

METRIC

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SUPERSEDING  
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## PERFORMANCE SPECIFICATION

### PROPELLANT, OXYGEN

This specification is approved for use by all Departments and Agencies of the Department of Defense

#### 1. SCOPE

1.1 Scope This specification covers the requirements for three grades and two types of oxygen.

1.2 Classification. The oxygen shall be of the following types and grades as specified (6.2):

1.2.1 Types. The types of oxygen are as follows

Type I - Gaseous

Type II - Liquid

1.2.2 Grades The grades of oxygen are as follows

Grade A - 99.6 percent pure, standard

Grade B - 99.5 percent pure, reduced standard

Grade F - 99.990 percent pure, fuel cell and breathing

#### 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to SA-ALC/SFSP, 1014 Billy Mitchell Blvd/STE 1, Kelly AFB TX 78241-5603, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9135

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must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed

2.2 Government documents

2.2.1 Specifications, standards, and handbooks The following specifications and standards form a part of this document to the extent specified herein Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2)

SPECIFICATIONS

DEPARTMENT OF DEFENSE

- |             |  |
|-------------|--|
| MIL-S-27626 | - Sampler, Cryogenic Liquid                            |
| MIL-T-27730 | - Tape, Antiseize, Tetrafluoroethylene, with Dispenser |

STANDARDS

DEPARTMENT OF DEFENSE

- |         |  |
|---------|--|
| AN818   | - Nut, Tube Coupling, Short                  |
| MS20819 | - Sleeve, Flared Tube Fitting                |
| MS33584 | - Tubing End, Standard Dimensions for Flared |

(Unless otherwise indicated, copies of the above specifications and standards are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094)

2.3 Non-Government publications The following documents form a part of this document to the extent specified herein Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |            |   |
|------------|---|
| ASTM E 29  | - Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications |
| ASTM F 307 | - Practice for Sampling Pressurized Gas for Gas Analysis  |
| ASTM F 310 | - Practice for Sampling Cryogenic Aerospace Fluids  |

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia PA 19103-1187.)

COMPRESSED GAS ASSOCIATION (CGA)

- |           |                                      |
|-----------|--------------------------------------|
| CGA G-4.3 | - Commodity Specification for Oxygen |
|-----------|--------------------------------------|

CGA P-15 - Filling of Industrial and Medical Nonflammable Compressed Gas Cylinders

(Application for copies should be addressed to the Compressed Gas Association, Inc, 1725 Jefferson Davis Highway, Arlington VA 22202-4100 )

2 4 Order of precedence In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained

3. REQUIREMENTS

3 1 Grade requirements. The purity and impurity concentrations as applicable to each grade of oxygen shall conform to the limits of Table I when tested in accordance with the applicable test method also specified in Table I Other limits and tests may be specified by the procuring activity (see 6 2)

3 2 Limiting values The following applies to all specified limits in this specification For purposes of determining conformance with these requirements, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand digit used in expressing the specification limit according to the rounding-off method of ASTM Practice E 29 for using Significant Digits in Test Data to Determine Conformance with Specifications.

3 3 Filter A filter with no more than a 10-micrometer nominal and 40-micrometer absolute rating shall be installed between the manufacturer's plant system and the manifold used to fill the gas or liquid containers for delivery

3 4 Filled containers (Type I only)

3.4.1 Pressure. Cylinders and tubes shall be within 99 to 100 percent of rated service pressure when tested as specified in 4 5 1 Pressure-Temperature Filling Charts in CGA P-15 may be used

3.4 2 Leakage Cylinders shall not leak when tested according to 4.5 2

4 VERIFICATION

4 1 Points of inspection (6.2). Unless otherwise specified, acceptance tests shall be conducted at the site of filling prior to shipment or departure.

4 2 Conformance inspection. Quality conformance tests shall consist of the following:

- a. Individual tests (Type I only) . . . . 4.2.1
- b. Sampling tests . . . . . 4 2.2

4 2 1 Individual tests (Type I only). Each container (cylinder or tube) shall be subjected to the following tests as described under 4 5

- a. Filling pressure . . . . . 4 5 1
- b. Leakage . . . . . 4 5 2

TABLE I. Grade limits for oxygen

	Grade			Test Method
	A	B	F	
Purity, % by vol, min	99.6	99.5	99.990	4.4.1
Impurities, ppm by volume, max	4000	5000	100	4.4.1
Total hydrocarbons as methane	50	67.7	20	4.4.2
Alkynes as acetylene <sup>a</sup>	0.25	0.5	0.05	4.4.2
Water	3	26.3	3	4.4.2
Methane	b	b	16	4.4.2
Ethane	b	b	2	4.4.2
Propane and higher hydrocarbons as propane	b	b	1	4.4.2
Nitrous oxide	b	b	1	4.4.2
Halogenated hydrocarbons	b	b	1	4.4.2
Carbon monoxide and carbon dioxide	b	b	1	4.4.2
Other (N, Ar, Kr, etc)	b	b	75	4.4.2
Odor	b	b	None	4.4.2
Particulate <sup>d</sup> , mg/L, max	1.0	1.0	1.0	4.4.3

a. Applies to all grades of type II and both types of grade F only.

b. No limit for this grade

c. Applies to type II only.

d. The particulate limit and test requirement may be deleted by the procuring activity (6.2)

4.2.2 Sampling test The number of oxygen containers shall be selected in accordance with Table II and subjected to the tests required by Table I

TABLE II Sampling for test

Number of containers in lot	Number of containers to be sampled
1	1
2 - 40	2
41 - 70	3
71 - over	4

4.2.3 Lot A lot shall consist of one of the following.

a The oxygen produced in not more than 24 consecutive hours from a continuous process which is used to fill shipping containers directly from the process output A continuous process shall be the production of product by continuous input of raw materials and output of finished product by one manufacturer in one plant with no change in manufacturing conditions or materials

b. The oxygen from individual runs of a batch process which is used to fill shipping containers directly from the process output A batch process shall be the production of product by runs from single additions of raw materials which are reacted and purified forming the product

c The oxygen from either or both the continuous and batch processes which is held in a single storage tank and subsequently withdrawn to fill shipping containers The product shall be homogeneous at the time of withdrawal and shall not be added to while being withdrawn After each addition to the storage tank, the contents shall constitute a separate lot

4.2.4 Sample Each sample shall be of sufficient size to conduct all the quality conformance tests as specified herein Unless otherwise specified, the quality conformance tests shall be made of each required sample (6.2) When required, an equivalent sample shall be forwarded to a laboratory designated by the procuring activity for testing

4.2.4.1 Samplers The sampler for Type I (gaseous) oxygen shall be a small compressed gas cylinder The sampler for Type II (liquid) oxygen shall be in accordance with MIL-S-27626 or functionally equivalent thereto. The liquid samplers convert the entrapped liquid to gas The aliquots taken for analysis are representative samples.

4.2.4.2 Sampling methods. Unless otherwise specified (6.2), Type I (gaseous) oxygen shall be sampled in accordance with ASTM F 307 and Type II (liquid) oxygen shall be sampled in accordance with ASTM F 310 except for the following changes Replace paragraph 5.1 with "5.1 Ensure that the outlet of the sampling port is clean" Replace paragraph 6.1 with "6.1 Ensure that the outlet of the sampling port is clean."

4.2.5 Cylinders. The number of cylinders (high pressure and cryogenic types) filled with Type I (gaseous) or Type II (liquid) oxygen selected for

sampling from each lot shall be in accordance with Table II. The first and last cylinders to be filled within a given lot shall be sampled. Other samples may be selected at random. The oxygen from each cylinder sampled shall constitute a separate sample. For the purpose of selecting sample cylinders only, any one cylinder may be selected from a group of cylinders filled simultaneously from a single manifold.

4.2.6 Bulk transports. A sample shall be taken from each portable tank, cargo tank, or tank car filled with Type I (gaseous) or Type II (liquid) oxygen.

4.2.6.1 Continuous service (6.4.2) Unless otherwise specified by the procuring activity, the following sample option for oxygen shall be used for storage and transport tanks engaged in continuous oxygen service (6.2). Contractor shall sample the contents of each transport tank engaged in continuous oxygen service at least once every seven days at uniform intervals of time. Samples shall be taken from the filled transport tanks. Contractor shall sample the contents of each transport tank when entering continuous service and when the transport tank has remained empty for a period greater than 24 hours. When empty, all ports and vents shall remain closed to the atmosphere. While in continuous service, compliance with quality conformance tests specified herein shall be determined by sampling the filling point storage tank after each addition or, in case of continuous production, at established intervals not less frequent than once every 24 hours. When a storage tank is being filled during a change of duty shift, sampling shall be performed after filling.

4.2.7 Other containers (6.2) Unless otherwise specified, other containers of 400 liters or less water capacity shall be sampled in accordance with 4.2.5. Containers greater than 400 liters water capacity shall be sampled in accordance with 4.2.6.

4.3 Rejection When any sample tested in accordance with 4.4 fails to conform to the requirements specified herein, the entire lot represented by the sample shall be rejected. Unless otherwise specified, disposition of rejected product shall be specified by the procuring activity (6.2).

4.4 Analytical procedures Unless otherwise specified, samples shall be analyzed according to the procedures described below (6.2). Calibration gas standards may be required to calibrate (zero and span) analytical instruments used to determine the purity and impurity contents of the oxygen. The accuracy of the calibration gas standards is to be traceable to the National Institute of Standards and Technology. A suggested procedure for infrared analysis is provided in 6.8.

4.4.1 Purity Methods shall be selected from CGA G-4.3 except for grade F. The purity of grade F shall be determined by difference as follows:

$$\%O_2 = 100 - 10^{-4} \sum_i$$

where  $\sum_i$  equals the sum of the water content, total hydrocarbons; carbon dioxide and carbon monoxide, and inert gases in ppm by volume.

4.4.2 Gaseous impurities. Methods shall be selected from those of CGA G-4.3.

4.4.3 Particulate content A filter holder assembly, (Gelman part No 4250X), or equivalent modified as shown on Figure 1 shall be attached to the withdrawal line of the vessel to be utilized to fill the tanks. A preweighed filter paper (Gelman 47 mm glass fiber paper, type A/E or equivalent) shall be placed on top of another filter of the same kind. The filters shall then be placed on the porous filter support, which, in turn, shall be placed in the filter holder as shown in Figure 1. The male threads of the filter holder shall be wrapped with thin, nonadhesive-backed polytetrafluoroethylene tape MIL-T-27730 to prevent galling of the threads. The holder shall be tightened by hand as tight as possible to prevent bypassing of the filter element. The discharge liquid from the filter housing shall be collected in a clean, uninsulated, ambient temperature vessel marked to indicate when 5 liters of liquid have been collected. The liquid flow shall be terminated when 5 liters of liquid have been collected. The filter holder shall be removed from the line and permitted to reach ambient temperature. The warmup to ambient temperature may be expedited by use of an oven or other heat source. Care shall be exercised to ensure that any airflow which enters the unit will be directed through the inlet of the assembly to prevent displacing any particles from the surface of the filter. Upon warmup, the other side of the holder shall be wiped with a clean cloth and the holder then disassembled. The filter paper shall be closely inspected. The test shall be repeated if evidence of either (a) the filter not being securely clamped by uniform depression of its edge, (b) the filter having been cut by the holder; or (c) when dirt particles are detected in the clamped area indicating bypassing had been encountered. The test shall also be repeated when either the bottom filter shows any discoloration or when leakage of liquid from the filter holder is detected. Upon completion of a valid test the filter shall be removed from the housing and weighed to the nearest 0.1 mg.

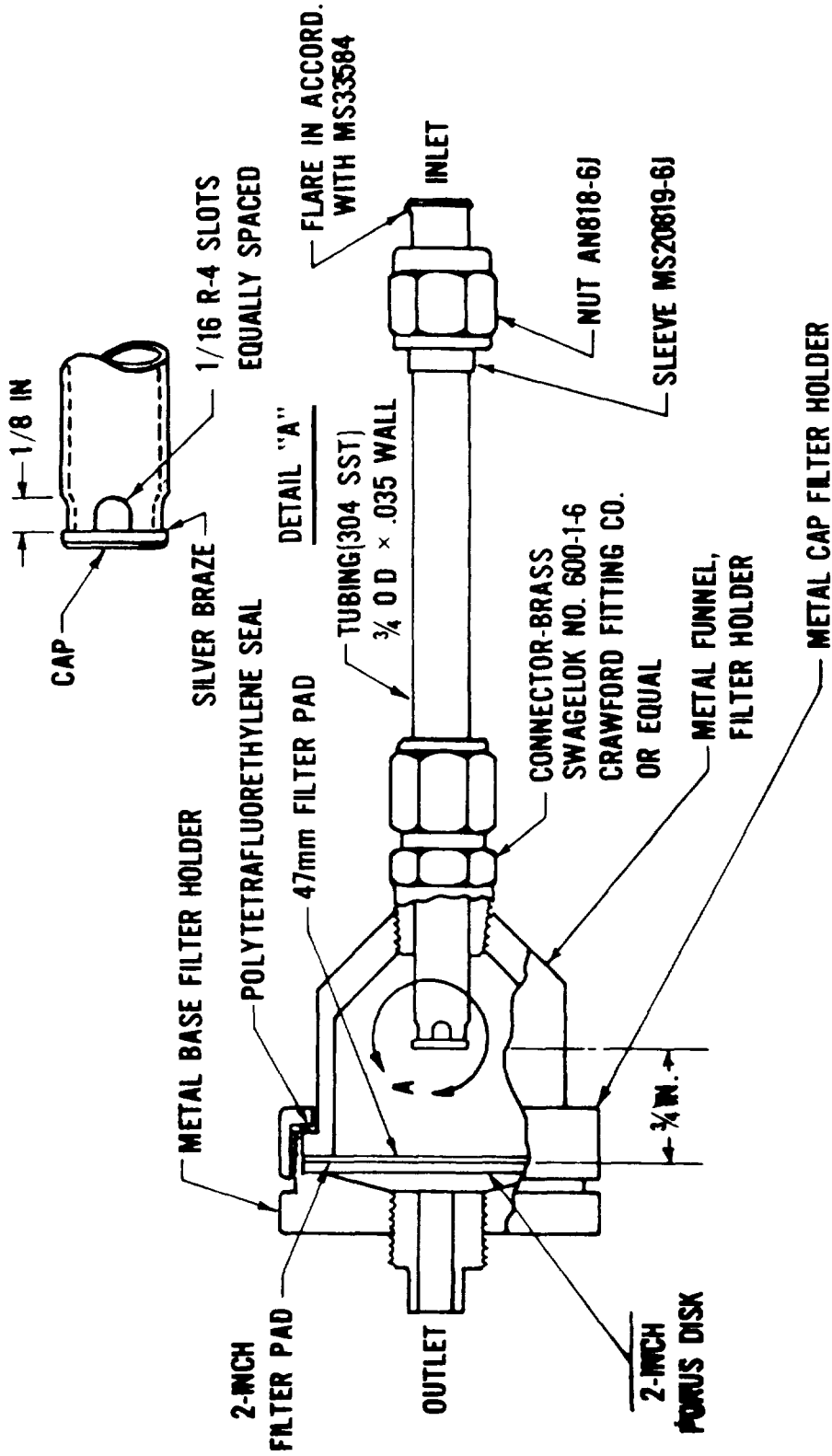
#### 4.5 Containers of Type I oxygen.

4.5.1 Filling pressure Samples shall be tested for proper filling pressure by attaching a calibrated Bourdon-tube gauge or equivalent to the valve outlet and by attaching either a thermocouple or thermometer to the container wall. The gauge shall have scale divisions not greater than 100 kPa (15 psi). If a thermometer is used, tape or putty shall be applied to the bulb to protect it from extraneous temperatures. Putty shall not be applied between the bulb and the cylinder wall. The thermometer shall have scale divisions not greater than 1°C (2°F). The containers shall be stabilized to ambient temperature. Then the valve shall be opened and the internal pressure observed on the gauge.

4.5.2 Leakage Each Type I oxygen container shall be tested for leaks at the neck threads, stem packing, and safety device of the valve with leak-detection fluid. Valve seat leakage shall be tested by means of a tube from the valve outlet to a container of liquid.

### 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or



**FIGURE 1. Filter, Cryogenic Liquids**



Defense Agency, or within the Military Department's System Command Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use. The propellant covered by this specification is intended for use as follows

- a. Grade A, type I - Purging and pressurization of propellant systems and rocket engines
- b. Grade A, type II - Oxidizer
- c. Grade B, type II - Oxidizer
- d. Grade F, types I and II - Fuel cell grade that may be used for crew breathing in subsystems utilizing a common storage for both functions

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification
- b. Type and grade of oxygen required (see 1 2).
- c. Issue of DoDISS to be cited in the solicitation, and, if required, the specific issue of individual documents referenced (see 2 2.1 and 2.3).
- d. When other limits or tests are required (see 3.1).
- e. When the particulate test is not required (see Table I).
- f. When a variation in the points of inspection is required (see 4 1).
- g. When a variation of the quality conformance tests to be performed on each sample is required (see 4.2 4).
- h. When a variation to the sampling method is required (see 4.2.4.2).
- i. When a variation to the continuous service option is required (see 4.2 6 1).
- j. When a variation to the 400 liter criteria for sampling is required (see 4 2.7).
- k. When a variation to the disposition of rejected product is required (4 3).
- l. When a variation of the analytical procedures is required (see 4.4).
- m. Packaging requirements (see 5 1 and 6.4).

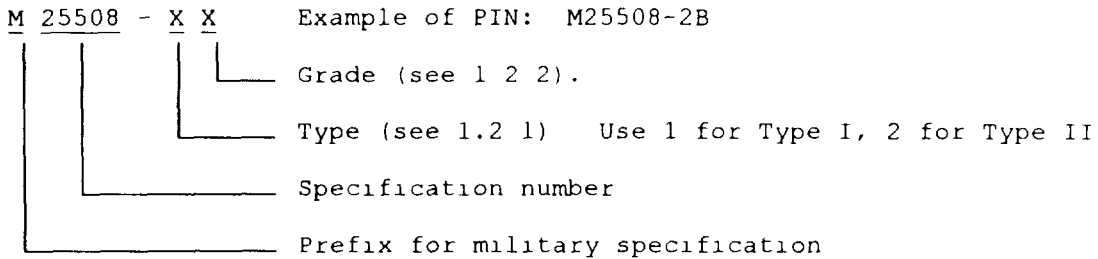
6.4 Packaging requirements. Guidance for cylinders may be found in the following documents

- a RR-C-901 - Cylinder, Compressed Gas, High Pressure, Steel DOT 3AA, and Aluminum Applications, General Specification For
- b MIL-V-2/39 - Valve, Cylinder, Gas, Oxygen Outlet 541
- c MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders
- d. MIL-STD-1411 - Inspection and Maintenance of Compressed Gas Cylinders
- e 49 CFR 171 - 199 - Code of Federal Regulations

6.5 Definition

6.5.1 Continuous service Continuous service applies to continuous deliveries under Government contract of oxygen complying with the quality conformance tests specified herein

6.6 Part or identifying number (PIN) The PINs to be used for oxygen acquired to this specification are created as follows



6.7 Subject term (key word listing)

- Aerospace
- Breathing
- Cryogenic
- Cylinders
- Fuel Cell
- Oxygen
- Propellant
- Space vehicle

6.8 Infrared analysis. Procedures for calibration and analysis may be found in MIL-STD-1564, *Procedure for Calibration and Analysis of Trace Contaminants in Aviator's Breathing Oxygen by Infrared Spectroscopy*

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians

Army - MI

Navy - AS

Air Force - 68

Review Activities

Air Force - 19

Preparing Activity

Air Force - 68

Civil Agency Interest

NASA

(Project 9135-0134)