INCH-POUND

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05 February 2007
SUPERSEDING
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DETAIL SPECIFICATION

CONVERTER, LIQUID OXYGEN, 10-LITER, GCU-24A/A

Reactivated after 05 February 2007 and may be used for new and existing designs and acquisitions.

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

1. SCOPE

1.1 Scope. This specification covers one type of aircraft converter, GCU-24A/A, used for storing and pressuring 10 liters of liquid oxygen.

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 cited 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 must meet all specified requirements of 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, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 491000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to thomas.omara@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

FEDERAL STANDARD

FED-STD-595	-	Colors Used in Government Procurement: Color number: 14187

COMMERCIAL ITEM DESCRIPTIONS

A-A-58092	-	Tape, Antiseize, Polytetrafluorethylene
A-A-59503	-	Nitrogen, Technical

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-9050	-	Valves, Oxygen, Pressure Relief, Aircraft
MIL-DTL-25516	-	Connectors, Electrical, Miniature, Coaxial, Environment Resistant Type, General Specification for
MIL-PRF-25567	-	Leak Detection Compound, Oxygen Systems
MIL-PRF-25961	-	Valve, Fill-Buildup-Vent, Liquid Oxygen Converter, CRU-50/A
MIL-PRF-27210	-	Oxygen, Aviator’s Breathing, Liquid and Gas

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129	-	Military Marking for Shipment and Storage
MIL-STD-130	-	Identification Marking of U.S. Military Property
MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-889	-	Dissimilar Metals
MIL-STD-1916	-	DoD Preferred Methods for Acceptance of Product

MS22068	-	Coupling Assemblies, Quick Disconnect, Aircraft Liquid Oxygen Systems. (Inactive for New Design)
MS90341	-	Mounting Bracket, Configuration, Mating Portion for 5 and 10 Liter Liquid Oxygen Converters. (Inactive for New Design)

DEPARTMENT OF DEFENSE HANDBOOK

MIL-HDBK-781	-	Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch or http://assist.daps.dla.mil or from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, 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 these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR QUALITY (ASQ)

ASQ-Z1.4	-	Sampling Procedures and Tables for Inspection for Attributes. (DoD Adopted)

(Copies of this document are available from the American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203-4606 or http://www.asq.org.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE-ARP1176	-	Oxygen System and Component Cleaning and Packaging. (DoD Adopted)

(Copies of this document are available from www.sae.org or SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

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 Qualification. The converter furnished under this specification shall be a product that is authorized by the qualifying activity for listing on the applicable qualified products lists before contract award (see 4.1 and 6.3).

3.2 First article. When specified (see 6.2), the converter shall be subjected to first article inspection in accordance with 4.3 and 6.4.

3.3 Materials. Materials shall conform to applicable specifications and shall be as specified herein and on applicable drawings. Materials which are not covered by specifications, or which are not specifically described herein, shall be of the best quality, of the lightest practicable weight, and for the purpose intended.

3.3.1 Metal parts. All metals parts shall be of a corrosion-resistant material or treated in a manner to render them resistant to corrosion.

3.3.1.1 Dissimilar metals. Unless protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are specified in MIL-STD-889.

3.3.2 Nonmetallic materials. Any nonmetallic material that is affected by continued use with oxygen shall not be used.

3.3.2.1 Age. Elastomer components, except silicon, shall be not greater than 12 months old from the date of manufacture to the date of delivery to any Government Service or to any airframe or accessory manufacturer.

3.3.3 Protective treatment. When materials are used in the construction of the converter that are subject to deterioration when exposed to environmental conditions likely to occur during service usage, they shall be protected against such deterioration in a manner that shall in no way prevent compliance with the performance requirements (see 3.5) of this specification. Protective coating which might crack, chip or scale during normal service life or under extremes of environmental conditions shall not be used.

3.4 Design and construction. The design and construction shall be in accordance with figures 1, 2, 3, and 4. The converter shall include provisions for filling with liquid oxygen when either installed or not installed in the aircraft and for being transported in the filled condition. The converter shall consist of the following major components:

Container
Container outer shell

Sensing element
Electrical connectors
Combination fill-buildup-vent valve
Relief valve
Secondary overpressure safety device
Pressure control valve
Mounting base

3.4.1 Components and hardware. The design of the components and associated hardware shall be such that the assembly/disassembly of the converter can be accomplished without the use of any special tools. All components and hardware shall be designed, protected, or positioned to prevent chafing due to normal service, shipping, and handling environments. Tube assemblies and warming coils shall be a minimum of 0.0625 inch (1.58 mm) from the container outer shell.

3.4.2 Container. The container shall be designed to contain a minimum of 10 liters of liquid oxygen measured at 1 atmosphere (101.3 kPa). The container shall be designed such that in case of contamination the container can be easily and completely cleaned by Overhaul and Repair servicing personnel and then returned to service status. If the container employs a vacuumized space as insulation, it shall be provided with a functional adsorbent. The container shall be baffled to prevent direct exit of liquid oxygen through the vent line during initial stages of the filling operation.

3.4.3 Container outer shell. The outer shell of the container shall be provided with a rupture point having not less than a 0.375 inch (9.525 mm) diameter escape area. Pressure required to rupture the escape area shall be at least 20 percent less than the burst pressure of the outer container shell. The rupture point shall be located in such a position that in case of rupture the danger to personnel shall be at a minimum.

3.4.4 Sensing element. The sensing element shall consist of an electrical capacitance having characteristics that provide for a linear relationship between electrical capacitance and volume sensed. The element shall be designed for use with indicator system components to indicate the amount of liquid oxygen in the liquid oxygen container. The sensing element shall be an integral part of the container and shall be permanently installed. The sensing element shall not be electrically grounded to the container. The interference limits shall be in accordance with MIL-STD-461.

3.4.4.1 Electrical connectors. The high impedance sensing elements lead shall be terminated in a connector conforming to MIL-DTL-25516, B polarity. The low impedance lead shall be terminated in a connector conforming to MIL-DTL-25516, E polarity. The connectors shall provide waterproof connection. The connectors shall be provided with dust caps connected to the converter by a chain or linkage arrangement. Storage clips shall be provided for these caps near the electrical connectors.

3.4.5 Combination fill-buildup-vent valve. The combination fill-buildup-vent valve, as a component only, shall meet the performance requirements of MIL-PRF-25961.

3.4.6 Relief valve. The relief valve, as a component only, shall meet the performance requirements of MIL-PRF-9050, Type II.

3.4.7 Pressure control valve. The pressure control valve shall be a pressure closing (shut-off) valve.

3.4.8 Check valve. The check valve, if used, shall be spring loaded.

3.4.9 Test port. A test port with a cap and retaining chain shall be incorporated in the tubing and located in such a manner that the entire converter assembly can be pressurized through the test port.

3.4.10 Secondary overpressure safety device. A secondary overpressure safety device, incorporating a frangible safety burst disc, shall be embodied in the plumbing of the converter. The location of the safety device shall be such that it will ensure rapid dumping of the head pressure from the converter in the event the pressure relief valve fails to open. The safety device shall contain a visible means of ascertaining the condition of the frangible safety burst disc without disassembly.

3.4.11 Shock mounts. Shock mounts and sway clearance due to shock mounting shall be within the specified envelope.

3.4.12 Antiseize tape. Antiseize tape shall be used on all male pipe thread fittings. Antiseize tape shall conform to and shall be applied as specified in A-A-58092. Tape shall not be used on flare tube fittings, straight threads, coupling sleeves, or on the outer side of tube flares. None of the tape shall be allowed to enter the inside of a fitting.

3.4.13 Mounting base. The mounting base shall conform to the configurations and dimensional requirements on figure 4.

3.5 Performance.

3.5.1 Permanent volumetric expansion. The permanent volumetric expansion of the inner vessel shall be not greater than 10 percent of the volumetric expansion at the test pressure when tested as specified in 4.6.2. There shall be no evidence of mechanical or material failure.

3.5.2 Pressure tests.

3.5.2.1 Inner vessel. The inner vessel shall show no evidence of material failure when tested as specified in 4.6.3.1.

3.5.2.2 Complete assembly. The complete converter assembly shall show no evidence of system leaks except as noted herein when tested as specified in 4.6.3.2.

3.5.3 Filling time. The time required to fill the converter, which shall have been initially at room temperature, shall be not greater than 6 minutes when tested as specified in 4.6.4.

3.5.4 Buildup time. The time required to attain the buildup pressure of 70 psig (482 kPa) shall be not greater than 5 minutes when testing as specified in 4.6.5.

3.5.5 Dielectric strength. The leakage current of the converter sensing element shall be not greater than 1.0 milliampere when measured as specified in 4.6.6.

3.5.6 Insulation resistance. The insulation resistance of the converter sensing element shall be 10 megohms between each electrode and converter ground and be not less than 20 megohms between the electrodes when measured as specified in 4.6.7.

3.5.7 Sensing element calibration.

3.5.7.1 Empty converter. The capacitance of the sensing element shall be 123.5 $\pm$ 2 picofarads (pf) when tested as specified in 4.6.8.1.

3.5.7.2 Filled converter. The capacitance of the sensing element shall be between the maximum and minimum limits as derived from the following equations when tested as specified in 4.6.8.2.

$$Cmax = (2.33 \times W) + 124.7$$

$$Cmin = (2.25 \times W) + 122.3$$

C = Capacitance in pf

W = Exact weight of the liquid oxygen in pounds at the test point.

3.5.8 Relief valve test. The relief valve shall operate between 100 and 120 psig (689 and 827 kPa) and shall allow a minimum flow of 80 liters/min (Lpm) (0.080 cubic meters/min.) at 120 psig (827 kPa) through the valve when tested as specified in 4.6.9.

3.5.9 Evaporation loss test.

3.5.9.1 Initial evaporation loss in vented condition. The converter shall not have a weight loss greater than 3.0 pounds (1.36 kg) for a 24-hour period with the unit vented to the atmosphere when tested as specified in 4.6.10.1.

3.5.9.2 Second evaporation loss in vented condition. The converter shall meet the requirements specified in 3.5.9.1 when tested as specified in 4.6.10.2.

3.5.9.3 Evaporation loss in pressurized condition. The converter shall not have a weight loss greater than 7.5 pounds (3.375 kg) for a 48-hour period when tested as specified in 4.6.10.3.

3.5.10 Secondary overpressure safety.

3.5.10.1 Secondary overpressure safety (standard temperature). The secondary overpressure safety device shall not leak at a pressure below 175 psig (1,206.58 kPa), and the frangible safety burst disc (see 3.4.10) shall rupture within a pressure range of 200 psig (1,378.95 kPa) minimum and 250 psig (1,723.68 kPa) maximum when tested as specified in 4.6.11.1. The safety device shall provide a minimum flow of 150 Lpm with the safety disc in the ruptured condition.

3.5.10.2 Secondary overpressure safety (low temperature). The secondary overpressure safety device shall not leak at a pressure level below 175 psig (1206.58 kPa), and the frangible safety burst disc (see 3.4.10) shall rupture within a pressure range of 200 psig (1378.95 kPa) minimum and 315 psig (2171.84 kPa) maximum when tested as specified in 4.6.11.2. The safety device shall provide a minimum flow of 150 Lpm with the safety disc in the ruptured condition.

3.5.10.3 Secondary overpressure safety (high temperature). The secondary overpressure safety device shall not leak at a pressure below 175 psig (1206.58 kPa), and the frangible safety burst disc (see 3.4.10) shall rupture within a pressure range of 175 psig (1206.58 kPa) minimum and 250 psig (1723.68 kPa) maximum when tested as specified in 4.6.11.3. The safety device shall provide a minimum flow of 150 Lpm with the safety disc in the ruptured condition.

3.5.11 Vibration. The converter shall show no evidence of mechanical failure, and the evaporation loss shall be not greater than 3.0 pounds (1.36 kg) when tested as specified in 4.6.12.

3.5.12 Acceleration test. The converter shall show no evidence of mechanical or material failure, and the evaporation loss shall be not greater than 3.0 pounds (1.36 kg) when tested as specified in 4.6.13.

3.5.13 Shock test.

3.5.13.1 Shock test (procedure I). The converter shall show no evidence of mechanical or material failure, and the evaporation loss shall be not greater than 3.0 pounds (1.36 kg) when tested as specified in 4.6.14 and 4.6.14.1.

3.5.13.2 Shock test (procedure III). The converter shall not break free from the mounting provisions when tested as specified in 4.6.14 and 4.6.14.2.

3.5.14 Salt fog. The converter shall show no evidence of corrosion or mechanical failure when tested as specified in 4.6.15.

3.5.15 Delivery rate. The converter shall function normally and deliver oxygen on demand for at least 90 minutes and until not greater than one pound of oxygen remains in the converter when tested as specified in 4.6.16.

3.5.16 Reliability. The converter shall have a specified mean time between failures (MTBF) of not less than 300 hours at the 90 percent lower confidence limit when tested as specified in 4.6.17. (This is equivalent to a minimum acceptable MTBF of 200 hours and a reliability of 0.9933 for a 2-hour mission.)

3.5.17 Maintainability. The total corrective maintenance time shall be not greater than 1 hour of maintenance downtime when performed as specified in 4.6.18.

3.5.18 Gunfire test. The converter shall show no evidence of shattering when tested as specified in 4.6.19. The installation mounting base of the converter shall withstand the forces exerted by the gunfire test.

3.6 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable.

3.7 Weight. The empty weight of the complete converter, including shock mounts if provided and the receptacle halves of the quick disconnect couplings, shall be not greater than 20 pounds (9.07 kg).

3.8 Color. The converter container shall be green, approximately matching color number 14187 of FED-STD-595. The color of all other parts shall be optional.

3.9 Cleanliness.

3.9.1 Degreasing. Prior to assembling the converter, all internal surfaces of the converter shall be degreased and cleaned in accordance with SAE-ARP1176. After assembly, the absence of cleaning compounds shall be verified in accordance with SAE-ARP1176.

3.9.2 Purging. The completed converter, prior to preparation for delivery, shall be purged with hot, dry oxygen, conforming to MIL-PRF-27210, Type I or nitrogen conforming to A-A-59503, Type I, Class I, Grade B, until all traces of the contaminants are removed. The temperature of the purging gas shall be not greater than 250 °F (121 °C) at the converter inlet,

and the purge pressure shall be 50 ± 5 psig (345 ±34 kPa). After purging, charge the container with gaseous oxygen at 25 ± 5 psig (172 ± 34 kPa) and close all openings with approved closures.

3.10 Odors. The interior of the converter shall be free from odor. The converter shall be free of toxic gases or by-products (see 6.2.d).

3.11 Identification of product. The converter shall be marked for identification in accordance with MIL-STD-130 except that the Federal Stock Number shall be omitted and the contract and serial number shall be stamped on the nameplate.

3.11.1 Vacuum performance test plate. A metal plate shall be attached to the converter to provide spaces and columns to show results and dates of evaporation loss tests. The plate shall provide sufficient space for permanently recording results of at least 12 tests. Results and dates of all the evaporation loss tests conducted by the converter manufacturer shall be legibly recorded upon the plate by the manufacturer.

3.11.2 Marking. Each unit and shipping container shall be marked in accordance with MIL-STD-129. In addition, the following precautionary marking shall be required on each unit package and shipping container:

CAUTION

DO NOT ALLOW PETROLEUM CONTAMINANTS OF ANY
KIND TO BE USED/STORED ON OR ABOUT THESE
CONTAINERS.

3.11.2.1 Special requirements. All wrapping cushioning, dunnage and containers shall be completely free of contamination by oil or grease.

3.11.3 Warning notes. A warning note shall be located in a conspicuous place on the container. The note may be applied by decal, plate, or stencil. The following information, in 0.25 inch (6.35 mm) high red letters on a white or frosted aluminum background shall be provided:

CAUTION
HIGH VACUUM CONTAINER
HANDLE WITH CARE

3.12 Workmanship. The converters shall be uniform in quality and shall be free from irregularities, defects, or foreign material which could adversely affect safety, performance, reliability, or durability.

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. Qualification inspection. (See 4.2 and 6.3.)

b. First article inspection. (See 4.3.)

c. Conformance inspection. (See 4.4.)

4.2 Qualification inspection. Qualification inspection shall consist of all the examinations and tests of this specification.

4.2.1 Qualification samples. Qualification samples shall consist of:

a. Two each complete converter assemblies.

b. One each inner vessel complete with all lines and fittings.

c. One each additional sample of the major components specified in 3.6 (excluding the secondary overpressure safety device).

d. Three each secondary overpressure safety devices (see 3.4.10).

e. A Statement of Certification (with supported test data) from the manufacturer that the converters conform to the reliability requirements cited in 3.5.16 and 4.6.17.

Samples shall be forwarded to a test facility set forth in the letter of authorization to submit samples (see 6.3). The samples shall be plainly identified by securely attached durable tags marked with the following information:

> Sample submitted by (name) (date) for qualification inspection in accordance with the requirements of MIL-DTL-19803 and number under authorization (reference authorizing letter and number, (see 6.3)).

4.3 First article inspection. First article inspection shall consist of the following examinations and tests:

Visual examination
Dimensions
Permanent volumetric expansion
Pressure tests

Filling time
Buildup time
Dielectric strength
Insulation resistance
Relief valve test
Sensing element calibration
Evaporation loss tests
Secondary overpressure safety
Delivery rate

4.3.1 First article samples. Unless otherwise specified, as soon as practicable after the award of the contract or order, the manufacturer shall submit two complete converters, one inner vessel (complete with all lines and fittings) and one secondary overpressure safety device. The samples shall be representative of the construction, workmanship, components, and materials to be used during production. When a manufacturer is in continuous production of these units from contract to contract, submission of further first article samples on the new contract may be waived at the discretion of the procuring activity (see 6.2b). Approval of the first article samples or the waiving of the first article inspection does not preclude the requirements of submitting to a conformance inspection. The first article inspection samples shall be furnished to the Government as directed by the contracting officer (6.2c).

4.3.1.1 First article information. Upon completion of the first article inspection program, pertinent comments and recommendations will be forwarded by the Government activity responsible for conducting the inspection program (see 6.2c) to the contracting officer. One approved converter shall be returned to the manufacturer for use in monitoring production. The other sample shall be consumed or destroyed in the first article inspection and shall not be considered as part of the quantity to be delivered under the contract.

4.4 Conformance inspection. The sampling and inspection levels shall conform to ASQ-Z1.4. Conformance inspection shall consist of the following examinations and tests:

Visual examination
Dimensions
Permanent volumetric expansion
Pressure tests
Filling time
Buildup time
Dielectric strength
Insulation resistance
Relief valve test
Sensing element calibration
Evaporation loss tests
Secondary overpressure safety

Delivery rate (room temperature)

4.4.1 Sampling.

4.4.1.1 Inspection lot.

4.4.1.1.1 Converter. An inspection lot size shall be expressed in units of one converter made under essentially the same conditions and from the same materials and components. The sample unit shall be one converter.

4.4.1.2 Sampling for tests and examinations of converters. The sample size, acceptance criteria, tests, and examinations required for the converters shall be as specified in table I.

TABLE I. Test method, sample size, and acceptance criteria of the converters.

Inspection	Test method	Sample size	Acceptance criteria
Visual examination (See table II, classification of defects)	4.6.1.1	Every converter for critical defects.	Reject all units with any critical defects.
		Inspection level II for minor defects.	Acceptance Quality Level of 2.5 defects per hundred units for minor defects.
Dimensions	4.6.1.1.1	Inspection Level S-2	Acceptance number zero, rejection number 1.
Permanent volumetric expansion	4.6.2	Inspection Level S-4	Acceptance number zero, rejection number 1.
Pressure tests	4.6.3	Every converter	Reject all defective units.
Filling time	4.6.4	Every converter	Reject all defective units.
Building time	4.6.5	Every converter	Reject all defective units.
Dielectric strength	4.6.6	Inspection Level S-2	Acceptance number zero, rejection number 1.
Insulation resistance	4.6.7	Every converter	Reject all defective units.
Relief valve test	4.6.9	Every converter	Reject all defective units.
Sensing element calibration (empty converter)	4.6.8.1	Every converter	Reject all defective units.
Sensing element calibration (filled converter)	4.6.8.2	Inspection level S-2	Acceptance number zero, rejection number 1.
Evaporation loss tests	4.6.10	Every converter	Reject all defective units.
Secondary overpressure safety	4.6.11	Inspection Level S-2	Acceptance number zero, rejection number 1.
Delivery rate (room temperature)	4.6.16.1	Inspection Level S-2	Acceptance number zero, rejection number 1.

TABLE II. Classification of defects for visual examination of converter.

Critical	Minor
1. Material imperfections - foreign matter embedded. 2. Surface - unclean, rough, misaligned, or containing cracks, nicks, or other flaws. 3. Any component missing, malformed, fractured, or otherwise damaged. 4. Any component loose or otherwise not securely retained. 5. Incorrect assembling or improper positioning of components. 6. Any functioning part that works with difficulty. 7. Faulty workmanship or other irregularities.	201. Marking - missing, insufficient, incorrect, illegible or not permanent. 202. Color not as specified.

4.5 Test conditions.

4.5.1 Oxygen. Unless otherwise specified, the oxygen used in testing the converters shall conform to MIL-PRF-27210, Type I or Type II.

4.5.2 Temperature and pressure. Unless otherwise specified, tests shall be conducted at local ambient temperatures and barometric pressure. Corrections shall be made to provide agreement with the temperature and pressure calibration of the instruments. Inspection data provided by any instrument not calibrated to normal temperature and pressure (NTP) conditions shall be corrected to determine NTP requirements. NTP conditions are 29.92 inches of mercury (101.3 kPa) and 70 °F (21.1 °C).

4.5.3 Test equipment. The delivery rate tests shall be performed on a breathing machine capable of fulfilling all tests requirements of this specification.

4.5.3.1 Master capacitance bridge. The master capacitance test bridge employed for capacitance testing the sensing element shall have an accuracy of 0.2 percent or 0.2 pf, whichever is greater. In all subsequent tests and measurements specified herein, the tolerance of the measuring equipment shall be added to the specified tolerance for the given test or measurement.

4.6 Inspection methods.

4.6.1 Visual examination.

4.6.1.1 Converter. Every converter shall be examined visually (for critical defects) to determine conformance to this specification. The classification of defects, table II, shall be used to classify the defects found.

4.6.1.1.1 Dimensions. The converter shall be checked dimensionally to determine conformance to the dimensions specified herein.

4.6.2 Permanent volumetric expansion. This test shall be conducted before the outer vessel is added. The inner vessel, complete with all lines and fittings, shall be subjected to a hydrostatic or pneumatic test in a water jacket in which the vessel is totally submerged and free to expand in all directions. The difference is temperature between the water in the jacket and the water or gas in the vessel shall be not greater than 5 °F (2.8 °C). The test pressure shall be not less than 200 psig (1379 kPa) and shall be maintained not less than one minute or longer, to ensure complete expansion of the vessel. Any internal pressure previously applied shall be not greater than 90 percent of the test pressure. The pressure gage shall permit readings to an accuracy of one percent. The expansion gage shall permit readings to an accuracy of one percent or 0.1 cubic centimeter (cc). The expansion shall be recorded in cc. The water in the expansion gage shall come to rest quickly. If the water in the expansion gage drops below its original position or does not come to rest quickly after the pressure is released, the test shall be repeated. The inner vessel shall meet the requirements specified in 3.5.1.

4.6.3 Pressure tests.

4.6.3.1 Inner vessel. The test shall be conducted before the outer vessel is added. The inner vessel shall be charged to a pressure of 200 $\pm$ 5 psig (1379 $\pm$ 35 kPa) and maintained for not less than one minute. The inner vessel shall meet the requirements specified in 3.5.2.1.

4.6.3.2 Complete assembly. The complete converter assembly, including all fittings and tube connections, shall be subjected to a pneumatic pressure of 95 psig (655 kPa) applied through the test port. While the test pressure is maintained, all fittings and connections shall be examined for leaks by application of leak test compound conforming to MIL-PRF-25567. The complete converter assembly shall meet the requirements specified in 3.5.2.2. Care shall be taken to remove all traces of the leak test compound from the converter assembly after the test is performed.

4.6.4 Filling time. The time required to fill the converter to its specified capacity by transfer of liquid oxygen using standard transfer equipment shall be determined. The filling pressure at the converter filler valve shall be maintained at 30 psig (207 kPa). The time required to fill the converter shall be within the time specified in 3.5.3.

4.6.5 Buildup time. The time required to attain buildup pressure shall be determined with a converter that has been empty for a minimum of 30 minutes. Fill the converter with liquid oxygen to design capacity and immediately after filling the converter, actuate the pressure

generating system. The time required to attain buildup pressure shall be within the time specified in 3.5.4.

4.6.6 Dielectric strength. The sensing element shall be installed in an empty converter, and the dielectric strength of the sensing element shall be measured at a voltage of 500 volts, rms, at a commercial frequency. The voltage shall be maintained for a period of 10 seconds between each lead wire and the converter ground and between the two lead wires. The sensing element of the converter shall meet the requirements specified in 3.5.5.

4.6.7 Insulation resistance. The sensing element shall be installed in an empty converter, and the insulation resistance of the sensing element shall be measured at 50 volts, direct current, between each electrode and the converter ground and between the electrodes. The sensing element of the converter shall meet the requirement specified in 3.5.6.

4.6.8 Sensing element calibration.

4.6.8.1 Empty converter. The sensing element shall be installed in an empty converter and the capacitance of the sensing element measured. The capacitance shall be within the limits specified in 3.5.7.1.

4.6.8.2 Filled converter. The converter assembly shall be filled to rated capacity with liquid oxygen. The liquid oxygen shall then be removed in five increments of 5.1 $\pm$ 0.2 pound (2.31 $\pm$ 0.09 kg). The capacitance of the sensing element shall be measured with the converter filled and at each increment. The capacitance shall be within the limits specified in 3.5.7.2.

4.6.9 Relief valve test. A pressure source capable of being varied from 0 to 150 psi (0 to 1034 kPa) shall be connected to the converter test port. The pressure in the converter shall be slowly increased until the relief valve of the converter actuates, continue increasing pressure to 120 psi (827 kPa). The opening pressure of the relief valve and the flow rate through the valve shall be within the limits specified in 3.5.8.

4.6.10 Evaporation loss tests. The evaporation loss tests in the vented condition may be conducted on the container only. The weight losses shall be recorded on the vacuum performance test plate as specified in 3.5.9.

4.6.10.1 Initial evaporation loss in vented condition. The container shall be filled with liquid oxygen to rated capacity and allow to stand in vented condition for a minimum period of two hours for equilibrium to be established. After which, with the unit vented to the atmosphere, the loss in weight for a 24-hour period shall be recorded. The container shall meet the requirements specified in 3.5.9.1.

4.6.10.2 Second evaporation loss in vented condition. After a lapse of at least 30 days from the above test, the vented evaporation loss test shall be conducted in the same manner and the

evaporation loss for a 24-hour period recorded. The container shall meet the requirements specified in 3.5.9.2.

4.6.10.3 Evaporation loss in pressurized condition. Upon completion of the vented evaporation loss tests, the complete converter assembly including all components shall be subjected to a 48-hour evaporation loss test in the pressurized condition. The converter shall be placed in the pressurized condition, and the initial weight reading shall be taken immediately after the converter has been filled. The loss in weight for a 48-hour period shall be recorded. The converter assembly shall meet the requirements specified in 3.5.9.3.

4.6.11 Secondary overpressure safety. The secondary overpressure safety test shall be performed on the secondary overpressure safety device prior to installation on the converter. The inlet of the secondary overpressure safety device shall be subjected to a gradually increasing pressure until rupturing of the frangible safety burst disk occurs.

4.6.11.1 Secondary overpressure safety (standard temperature). The secondary overpressure safety device shall be conditioned at 72 $\pm$ 5 °F (22 $\pm$ 3 °C) for three hours. After conditioning, and while still at this temperature, the safety device shall be tested as specified in 4.6.11. The safety device shall meet the requirements specified in 3.5.10.1.

4.6.11.2 Secondary overpressure safety (low temperature). The secondary overpressure safety device shall be conditioned -200 $\pm$ 5 °F (-129 $\pm$ 3 °C) for three hours. After conditioning, and while still at this temperature, the safety device shall be tested as specified in 4.6.11. The safety device shall meet the requirements specified in 3.5.10.2.

4.6.11.3 Secondary overpressure safety (high temperature). The secondary overpressure safety device shall be conditioned at 260 $\pm$ 5 °F (127 $\pm$ 3 °C) for three hours. After conditioning, and while still at this temperature, the safety device shall be tested as specified in 4.6.11. The safety device shall meet the requirements specified in 3.5.10.3.

4.6.12 Vibration. The converter shall be attached by its mounting plate to a rigid test fixture capable of transmitting the vibration conditions specified herein. The vibration test shall be conducted at room temperature with the converter filled with liquid oxygen and in the buildup condition. Tests shall be conducted under both resonance and cycling conditions as specified in 4.6.12.1 and 4.6.12.2. Vibration displacement, velocity or acceleration shall be measured and interpreted at the specific applied instantaneous test frequency. The vibration test table shall actually move through the displacement corresponding to the required acceleration at all frequencies. Local impacting of loose components which results in high “noise” content of the applied vibration shall not be considered as vibration input. If such “noise” is encountered, a low pass frequency filter which cuts off at approximately twice the test frequency shall be employed to reject the “noise.” After the vibration test, the converter shall be filled with liquid oxygen and then vented to the atmosphere for a 24-hour period. The converter shall meet the evaporation

loss requirements specified in 3.5.11. The converter shall then be subjected to and pass the delivery rate test specified in 4.6.16.1.

4.6.12.1 Resonance. Resonant modes of the converter shall be determined by varying the frequency of applied vibration slowly through the specified range at vibratory accelerations not greater than those shown on figure 5. Individual resonance surveys shall be conducted with vibration applied along each axis of any set of three mutually perpendicular axes of the converter. The converter shall be vibrated at the indicated resonant conditions for the periods shown in the vibration test schedule, table III, and with the applied double amplitudes of vibratory accelerations on figure 5. These periods of vibration shall be accomplished with vibration applied along each of the three mutually perpendicular axes of vibration. When more than one resonance is encountered with vibration applied along any one axes, each resonance shall be sustained for the period shown in the applicable portion of the vibration test schedule. If more than four resonances are encountered with vibration applied along any one axes, the four most severe resonances shall be chosen for test.

TABLE III. Vibration test schedule.

(Times shown refer to one axis of vibration.)

Number of resonances	0	1	2	3	4
Total vibration time at resonance 1/	-	30 min	1 hr	1.5 hr	2 hr
Cycling time	3 hr	2.5 hr	2 hr	1.5 hr	1 hr

1/ 30 minutes at each resonance.

4.6.12.2 Cycling. The converter shall be vibrated under the cycling conditions specified here for the applicable periods listed in the vibration test schedule (4.6.12.1). The frequency shall be cycled between 5 to 500 cycles/sec (cps) and return in 15-minute cycles at an applied double amplitude of 0.036 inch or an applied acceleration of ± 10 g whichever is the lower “g” value. The rate of change of frequency shall be logarithmic.

4.6.13 Acceleration test. The converter, with the probe assembled, shall be filled to rated capacity with liquid oxygen, allowed to reach operating pressure under no flow conditions, and then subjected to an acceleration test in accordance with MIL-STD-810, Method 513, Procedure II. The forward-backward and lateral forces applied shall be 10 g. The vertically downward force applied shall be 14 g. The vertically upward force applied shall be 6 g. After the acceleration test, the converter shall be vented to the atmosphere for a 24-hour period. The converter shall meet the evaporation loss requirements and the structural requirements specified in 3.5.12. The converter shall then be subjected to and pass the delivery rate (room temperature) test.

4.6.14 Shock test. The converter, filled to rated capacity with liquid oxygen and with the probe assembled, shall be subjected to the shock test specified in MIL-STD-810, Method 516.2, Procedures I and III, Figure 516.2-2.

4.6.14.1 Shock test (procedure I). After the shock test, procedure I, the converter shall be vented to the atmosphere for a 24-hour period. The converter shall meet the evaporation loss requirements and the structural requirements specified in 3.5.13.1. The converter shall then be subjected to and pass the delivery rate (room temperature) test.

4.6.14.2 Shock test (procedure III). The converter shall meet the structural requirements specified in 3.5.13.2.

4.6.15 Salt fog. The converter, with its ports adequately plugged and the probe assembled, shall be subjected to the salt fog test specified in MIL-STD-810, Method 509.1, Procedure I. The converter shall meet the requirements specified in 3.5.14. The converter shall then be subjected to and pass the following tests:

a. Visual examination.

b. Complete assembly pressure test (4.6.3.2).

c. Sensing element calibration (4.6.8).

d. Evaporation loss (4.6.10.1).

e. Delivery rate (room temperature) (4.6.16.1).

4.6.16 Delivery rate. The evaporation tubing shall consist of 100 $\pm$ 5 feet (30.48 $\pm$ 1.52 m) of 0.3125 inch (7.94 mm) outside diameter aluminum tubing. The supply port of the converter shall be connected to a breathing machine through the evaporation tubing. The breathing machine shall be set up to simulate the complete breathing characteristics of three human subjects, breathing in the flow patterns shown on figure 6. The converter shall be filled to rated capacity prior to the test. After 3 minutes of stabilization, the converter pressure at the supply port shall remain between 55 and 90 psig (379 and 620 kPa) throughout the test. A pressure drop below 55 psig (379 kPa) during the first three minutes of the test is acceptable.

4.6.16.1 Delivery rate (room temperature). The converter assembly shall be conditioned at room temperature for 3 hours. After conditioning and while still at this temperature, the converter shall be tested as specified in 4.6.16. The converter shall meet the requirements specified in 3.5.15.

4.6.16.2 Delivery rate (low temperature). The converter assembly shall be conditioned at a temperature of -65 $\pm$ 2 °F (-53.9 $\pm$ 1.1 °C) for 3 hours. After conditioning and while still at this

temperature, the converter shall be tested as specified in 4.6.16. The converter shall meet the requirements specified in 3.5.15.

4.6.16.3 Delivery rate (high temperature). The converter assembly shall be conditioned at a temperature of 260 ± 2 °F (126.7 ± 1.1 °C) for 3 hours. After conditioning and while still at this temperature, the converter shall be tested as specified in 4.5.16. The converter shall meet the requirements specified in 3.5.15.

4.6.17 Reliability. The converter shall be subjected to the delivery rate testing at room temperature (see 4.6.16.1). A failure shall be identified as any malfunction which causes the converter to deliver an insufficient flow of oxygen or to maintain an improper operating pressure. No parts shall be replaced as preventive maintenance during reliability testing. The converter shall be checked at least once every 24 hours during reliability testing to determine if a failure has occurred. Acceptance shall be based on the accept-reject criteria of Test Plan II of MIL-HDBK-781. Recording, data handling and reporting procedures shall be in accordance with MIL-HDBK-781. The converter shall meet the requirements specified in 3.5.16.

4.6.18 Maintainability. Maintainability tests shall be performed to show compliance with 3.5.17. All corrective maintenance tasks for expected failure modes shall be conducted by simulating failures. Each maintenance task shall be performed at least three times to determine average values. Only field level maintenance tasks shall be considered. The demonstration shall include the procedure to troubleshoot, fault isolation, removal (based only on the installation provisions of the item), fault correction, adjustment and realignment, final test, and replacement, but shall exclude supply and administrative time. Upon completion, the converter shall be operated to demonstrate normal functioning and will deliver oxygen on demand. The converter shall meet the requirements specified in 3.5.17.

4.6.19 Gunfire test. The converter containing all plumbing and components shall be mounted on a frame capable of withstanding the maximum force to which the converter will be subjected by the gunfire test. The converter shall be filled to rate capacity with liquid oxygen and the nominal operating pressure of the converter maintained. The converter shall be fired upon from a distance of approximately 50 yards (45.7 m) by a 0.50 caliber armor piercing incendiary bullet which has been tumbled. The bullet shall strike the converter in the liquid phase. There shall be no evidence of shattering, and the converter assembly shall remain in one piece except components in the direct line of fire. Shattering is the fragmentation of basic materials. Separation of small components from the converter when they are located in the immediate vicinity of the impact area is satisfactory. The converter shall meet the requirements specified in 3.5.18.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. 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 converter covered by this specification is intended to be used in military aircraft liquid oxygen systems for storing and pressurizing liquid oxygen for subsequent conversion to the gaseous phase as required for aircrewman breathing during flight.

6.2. Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification, including any amendments.

b. When first article is required (see 3.2).

c. Name and address of the first article inspection laboratory (see 4.3.1) and the name of the Government activity responsible for conducting the first article inspection program (see 4.3.1.1).

d. The contractor shall submit verifiable evidence that the converter system is free from any objectionable odor, toxic gases or by-products (see 3.10).

e. Marking requirements (see 3.11.2).

f. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List, QPL-19803, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be

obtained from the Commander, Naval Air Systems Command, Code 4.6.3.2, 48110 Shaw Road, Bldg 2187, Patuxent River, MD 20670-5304.

6.3.1 Drawings. When requested, the manufacturer should submit engineering drawings and inspection reports in accordance with SD-6, Provisions Governing Qualification.

6.4 First article. When a first article inspection is required, the item will be tested and should be a first article sample. The contracting officer should include specified instructions in procurement documents regarding arrangements for examinations, test and approval of the first article.

6.5 Laboratory information.

6.5.1 Applicable to Naval Air Systems Command. The successful bidder will be furnished with the name of the qualification inspection laboratory. The costs of the tests and examinations on samples initially submitted from a lot will be borne by the Government. Samples from a rejected lot will not be resubmitted for tests and examinations without the approval of the contracting officer. The costs of the tests and examinations on samples resubmitted from a reworked lot or from a new lot which is necessitated by the rejection of a previous lot will be borne by the manufacturer. Upon completion of testing, the samples will be returned to the contractor, at the contractor's expense.

6.5.2 Applicable to the Air Force. For purchases by Air Force, the pertinent information will be as specified by the contracting officer (see 6.2c).

6.6 Subject term (key word) listing.

Breathing
Pressurize

6.7 Unit conversion. Conversion of units in this document is in accordance with ASTM E380-82 Metric Practice. The following conversion factors are applicable to this specification.

Atmosphere x 101.325 = kilopascals (kPa)
Pounds per square inch (psi) x 6.894 = kPa
Inches x 25.4 = millimeters (mm)
Feet x 0.3048 = meters (m)
Liters per minute (1pm) x 0.001 = cubic meters per minute (cu m/min)
Pounds x 0.4535 = kilogram (kg)
Inches of Hg x 3.376 = kPa
[Degrees Fahrenheit (°F) - 32] ÷1.8 = Degrees Celsius (°C)

6.8 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

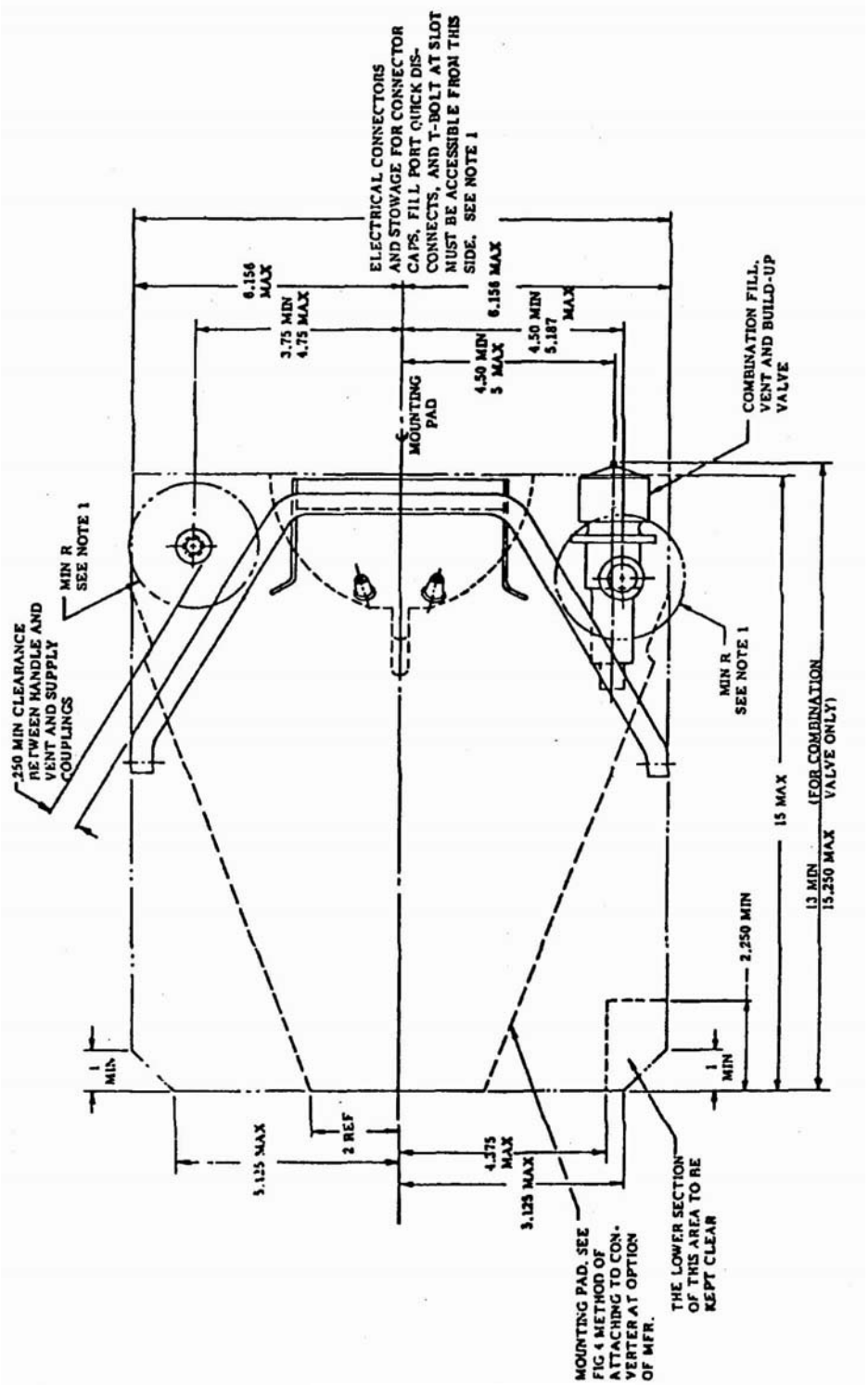


FIGURE 1. Top view.

NOTES:
1. 1 1/2 inch min. radius from center line of supply and vent ports shall be provided for glove clearance for mating and disconnecting couplings. Radius is not restricted to maximum envelope of converter.
2. All components shall be within the maximum specified envelope.
3. Unless otherwise specified, dimensions in inches.

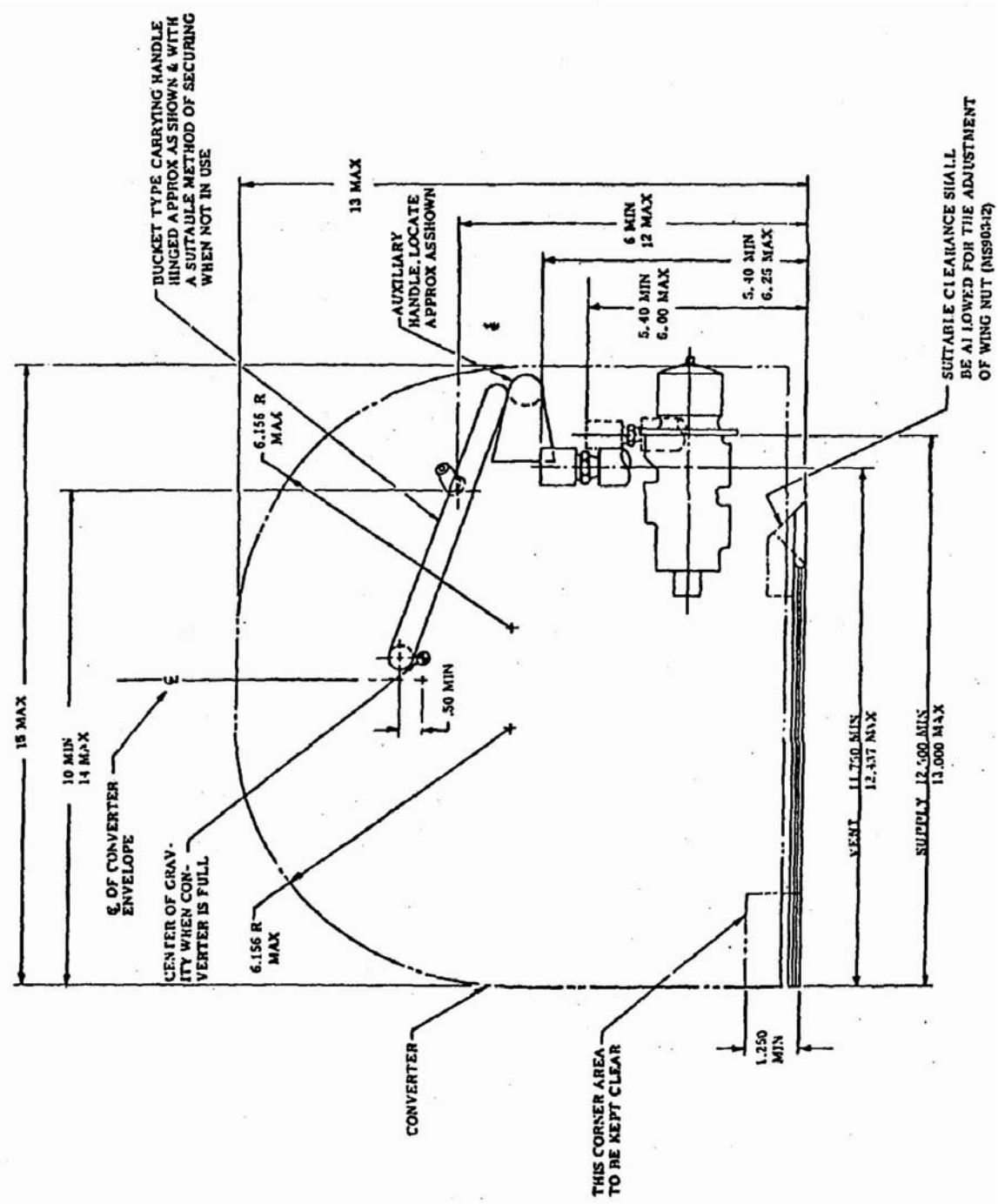
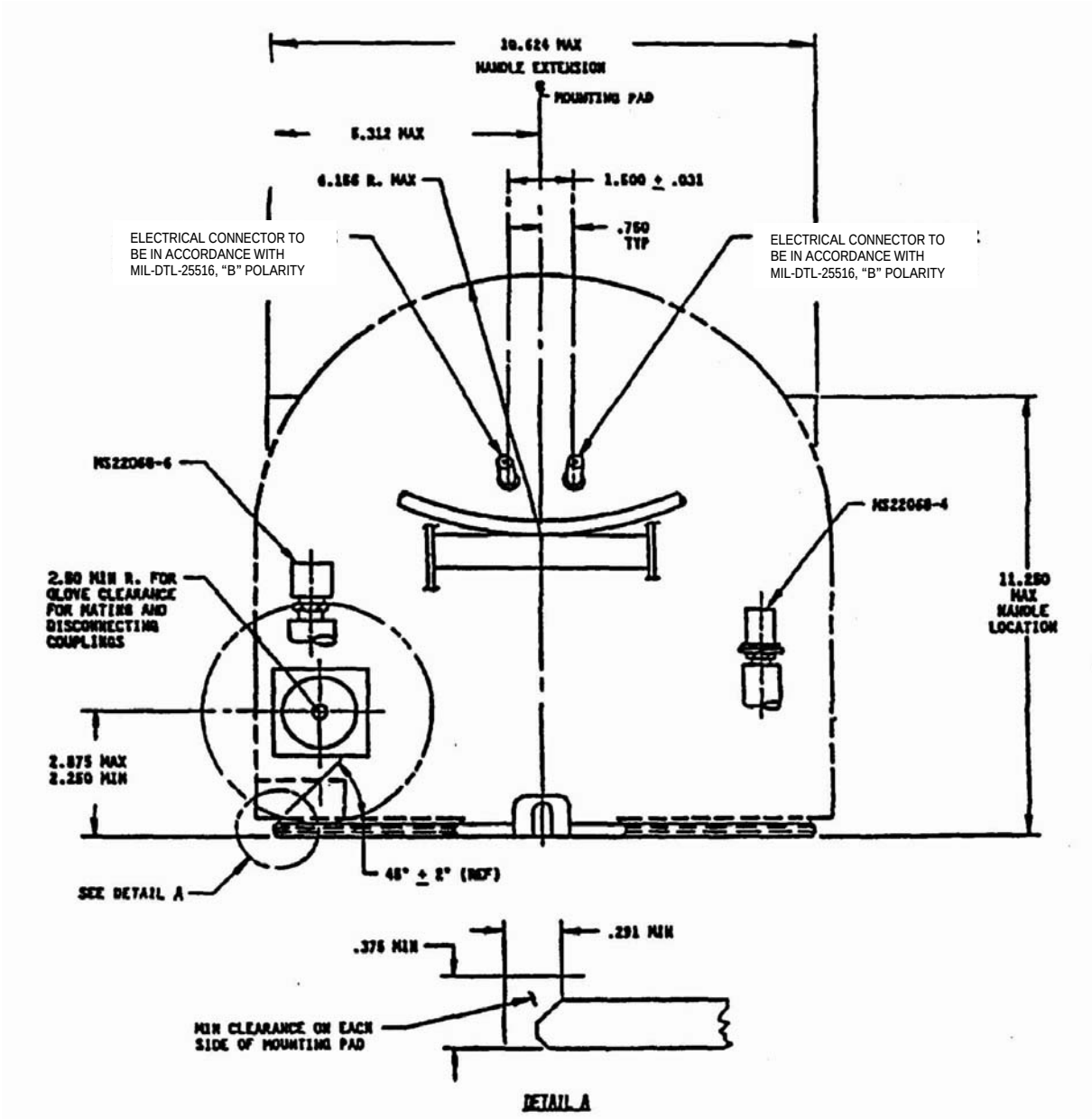


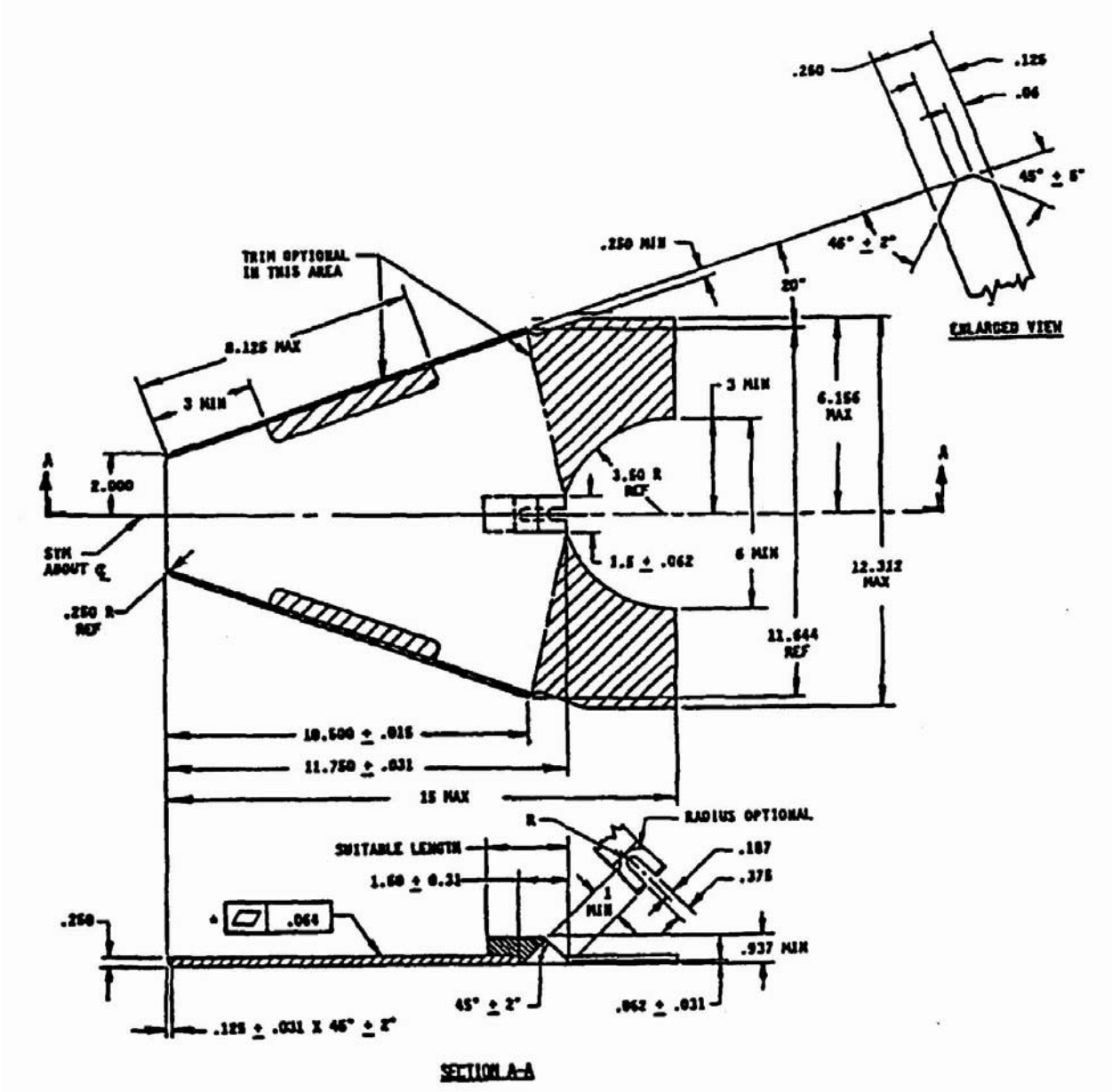
FIGURE 2. Side view.

NOTES:
1. 1 1/2 inch min. radius from center line of supply and vent ports shall be provided for glove clearance for mating and disconnecting couplings. Radius is not restricted to maximum envelope of converter.
2. All components shall be within the maximum specified envelope.
3. Unless otherwise specified, dimensions in inches.



NOTES:
1. All components shall be within the specified maximum envelope.
2. Unless otherwise specified, dimensions in inches.

FIGURE 3. Front view.



NOTES:
1. This mounting base is designed to mate with the mounting bracket shown on MS90341.
2. Unless otherwise specified, dimensions in inches. Tolerances: Decimals ± .010, Angles ± 1/2 °.

FIGURE 4. Mounting base.

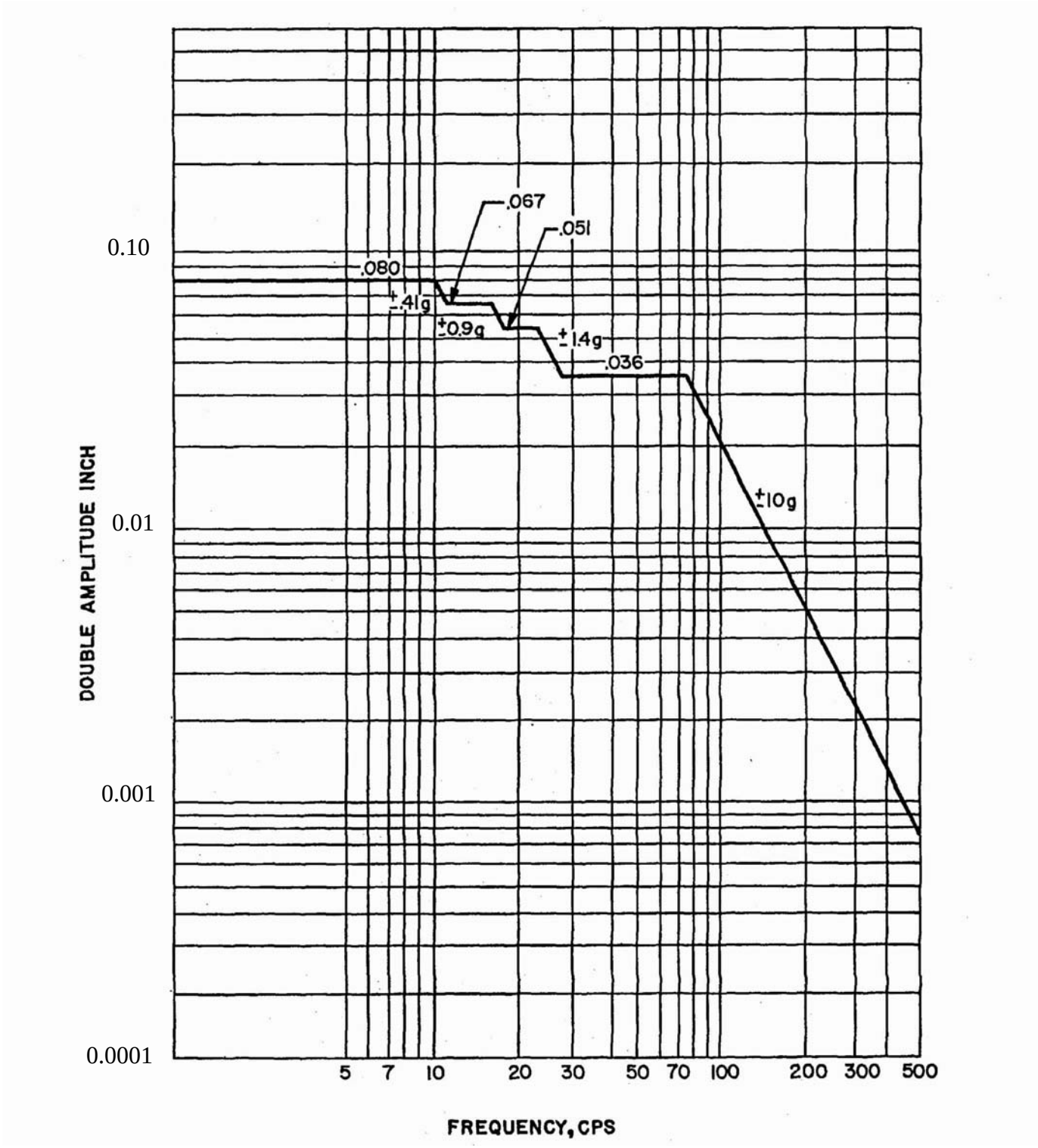


FIGURE 5. Range curve for converter vibration.

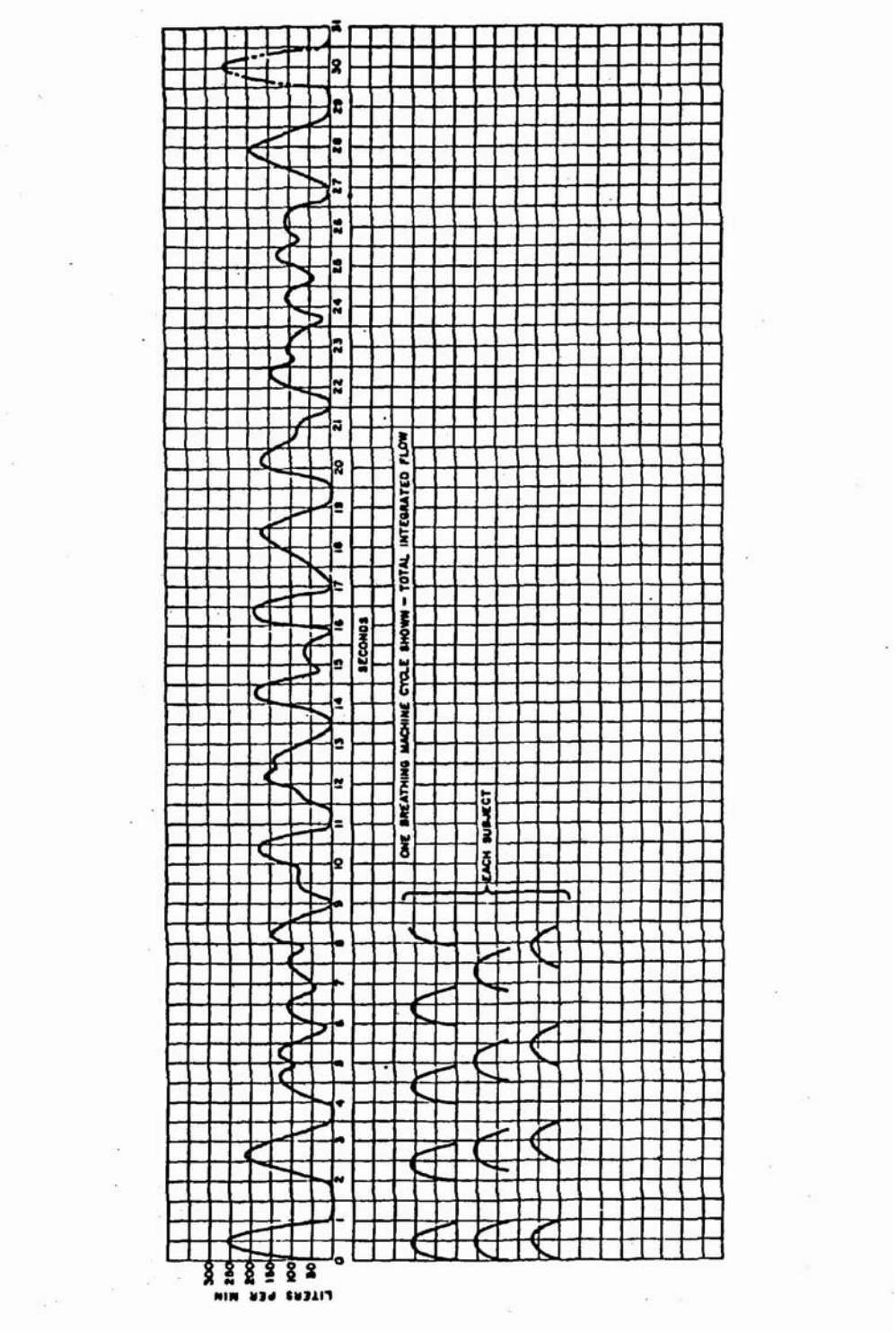


FIGURE 6. Delivery rate flow pattern, three subjects, moderate work.

CONCLUDING MATERIAL

Custodians:
Army - AV
Navy - AS
Air Force - 99

Preparing activity:
Navy - AS
(Project 1660-2006-004)

Review activities:
Air Force 71
DLA - GS

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 Online database at http://assist.daps.dla.mil.