50 ºC). A lateral expansion of 0.015 inch (0.381mm) measured in accordance with ASTM A 370 will be an acceptable criterion instead of a 50 percent fibrous fracture evaluation. Aluminum cylinders shall be exempt from impact testing, as the ductility of aluminum metal is nearly constant above its transitional temperature, which is far below the range of practical use for alloys allowed in DOT approved permits or in proposed DOT specifications.

4.3.4 Gunfire test. If the steel utilized is other than 4130X steel, two cylinders shall be charged to the rated pressure ±5 percent using a nonliquified gas. Each cylinder shall be placed behind a suitable steel barricade. The cylinder shall be in such a position that a bullet passing through a hole in the barricade strikes the cylinder at right angles to the longitudinal centerline within 1 inch of the longitudinal centerline and near to the vertical center of the cylinder. The cylinder temperature at the time of the test shall be between 50 ºF (10 ºC) and 100 ºF (37.8 ºC). An armor-piercing projectile 0.50 caliber in size shall be fired at the cylinder. The 0.50 caliber projectile shall strike the cylinders at a velocity of 2800 feet per second, ±100 feet per second. The projectile shall strike the cylinders straight on (not tumbled). A cylinder shall be considered as having failed this test if the cylinder breaks into more than two pieces provided, however, that pieces smaller than 2 inches in diameter coming from the areas (centering on the perforation and 4 inches in diameter) on the cylinder adjacent to the point of entry and exit of the projectile will not be counted. Cylinder designs, representative samples of which have passed this test, shall be permanently marked to indicate this fact. The term "NONSHAT" shall be permanently marked on the shoulder of the cylinder.

4.4 Inspection of preparation for delivery. An inspection shall be made to determine compliance with the requirements of section 5. A sample unit shall be one shipping container fully prepared for delivery.

4.5 Manufacturer's and inspector's reports and records. The contractor or the cylinder manufacturer shall offer and make available the manufacturer's and inspector's reports and records confirming that the fabrication of the purchased cylinders was performed by a DOT registered manufacturer and that all requirements of 49 CFR 178 and this specification have been met.

5. PACKAGING. Packing, packaging, and marking shall be as specified in the contract or acquisition order (see 6.2).

6. NOTES

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use. Cylinders covered by this specification are intended for storage and transportation of high pressure gases. Cylinders are prepared for specific gas use or are to be delivered plugged and finished in prime paint for future assigned applications.

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6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, revision, and date of this specification.
b. Type, intended gas service, size, and valve designation (see 1.2).
c. Impact resistance, if required (see 3.2.3).
d. Internal cylinder preparation, if required (see 3.3.4).
e. Internal cylinder preservation, if required (see 3.3.5).
f. Special markings, if required (see 3.6.3).
g. Treatment and painting (finish) for aluminum cylinders, when required (see 3.7).
k. Responsibility for inspection, if other than the contractor (see 4.1).
l. Inspection facility, if other than the contractor's chosen facility (see 4.1).
m. Oil content testing requirement (see 4.2.2.2).
n. Packing, packaging, and marking requirements (see 5).

6.3 Supersession data. This specification supersedes RR-C-901, dated 15 January 1981; RR-C-901/1, dated 15 January 1981; RR-C-901/2, dated 15 January 1981; and RR-C-901/3, dated 15 January 1981.

6.4 Serial numbers. Cylinder serial numbers shall be prefixed by a two- or three-letter symbol designating the procuring agency and shall have a two-letter suffix furnished by the contracting officer designating the contractor. The serial numbers shall be assigned by the contractor. These numbers may be consecutive with the contractor's regular production numbers or of a series established specifically for customer cylinders. However, all cylinders on a given contract will be numbered consecutively and controls will be exercised to preclude duplication on future deliveries to the government.

6.5 Nonshatterability. Historically, government agencies have gunfire tested high pressure cylinders to evaluate their nonshatterability and fragmentation properties. In applications where military personnel are in confined quarters, it is of prime interest to limit fragmentation and control release of the gas in a cylinder when it is pierced or burst. For ground cylinders over 4 inches in diameter, fragmentation in gunfire test should not exceed two pieces. Extensive testing has verified that cylinders over 4 inches in diameter made of 4130X steel to the limits of the DOT 3AA specification meet this requirement and have been marked "NONSHAT" by the fabricator. For cylinders in aircraft service, where the controlled release of the contained gas is more critical, tearing about the projectile apertures is limited to 3 inches from hole center. Government and industry have verified that this quality of nonshatterability is most directly related to the average wall stress in cylinder design. The DOT 3AA specification allows an average wall stress of 70,000 psig maximum. Independent investigators have arrived at wall stress limits from 50,000 to 60,000 psig as valid maximums for satisfactory nonshatterability characteristics. For procurement in accordance with this specification, cylinders under 4 inches in diameter that are fabricated in accordance with the DOT 3AA specification and have a 60,000 psig maximum wall stress will be accepted and permanently marked "NONSHAT". Cylinders under 4 inches in diameter with maximum wall stress greater than 60,000 psig will pass actual gunfire tests before being qualified as nonshatterable and permanently marked "NONSHAT".

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6.6 Recycled material. The use of recycled material is encouraged when practical, as long as it meets the requirements of the specification (see 3.1).

6.7 Part or identification number. The following PIN procedure is for government purposes and does not constitute a requirement for the contractor.

RRC901 - 2 C1 BB 039 Example of reference part number:

- 039 — Valve specification code (see table IV)
- BB — Size code (see tables II and III)
- C1 — Class code - intended gas service (see table I)
- 2 — Type 1 = I, 2 = II, 3 = III
- RRC901 — Specification number

6.8 Subject term (key word) listing.

ABO	carbon dioxide	hydrogen	nitrogen
acetylene	ethane	isobutane	nitrous oxide
argon	ethylene	medical	nonshatterable
boron	helium	methane	oxygen
butane	hexaflouroethane	neon	sufur hexaflouride

6.9 International standardization agreements. Certain provisions of this specification (see 3.6.1, 3.6.2, and 3.6.3) are the subject of international standardization agreements QSTAG 236, "Medical Gas Cylinders", STANAG 2121, "Cross-Servicing of Medical Gas Cylinders", and STANAG 3056, "Marking of Airborne and Ground Gas and Cryogenic Fluid Containers". STANAG 3056 has been canceled and is replaced by STANAG 7146, "Assignment of NATO Code Numbers to Gases Used in Aircraft Cross-Servicing". However, as of the date of this document, STANAG 7146 has been ratified by the United States but has not been promulgated. When amendment, revision, or cancellation of this specification is proposed that will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.10 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensive changes.

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MILITARY INTERESTS:

Custodians:
Army - EA
Navy - AS
Air Force - 68
DLA - PS

Review Activities:
Army - AI
Navy - MC, MS, OS

CIVIL AGENCY
COORDINATING ACTIVITY:

GSA - 2FYE

Preparing Activity:
DLA - GS3

(Project 8120-1044)