INCH-POUND

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SUPERSEDING
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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 designations (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

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center Richmond, ATTN: DSCR-VEB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5616, or e-mailed to STDZNMGT@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST database at https://assist.daps.dla.mil/.

AMSC N/A FSC 8120

1.3 International standardization agreement code numbers.

STANAG 2121 (see 6.8)
STANAG 7146 (see 6.8)

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 Descriptions

A-A-59503	- Nitrogen, Technical
A-A-59860	- Valves, Cylinder, Gas (for Compressed or Liquefied Gases)

(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 these specifications, 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. Electronic copies may be obtained from https://assist.daps.dla.mil/.)

Military Specifications

MIL-DTL-17376/1	- Caps and Flanges, Compressed-Gas Cylinder: Caps
MIL-DTL-17376/3	- Caps and Flanges Compressed-Gas Cylinder: Flanges, High Pressure

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 Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Electronic copies may be obtained from https://assist.daps.dla.mil/.)

Code of Federal Regulations (CFR)

49 CFR 173, subpart G	- Gases; Preparation and Packaging
49 CFR 173.34	- Qualification, Maintenance and Use of Cylinders
49 CFR 178	- Specifications for Packagings
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.gpoaccess.gov/cfr/.)

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 A370	- Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM E23	- Standard Test Methods for Notched Bar Impact Testing of Metallic Materials

(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	- Requirements for the Post Manufacture Tare Weight Marking of Cylinders
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 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 in accordance with 49 CFR 178.37. The aluminum cylinders shall conform to DOT specification 3AL in accordance with 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 E23. 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.

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 (see table IV).

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 3.6.1). 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 one year from the date of manufacture.

3.6 Cylinder identification. Unless otherwise specified herein, markings shall be in characters not less than 0.25 inch (6.350 millimeters (mm)) high. On cylinders 6 inches (152.4 mm) in outside diameter or larger, the markings shall be in characters 0.375 inch (9.525 mm) high.

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 four inches or greater in diameter shall be marked with 0.375-inch (9.525 mm) characters. Cylinders less than four inches in diameter shall be stamped with 0.25-inch (6.350 mm) 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 the applicable 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 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 gauge.

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 in characters not less than 0.188 inch (4.775 mm) high for cylinders less than 6 inches in outside diameter and not less than 0.375 inch (9.525 mm) high for cylinders 6 inches or more 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. The cylinders 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.

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 ±0.25 inch for the diameter and ±1.00 inch for the height.

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-DTL-17376/3 with a mating valve protection cap in accordance with MIL-DTL-17376/1. Fire extinguisher and industrial gas cylinders with a capacity less than 625 cubic inches, and "D" and "E" size medical cylinders (size codes BP and BQ) 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-DTL-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. All pressure relief devices shall be selected and tested in accordance with 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 A-A-59860 (see table IV) when specified. The valve shall meet the requirements of A-A-59860 as referenced by the part or identifying number (PIN). Unless otherwise specified (see 6.2), the inlet thread size of the valve shall be as specified in tables II or III herein. When a valve is not designated, the cylinder shall be closed with a brass plug (with hex wrenching flats) and Teflon tape to afford proper sealing and easy removal.

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 E23. Sub-size samples are acceptable. The sample plate shall be of a length, width, and thickness to provide six Charpy impact test specimens.

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

4.3 Test methods.

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 (1 ºC) 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.

4.3.3 Charpy impact test. The samples selected in accordance with 4.2.2.1 shall be tested in accordance with ASTM E23. 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 A370 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 manufactured to DOT specification 3AA, two cylinders shall be charged to the rated pressure ±5 percent using a non-liquefied 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 ±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, however, 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

5.1 Packing, packaging, and marking. 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.

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).
h. Inlet thread size, if other than specified (see 3.10.4).
i. Responsibility for inspection, if other than the contractor (see 4.1).
j. Inspection facility, if other than the contractor's chosen facility (see 4.1).
k. Oil content testing requirement (see 4.2.2.2).
l. Packing, packaging, and marking requirements (see 5.1).

6.3 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.

6.4 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".

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

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

RRC901 - 1 N1 AF 030 Example of reference part number:

- 030 — Valve specification code (see table IV)
- AF — Size code (see tables II and III)
- N1 — Class code - intended gas service (see table I)
- 1 — Type 1 = I - DOT 3AA steel; 2 = II - Non-shatterable steel; 3 = III - Aluminum
- RRC901 — Specification number

6.7 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

6.8 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 STANAG 2121, "Cross-Servicing of Medical Gas Cylinders", and STANAG 7146, "Assignment of NATO Code Numbers to Gases Used in Aircraft Cross-Servicing". 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.

6.9 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.

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	49453	Argon, technical
G1	49452	Argon-oxygen
H1	49454	Boron trifluoride, technical
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, technical
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, technical
E2	49487	Hydrogen-argon
F2	49488	Hydrogen chloride, anhydrous, technical
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 item name codes are found in the Federal Item Identification Guide T162.
[2] United States Pharmacopoeia (USP).

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	14.0	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	109.0	110.2	3058
AF	9.0	56.0	142.0	110.2	3058
2015 psig carbon dioxide					
AG	8.5	51.0	101.0	83.6	2320
AH	9.0	45.0	104.0	81.8	2270
2300 psig carbon dioxide					
AI	9.25	56.0	138.0	110.3	3060
AJ	10.625	58.0	190.0	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	116.0	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	140.0	107.4	2980
AY	10.5	56.0	191.0	133.0	3690
3500 psig industrial gases					
AZ	9.25	51.0	188.0	95.1	2640
3600 psig industrial gases					
BA	9.25	51.0	188.0	95.1	2640
6000 psig industrial gases					
BB	9.25	51.0	267.0	82.3	2285

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

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	0.750-16 UNF
BN "B"	4.4	9.18	3.4	3.1	87	0.750-16 UNF
BO	4.4	10.87	3.8	3.7	103	0.750-16 UNF
BP "D"	4.4	16.5	5.4	6.2	172	0.750-16 UNF
BQ "E"	4.4	25.63	8.1	10.2	283	0.750-16 UNF
2216 psig medical						
BR	3.2	9.0	1.9	1.6	43	0.750-16 UNF
BS	3.2	11.77	2.3	2.3	62	0.750-16 UNF
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	3/4-14 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	65.0	1800	3/4-14 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	3/4-14 NGT or 1.125-12 UNF as requested
CG	7.3	23.5	22.5	23.4	650	3/4-14 NGT or 1.125-12 UNF as requested
CH	7.3	32.9	30.0	34.6	960	3/4-14 NGT or 1.125-12 UNF as requested
CI	8.0	36.3	40.1	47.0	1302	3/4-14 NGT or 1.125-12 UNF as requested
CJ	9.8	51.9	89.6	102.1	2831	3/4-14 NGT or 1.125-12 UNF as requested

[1] Unified inch screw thread, fine-thread series.

TABLE IV. Valve identification designation.

Valve identification	Former detail specification number[1]	A-A-59860 PIN	Service pressure (psig)	Gas service
001	MIL-DTL-2/1	AA59860-001	0 - 500	Acetylene
002		AA59860-002		
003	MIL-DTL-2/2	AA59860-003	0 - 500	Acetylene
004		AA59860-004		
005	MIL-DTL-2/3	AA59860-005	0 - 500	Acetylene (10-ft^3 cylinders)
006		AA59860-006		Acetylene (40-ft^3 cylinders)
007	MIL-DTL-2/5	AA59860-007	1800 - 2400	Air for human respiration (non-medical)
008		AA59860-008	1800	
009		AA59860-009	2015	
010		AA59860-010	2265	
011		AA59860-011	2400	
012	MIL-DTL-2/6	AA59860-012	1800 - 2400	Air, industrial (oil tolerant)
013		AA59860-013	1800	
014		AA59860-014	2015	
015		AA59860-015	2265	
016		AA59860-016	2400	
017	MIL-DTL-2/7	AA59860-017	0 - 500	Anhydrous ammonia
018	MIL-DTL-2/8	AA59860-018	0 - 500	Anhydrous ammonia
019	MIL-DTL-2/9	AA59860-019	0 - 500	Anhydrous ammonia
020	MIL-DTL-2/10	AA59860-020	0 - 500	Anhydrous ammonia
021	MIL-DTL-2/11	AA59860-021	1800 - 2400	Argon, helium, nitrogen, neon, or xenon (Inert - oil free)
022		AA59860-022	1800	
023		AA59860-023	2015	
024		AA59860-024	2265	
025		AA59860-025	2400	
026	MIL-DTL-2/14	AA59860-026	240	Butane, propane, butane/propane mixture, MAPP gas, or propylene
027		AA59860-027	260	
028		AA59860-028	240	
029		AA59860-029	260	
030	MIL-DTL-2/15	AA59860-030	1800	Carbon dioxide (Industrial; non-medical)
031		AA59860-031	2015	
032	MIL-DTL-2/16	AA59860-032	0 - 3000	Carbon dioxide (medical)
033		AA59860-033		
034	MIL-DTL-2/17	AA59860-034	0 - 3000	Carbon dioxide (medical)
035	MIL-DTL-2/18	AA59860-035	0 - 3000	Carbon monoxide
036	MIL-DTL-2/19	AA59860-036	1800	Ethylene oxide/carbon dioxide mixture (Carboxide: 10% ethylene oxide, 90% carbon dioxide)
037		AA59860-037	2015	
038		AA59860-038	2265	
039	MIL-DTL-2/20	AA59860-039	0 - 500	Chlorine
040	MIL-DTL-2/21	AA59860-040	0 - 500	Chlorine (1-ton container)

TABLE IV. Valve identification designation - Continued.

Valve identification	Former detail specification number[1]	A-A-59860 PIN	Service pressure (psig)	Gas service
041	MIL-DTL-2/22	AA59860-041	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-227 Heptafluoropropane 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)
042		AA59860-042	240	
043		AA59860-043	260	
044		AA59860-044	300	
045		AA59860-045	400	
046		AA59860-046	300	
047		AA59860-047	400	
048		AA59860-048	240	
049		AA59860-049	300	
050		AA59860-050	400	
051		AA59860-051	225	
052		AA59860-052	240	
053		AA59860-053	260	
054		AA59860-054	300	
055		AA59860-055	400	
056		AA59860-056	300	
057		AA59860-057	400	
058		AA59860-058	240	
059		AA59860-059	300	
060		AA59860-060	400	
061	MIL-DTL-2/23	AA59860-061	0 - 500	Ethyl chloride (R-160)
062	MIL-DTL-2/24	AA59860-062	0 - 500	Ethylene oxide
063	MIL-DTL-2/26	AA59860-063	1800 - 2400	Helium or nitrogen (Inert - oil tolerant)
064		AA59860-064	1800	
065		AA59860-065	2015	
066		AA59860-066	2265	
067		AA59860-067	2400	
068	MIL-DTL-2/27	AA59860-068	0 - 3000	Oxygen/helium mixture (Medical) (Helium not over 80%)
069		AA59860-069		
070	MIL-DTL-2/28	AA59860-070	0 - 3000	Oxygen/helium mixture (Medical) (Helium not over 80%)
071	MIL-DTL-2/29	AA59860-071	0 - 3000	Hydrogen
072		AA59860-072		
073	MIL-DTL-2/37	AA59860-073	0 - 3000	Nitrous oxide (Medical)
074		AA59860-074		
075	MIL-DTL-2/38	AA59860-075	0 - 3000	Nitrous oxide (Medical)
076	MIL-DTL-2/39	AA59860-076	1800 - 2400	Oxygen (non-medical)
077		AA59860-077	1800	
078		AA59860-078	2015	

TABLE IV. Valve identification designation - Continued.

Valve identification	Former detail specification number1	A-A-59860 PIN	Service pressure (psig)	Gas service
079	MIL-DTL-2/39	AA59860-079	2265	Oxygen (non-medical)
080		AA59860-080	2400	
081	MIL-DTL-2/41	AA59860-081	0 - 3000	Oxygen (Medical)
082		AA59860-082		
083	MIL-DTL-2/42	AA59860-083	0 - 3000	Oxygen (Medical)
084	MIL-DTL-2/43	AA59860-084	0 - 3000	Phosgene (1-ton container)
085	MIL-DTL-2/44	AA59860-085	240	Butane, propane, butane/propane mixture, MAPP gas, or propylene
086		AA59860-086	260	
087		AA59860-087	240	
088		AA59860-088	260	
089	MIL-DTL-2/46	AA59860-089	1800 - 2400	Sulfur hexafluoride
090		AA59860-090	1800	
091		AA59860-091	2015	
092		AA59860-092	2265	
093		AA59860-093	2400	
094	MIL-DTL-2/47	AA59860-094	0 - 3000	Air for human respiration (Medical)
095	MIL-DTL-2/48	AA59860-095	0 - 3000	Air for human respiration (Medical)
096		AA59860-096		
097	MIL-DTL-2/50	AA59860-097	0 - 3000	Methyl bromide
098	MIL-DTL-2/51	AA59860-098	5501 - 7500	Argon, helium, nitrogen, neon, xenon or krypton (Inert - oil tolerant)
099	MIL-DTL-2/52	AA59860-099	240	Halon Halon-1202 (dibromodifluoromethane) Halon-1211 (bromochlorodifluoromethane) Halon-1301 (bromotrifluoromethane) Halon-2402 (dibromotetrafluoroethane)
100		AA59860-100	300	
101		AA59860-101	400	
102		AA59860-102	300	
103		AA59860-103	400	
104		AA59860-104	240	
105		AA59860-105	300	
106		AA59860-106	400	
107		AA59860-107	300	
108		AA59860-108	400	
109	MIL-DTL-2/53	AA59860-109	1800 - 2400	Hexafluoroethane
110		AA59860-110	1800	
111		AA59860-111	2015	
112		AA59860-112	2265	
113	MIL-DTL-2/54	AA59860-113	0 - 500	Sulfur dioxide
114		AA59860-114		
115	MIL-DTL-2/55	AA59860-115	1800 - 2400	Oxygen (non-medical)
116		AA59860-116	1800	
117		AA59860-117	2015	
118		AA59860-118	2265	
119		AA59860-119	2400	

TABLE IV. Valve identification designation - Continued.

Valve identification	Former detail specification number[1]	A-A-59860 PIN	Service pressure (psig)	Gas service
120	MIL-DTL-2/56	AA59860-120	3500 - 3600	Argon, helium, neon, nitrogen, xenon, or krypton (Inert - oil tolerant)
121		AA59860-121	4000	
122		AA59860-122	4500	
123	MIL-DTL-2/57	AA59860-123	3500 - 3600	Helium and nitrogen (Inert - oil tolerant)
124		AA59860-124	4000	
125		AA59860-125	4500	
126	MIL-DTL-2/58	AA59860-126	5501 - 7500	Argon, helium, neon, nitrogen, xenon, or krypton (Inert - oil tolerant)
127	MIL-DTL-2/59	AA59860-127	3500 - 3600	Air
128		AA59860-128	4000	
129		AA59860-129	4500	
130	MIL-DTL-2/60	AA59860-130	0 - 3000	Oxygen/helium mixture (Medical) (Helium over 80%)
131		AA59860-131		
132	MIL-DTL-2/61	AA59860-132	0 - 3000	Oxygen/helium mixture (Medical) (Helium over 80%)
133	MIL-DTL-2/62	AA59860-133	0 - 3000	Methane
134	MIL-DTL-2/63	AA59860-134	0 - 3000	Natural gas
135	MIL-DTL-2/64	AA59860-135	0 - 3000	Hydrogen chloride
136		AA59860-136		
137	MIL-DTL-2/65	AA59860-137	0 - 3000	Hydrogen sulfide
138		AA59860-138		
139	MIL-DTL-2/66	AA59860-139	1800 - 2400	Mildly oxidizing mixtures (5% to 23% Oxygen)
140		AA59860-140	1800	
141		AA59860-141	2015	
142		AA59860-142	2265	
143		AA59860-143	2400	
144	MIL-DTL-2/67	AA59860-144	0 - 500	Low pressure flammable
145		AA59860-145		
146	MIL-DTL-2/68	AA59860-146	1800 - 2400	Inert-oil free mixtures (With less than 5% Oxygen)
147		AA59860-147	1800	
148		AA59860-148	2015	
149		AA59860-149	2265	
150		AA59860-150	2400	
151	MIL-DTL-2/69	AA59860-151	0 - 3000	Corrosive (acidic) mixtures
152	MIL-DTL-2/70	AA59860-152	0 - 3000	High pressure, flammable or toxic mixtures
153		AA59860-153		
154	MIL-DTL-2/71	AA59860-154	1800 - 2400	High pressure, toxic and oxidizing mixtures
155		AA59860-155	1800	
156		AA59860-156	2015	
157		AA59860-157	2265	
158		AA59860-158	2400	
159		AA59860-159	1800 - 2400	
160		AA59860-160	1800	
161		AA59860-161	2015	

TABLE IV. Valve identification designation - Continued.

Valve identification	Former detail specification number[1]	A-A-59860 PIN	Service pressure (psig)	Gas service
161	MIL-DTL-2/71	AA59860-161	2015	High pressure, toxic and oxidizing mixtures
162		AA59860-162	2265	
163		AA59860-163	2400	
164	MIL-DTL-2/72	AA59860-164	0 - 3000	Fluorinating compound mixtures
165		AA59860-165		
166		AA59860-166		
167	MIL-DTL-2/73	AA59860-167	0 - 500	Corrosive (basic) mixtures
168	MIL-DTL-2/74	AA59860-168	0 - 500	Low pressure, toxic and oxidizing mixtures
169		AA59860-169		
170	MIL-DTL-2/75	AA59860-170	3500 - 3600	Oxygen (non-medical)
171		AA59860-171	4000	
172	MIL-DTL-2/76	AA59860-172	1800 - 2400	Oxidizing mixtures
173		AA59860-173	1800	
174		AA59860-174	2015	
175		AA59860-175	2265	
176		AA59860-176	2400	
177	MIL-DTL-2/77	AA59860-177	225	Methyl chloride
178		AA59860-178	240	
179		AA59860-179	300	
180		AA59860-180	225	
181		AA59860-181	240	
182		AA59860-182	300	
999	None	Plug	-	-

[1] The former detail specification number is given for cross-reference purposes only.

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

MILITARY INTERESTS:

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

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

Preparing Activity:
DLA - GS7

(Project 8120-2010-003)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST database at https://assist.daps.dla.mil/.