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March 5, 1982
SUPERSEDING
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June 21, 1976

FEDERAL SPECIFICATION

FLUOROCARBON REFRIGERANTS

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal Agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the requirements for fluorocarbon refrigerants with collateral use as nonpolar beat transfer and electronics isolation media. Fluorocarbon solvents are excluded from this specification.

1.2 Classification. The fluorocarbon refrigerant shall be of the following types, as specified (see 6.2):

Type	Chemical Name	Formula
11	Trichloromonofluoromethane	CCl_3F
12	Dichlorodifluoromethane	CCl_2F_2
13	Monochlorotrifluoromethane	$CClF_3$
21	Dichloromonofluoromethane	$CHCl_2F$
22	Monochlorodifluoromethane	$CHClF_2$
113	Trichlorotrifluoroethane	CCl_2FCClF_2
114	Dichlorotetrafluoroethane	$CClF_2CClF_2$
116	Hexafluoroethane	CF_3CF_3
500	Dichlorodifluoromethane/ difluoroethane	CCl_2F_2/CH_3CHF_2
502	Monochlorodifluoromethane/ Monochloropentafluoroethane	$CHClF_2/CClF_2CF_3$
503	Trifluoromethane/ Monochlorotrifluoromethane	$CHF_3/CClF_3$

2. APPLICABLE DOCUMENTS

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

Federal Specifications:

RR-C-910 - Cylinders, Compressed Gas: ICC 4BA, ICC 4BW, and ICC 4E.
TT-L-32 - Lacquer, Cellulose Nitrate, Gloss for Aircraft Use.

PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock Corner.
PPP-B-636 - Boxes, Shipping, Fiberboard.

Federal Standards:

FED. STD. No. H28 - Screw-Thread Standards for Federal Service.
FED. STD. No. 123 - Marking for Domestic Shipment (Civil Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, standards, and commercial item descriptions as outlined under General Information in the Index of Federal Specifications and Standards and Commercial Item Descriptions. The index which includes cumulative bimonthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

(Single copies of this specification and other Federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Service Centers in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, HO, Fort Worth, Houston, Denver, San Francisco, Los Angeles, and Seattle, WA.)

(Federal Government activities may obtain copies of Federal specifications, standards, commercial item descriptions, and the Index of Federal Specifications, Standards and Commercial Item Descriptions from established distribution points in their agencies.)

Military Specifications:

MIL-V-2 - Valves, Cylinder, Gas (For Compressed or Liquified Gases), General Specification.
MIL-V2/22 - Value, Cylinder, Gas, Dichlorodifluoromethane Monochlorodifluoromethane, Dichlorotetraflouroethane, Methyl Chloride, Sulfur Dioxide Bromochloromethane, and Bromotriflouromethane Outlet 621.
MIL-T-704 - Treatment and Painting of Materiel.

Military Standards:

MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders.
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-147 - Palletized and Containerized Unit Loads, 40 Inch by 48 Inch Pallets, Skids, Runners or Pallet Type Base.

MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; With Appropriate Test Methods.
MIL-STD-1411 - Inspection and Maintenance of Compressed Gas Cylinders.

Publications:

TM 88-250 (AFR 71-4, NAVSUP PUB 505, MCO P4030.19D, DSAM 4145.3) - Preparation of Hazardous Materials for Military Air Shipment.

DEPARTMENT OF TRANSPORTATION (DOT)
4.9 CFR 100-199 Code of Federal Regulations, Title 49-Transportation.
Title 49 Code of Federal Regulations, Specification 39.
Title 49 Code of Federal Regulations, Specification 17E.

(The Code of Federal Regulations (CFR) and the Federal Register (FR), are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20204. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

(Copies of Military specifications, standards and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Physical properties. Fluorocarbon refrigerants shall conform to table I.

3.2 Containers and valves. Unless otherwise specified herein, the fluorocarbon refrigerants shall be contained in Government-furnished cylinders in accordance with CFR Title 49, 171-190, and equipped with valves in accordance with outlet connection No. 668 or 660 in accordance with FED-STD-H28. When specified (see 6.2), cylinders shall be furnished by the contractor and shall be in accordance with RR-C-910 and shall be equipped with valves in accordance with MIL-V-2. When specified (see 6.2), the fluorocarbon refrigerants shall be contained in contractor-owned DOT-approved containers with valves with outlet connection No. 668.

3.2.1 Disposable containers. When specified (see 5.2), the contractor shall furnish disposable containers of the capacity as specified in accordance with the CFR Title 49, Specification 39. The unit of pack for disposable containers requires packaging in fiberboard boxes in accordance with Specification 39 and marking (see 5.2) shall be in high visibility on each unit of park. Drums 100-200 pounds conforming to Specification 17E shall be used to contain type II and type 113 fluorocarbon refrigerants.

3.3 Container maintenance. Government furnished containers that require maintenance shall be processed by the contractor for serviceability to meet the requirements of this specification and MIL-STD-1411.

3.3.1 Container inspection and cleanup. Prior to filling the fluorocarbon refrigerants, each container shall be inspected. The container interior shall be clean and free of contaminants which could alter the properties of the fluorocarbon refrigerants.

TABLE I. Physical Properties of Fluorocarbon Refrigerants

Physical Properties	Type										
	11	12	13	21	22	113	114	116	500	502	503
Water content, max. percent by weight	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Air in vapor-phase, in filled container max. percent by volume, liquid sample	-	1.5	5.0	1.5	1.5	-	1.5	1.5	1.5	1.5	5.0
Boiling point, °F, at 29.92 ins. Hg	74.9°	-21.6°	-114.6°	48.1°	-41.4°	117.6°	38.8°	-108.8°	-28.3°	-49.8°	-127.6°
Boiling range, °F, 5 to 85 percent distilled	0.5°	0.5°	0.9°	0.5°	0.5°	0.5°	0.5°	0.5°	0.9°	0.9°	0.5°
High boiling impurities, max. percent by volume	0.01	0.01	0.05	0.01	0.01	0.03	0.01	0.01	0.05	0.01	0.01
Chloride ion by test	None	None	None	None	None	None	None	None	None	None	None

3.3.2 Treatment and painting. Government-furnished cylinders and containers for fluorocarbon refrigerants requiring repainting shall have the old paint, decals and rust removed. The metal surface shall be pretreated and painted in accordance with MIL-T-704, type C finishing system. When a contractor services all acceptable cylinders and containers, including paint removal and refinishing, at no cost to the Government above the base price of the fluorocarbon commodity, the practice of applying a one coat finishing system by electrostatic or automatic spraying principles on a conveyor process shall be acceptable. The paint shall be a fast drying lacquer in accordance with TT-L-32 applied with quality equal to or better than that practiced on the contractor's regular product line (see 6.4). When specified for overseas or unprotected storage, military cylinders and containers for fluorocarbon shall have the paint removed, the metal pretreated and painted with a prime coat and a finish coat in accordance with MIL-T-704, type A finishing system (see 6.2). Government-owned cylinders shall be color-coded and marked in accordance with MIL-STD-101.

3.4 Capacity. Unless otherwise specified (See 6.2), containers shall be filled to the rated capacity. The weight of fluorocarbon refrigerant supplied shall be the difference between the filled weight and the unfilled tank weight of the container (see 6.3).

3.5 Leakage. Containers and valves shall not leak after being filled.

3.6 Caution markings. Each fluorocarbon refrigerant container shall be marked to warn personnel to avoid the breathing of vapors. The decal or label shall be placed on the shoulder of the cylinder, but not over identification marking. Labels shall be placed away from outlets on drumheads. A contractor's decal warning against the breathing of vapors is acceptable.

3.7 Leak detecting dye. When specified (see 6.2), a leak detecting dye shall be added to the refrigerant. Each container having a leak detecting dye shall be marked to indicate that the dye has been added and that the refrigerant shall be charged in the liquid phase only. The dye shall be of a type which shall not effect the performance of the refrigerant or the refrigeration system.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements specified herein. Except as otherwise specified in the contract, 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 supplies and services conform to prescribed requirements.

4.1.1 Component and material inspection. The contractor is responsible for insuring that components and materials used are manufactured, examined, and tested in accordance with referenced specifications and standards.

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

(a) Quality conformance inspection (see 4.3).
(b) Examination of preparation for delivery (see 4.5).

4.3 Quality conformance inspection.

4.3.1 Inspection lot. Cylinders or containers filled in a 24-hour period from the same source and with the same type of fluorocarbon refrigerant shall be considered a lot.

4.3.2 Sampling. Sampling for tests shall be from filled cylinders or containers and shall be in accordance with MIL-STD-105, Inspection level S-4.

4.3.3 Examination. Samples selected in accordance with 4.3.2 shall be examined for the following major defects. AQL shall be 4.0 percent defective.

101. Cylinder or container not as specified.
102. Evidence of leakage.
103. Marking not as specified.
104. Net weight not in accordance with rated cylinder capacity.

4.3.4 Tests. Samples selected in accordance with 4.3.2 shall be tested as specified in 4.4.1 through 4.4.4. AQL shall be 1.5 percent defective.

4.4 Test methods.

4.4.1 Water content. The fluorocarbon refrigerant shall be tested for water content. The analysis may be conducted by using the phosphorus pentoxide method, by infrared absorption, by an electrolytic moisture analyzer, or by a piezoelectric analyzer. The Karl Fischer method shall be the referee method in confirming accuracy of results. Water content greater than specified in table I shall constitute failure of this test.

4.4.2 Air in the vapor phase.

4.4.2.1 Types 12, 13, 21, 22, 114, 116, 500, 502, and 503. Fluorocarbon refrigerant numbers 12, 13, 21, 22, 114, 116, 500, 502, and 503 shall be tested for air in the vapor phase in the original container by the determination of gases not absorbable in perchloroethylene using water as a sealant. The test may be conducted by the determination of gases not absorbable in perchloroethylene using mercury as a sealant, or by the determination of gases remaining when the refrigerant is frozen. The determination of gases not absorbable in perchloroethylene using water as a sealant shall be the standard.

4.4.2.1.1 Apparatus.

(a) Absorption vessel, Lab Glass Co. No. LG-11119 or equal.
(b) Leveling bulb and connecting tubing.

(c) Perchloroethylene reagent: specific gravity at 59 deg./39 deg. F, 1.628-1.632; no free halogens; 0.001 maximum free acid as HC1: 0.0007 maximum residue on evaporation; distill completely between 238 and 252 deg. F; 31 deg. F maximum cloud point.

(d) Silicone solution: 1 part "Siliclad" (Scientific Glass Co.) in 100 parts of water.

4.4.2.1.2 Procedure.

(a) Wash the absorption vessel thoroughly and rinse in distilled water. Coat the inside with the silicone solution, let stand for 5 minutes and then discard the solution. Rinse again with distilled water and dry at 212 deg. F for 10 minutes.
(b) When cool, add 20 ml of distilled water and fill with perchloroethylene.
(c) Add sufficient water to the leveling bulb to give a water seal.
(d) Collect a 100 cc sample from the vapor space of the refrigerant unit directly into the absorption vessel. A slight positive pressure is needed to prevent entry of extraneous air.
(e) Tilt the vessel in such a way as to remove all the water lock which separated the perchloroethylene from the refrigerant gas. Allow the perchloroethylene to flow into the upper chamber of the vessel and gently agitate to aid in the absorption of the refrigerant gas.
(f) Return the vessel to an upright position and allow the water layer to flow back into the burette section.
(g) Adjust the leveling bulb so that the liquid layers are at the same level.
(h) Read the percent of nonabsorbable gas from the burette.
(i) A blank run is made with a sample from the liquid phase of the refrigerant unit and the result subtracted from the analysis of the vapor phase.

The presence of air in the vapor phase in excess of 1.5 percent by volume shall constitute failure of this test.

4.4.2.2 Gas chromatography. Fluorocarbon refrigerants may be tested for the concentration of air in the vapor phase by gas chromatography. A concentration of air in excess of the percent by volume listed in table I shall constitute failure of this test.

4.4.3 Boiling point, boiling range, and high boiling impurities.

4.4.3.1 Apparatus.

(a) Goetz phosphorus tube, 100 ml capacity.
(b) Thermometer, National Bureau of Standards certified for the temperature range anticipated.
(c) Carborundum crystals, 20 mesh.

4.4.3.2 Procedure.

(a) Fill the Goetz tube with 100 ml of the sample, add two or three crystals of carborundum, and suspend temperature indicating instrument in the sample.
(b) Suspend the tube in a medium (air or water) held at a minimum temperature of 90 deg. F above the expected boiling point.
(c) As soon as the thermometer is constant after 5 ml of the sample has been distilled, record the reading as the initial observed boiling point.
(d) Record as the end point the temperature reached when 85 ml of sample has evaporated. Calculate the boiling range.
(e) Transfer the tube and the remaining 15 ml of sample to a second medium maintained at a temperature 50 deg. F above the boiling point.
(f) After 30 minutes, record the residual material as the percentage of high boiling impurities.
(g) Correct the boiling point to 29.92 inches Hg as follows:

Obtain atmospheric pressure at point of test in inches of mercury. Corrected boiling point (deg. F) equals the observed boiling point plus factor for each inch below 29.92 inches or minus factor for each inch above 29.92 inches as applicable in table II.

TABLE II. Factors for Correcting Boiling Point to 29.92 In. Hg.

Fluorocarbon Refrigerant	Correction Factor deg. F/inc. Hg.
11	1.7
12	1.5
13	1.1
21	1.6
22	1.3
113	1.8
114	1.6
118	1.2
500	1.4
502	1.3
503	1.1

A corrected boiling point other than that specified in table I, a corrected boiling range in excess of that specified in table I, or a percentage of high boiling impurities more than that specified in table I, shall constitute failure of this test.

4.4.4 Chlorination test. Add 3 or 4 drops of a saturated solution of silver nitrate to 5 ml of absolute methyl alcohol in a test tube and shake. Reagent shall be negative. Add 5 ml of the sample. Any turbidity indicates the presence of chloride ions and constitutes failure of this test.

4.5 Examination of preparation for delivery. An examination shall be made to determine compliance with the requirements of section 5. A sample unit shall be one shipping container fully prepared for delivery. Sampling shall be in accordance with MIL-STD-105. The inspection level shall be S-2 with an AQL of 4.0 expressed in terms of percent defective.

5. PREPARATION FOR DELIVERY

5.1 Packing. Packing shall be level A, B, or Commercial, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Disposable cylinders. Disposable cylinders in unit packs (see 3.2.1) shall be packed in an upright position in a close fitting box conforming to PPP-B-601, overseas type, style I or J, or PPP-B-621, class 2, style optional. Contents shall be blocked and cushioned in accordance with MIL-STD-1186. Boxes shall be closed and reinforced in accordance with the appendix to PPP-B-636.

5.1.1.2 Cylinders and drums. Unless otherwise specified, cylinders and drums shall be either packed in boxes as specified in 5.1.1.1, or pelletized in accordance with MIL-STD-147, as specified in the contract or order (see 6.2). The loads shall be secured in accordance with the appendix to the applicable specification.

5.1.2 Level B.

5.1.2.1 Cylinders, drums, and disposable cylinders. Packing shall he specified in 5.1.1, except that domestic boxes shall be used.

5.1.3 Commercial. Refrigerant containers shall be packed in accordance with Title 49 Code of Federal Regulations. Packing for military air shipment shall be in accordance with TM 38-250.

5.2 Marking.

5.2.1 Military agencies. Marking for level A or B shall be in accordance with MIL-STD-129.

5.2.2 Civil agencies. Marking shall he in accordance with FED. STD. No. 123.

6. NOTES

6.1 Intended use. The fluorocarbon compounds covered by this specification are intended primarily for use in refrigeration and air conditioning units, however, some of the gases may be used as an aerosol propellant or as nonpolar heat transfer and electronic isolation media. Fluorocarbons of solvent grades are not covered by this specification.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Type fluorocarbon required (see 1.2).
(c) When contractor shall furnish Government-approved cylinders (see 3.4).
(d) When contractor-owned DOT-approved cylinders shall be furnished (see 3.2).
(e) When the contractor will furnish DOT-approved disposable containers (see 3.2.1).
(f) When military materiel painting is required (see 3.3.2).
(g) When cylinder capacities shall differ from capacities of Government-approved cylinders (see 3.4).
(h) Level of packing required (see 5.1).
(i) When containers shall be boxed, pelletized, or shipped loose (see 5.1.1.2).
(j) When leak detecting dye is to be added (see 3.7).

6.3 Cylinder capacities. Fluorocarbon refrigerants should be purchased by weight (pounds avoirdupois). Type II is available in disposable containers or gas cylinders. Type 113 is usually furnished in disposable containers. All other types are supplied in cylinders or DOT-approved containers having nominal capacities between 10 and 150 pounds, depending upon material purchased and container size.

6.4 Automated cylinder handling systems. Fluorocarbon refrigerants have been purchased for a number of years on a cost per unit basis. Suppliers of fluorocarbons operate near automated filling plants in which valves, cylinders and containers are serviced internally and externally in accordance with the requirements of Title 49 Code of Federal Regulations, to maintain the purity and integrity of the suppliers' fluorocarbon products. In these contracts Government cylinders are received serviced (including color coding, MIL-STD-101) and filled, or rejected and returned to the supplying agency at no additional charge for cylinder service. This specification has been written .o accept automatic internal and external cylinder handling unless otherwise specified for special military requirements.

6.5 Recycled material. It is encouraged that recycled material be used when practical as long as it meets the requirements of the specification.

6.6 Venting to atmosphere. In compliance with EPA regulations limiting refrigerants to the atmosphere fluorocarbon aerosol propellants have been deleted from this specification. Care should be exercised in utilization of these products to minimize venting to the atmosphere in all applications.

MILITARY INTERESTS:

Custodians:
Army - ME
Navy - SH
Air Force - 68

Review activities:
Army - MD, EA, MI
DSA - GS

User activity:
Navy - YD
DOD - MA

CIVIL AGENCY COORDINATING ACTIVITIES:
GSA - FSS
HEW - FDA
VA - OSS

Preparing activity:
Army - ME

DOD Project 6830-0104

Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See Section 2 of this specification to obtain extra copies and other documents referenced herein.