



Designation: **D7194—05 D7194 – 12**

Standard Specification for Aerospace Parts Machined from Polychlorotrifluoroethylene (PCTFE)¹

This standard is issued under the fixed designation D7194; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification is intended to be a means of calling out finished machined parts ready for aerospace use. Such parts may also find use in selected commercial applications where there are clear benefits derived from the use of parts with known or controlled crystallinity, high molecular weight, good molecular weight ~~retention~~, retention during processing, dimensional stability in the finished part, and tightly controlled engineering tolerances.

1.2 This specification establishes requirements for parts machined from virgin, unplasticized, ~~100%–100 %~~ polychlorotrifluoroethylene (PCTFE) homopolymers.

1.3 This specification does not cover parts machined from PCTFE copolymers, PCTFE film or tape less than 0.25-mm (0.010-in.) thick, or modified PCTFE (containing pigments or plasticizers).

1.4 This specification does not allow parts containing recycled material.

1.5 The specification does not cover PCTFE parts intended for general use applications, in which control of dimensional stability, molecular weight, and crystallinity are not as important. For machined PCTFE parts intended for general use, use Specification D7211.

1.6 This specification classifies parts into three classes based upon intended uses and exposures: oxygen-containing media, reactive media, and inert gases media.

1.7 *Application*—PCTFE components covered by this specification are virgin, ~~100%–100 %~~ PCTFE resin, free of plasticizers and other additives. The components are combustion resistant in oxygen, dimensionally stable, and meet other specific physical characteristics appropriate for their end use. They are used in valves, regulators, and other devices in oxygen, air, helium, nitrogen, hydrogen, ammonia, and other aerospace media systems. The components typically are used as valve seats, o-rings, seals, and gaskets. They are removed and replaced during normal maintenance procedures. The components provide reliable sealing surfaces resulting in proper closure of valves and related devices and no leakage from the system into the environment. They will experience static mechanical loading, cyclic mechanical loading, temperatures ranging from cryogenic to ~~71°C (160°F)~~, 71 °C (160 °F), and pressures up to ~~46.2 MPa (6700 psi)~~, 68.9 MPa (10,000, psig) for oxygen and air media, and 103.4 MPa (15,000 psig) for inert media.

1.8 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.9 The following precautionary caveat pertains only to the test methods portion, Section 12, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*²

~~D621~~D618 Specification for Jute Rope and Plied Yarn for Electrical and Packing PurposesPractice for Conditioning Plastics for Testing (Withdrawn 2000)

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials. Current edition approved July 1, 2005/Oct. 1, 2012. Published August 2005/November 2012. Originally approved in 2005. Last previous edition approved in 2005 as D5111 - 05. DOI: ~~10.1520/D7194-05~~10.1520/D7194-12.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D638 Test Method for Tensile Properties of Plastics
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D883 Terminology Relating to Plastics
- D1430 Classification System for Polychlorotrifluoroethylene (PCTFE) Plastics
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
- ~~D2117 Test Methods for Carbon Black—Surface Area by Nitrogen Adsorption (Withdrawn 1999)³~~
- D2512 Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Techniques)
- D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
- D7211 Specification for Parts Machined from Polychlorotrifluoroethylene (PCTFE) and Intended for General Use
- G86 Test Method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Ambient Liquid Oxygen and Pressurized Liquid and Gaseous Oxygen Environments

2.2 Federal Standards³

~~NASA-STD-6001~~NASA-STD-6001B Flammability, ~~Odor~~,Offgassing, and ~~Offgassing~~Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion—~~Mechanical Procedures—Mechanical Impact~~ for Materials in Ambient Pressure LOX (Test 13A) and Mechanical Impact for Materials in Variable Pressure GOX and LOX (Test 13B)

3. Terminology

3.1 Definitions:

3.1.1 Terms are defined in accordance with Terminologies **D883** and **D1600** unless otherwise indicated.

3.1.2 *air media, n*—liquid air, pressurized air, and breathing air.

3.1.3 *cognizant engineering organization, n*—the company, agency, or other authority responsible for the system or component in which aerospace grade PCTFE is used. This, in addition to design personnel, may include personnel from material and process engineering, or quality groups and others as appropriate.

3.1.4 *inert media, n*—gaseous helium (GHe) and gaseous nitrogen (GN₂); up to 103.4 MPa (15,000 psig).

3.1.5 *oxygen media, n*—liquid oxygen (LOX) and gaseous oxygen (GOX); (GOX) up to 68.9 MPa (10,000 psig).

3.1.6 *processing route, n*—the method whereby a thermoplastic is taken above its melting point and processed into a semifinished article, typically sheet or rod stock. For PCTFE, the common processing methods are extrusion and compression molding.

3.1.7 *reactive media, n*—ammonia (NH₃) up to ~~1-723.5~~ 250(500) MPa (250(500) psig), gaseous hydrogen (GH₂) up to 46.2 MPa (6700 psig), and liquid hydrogen (LH₂) up to ~~2-762.8~~ 400 MPa (400 psig).

<https://standards.iteh.ai/catalog/standards/sist/6158528a-ac24-4c1a-91b6-47e6c9f22bfb/astm-d7194-12>

4. Classification

4.1 Part shape and size shall be defined by the applicable purchase order.

4.2 The type of product shall be categorized by the intended use category:

4.2.1 *Type I* for use in air and oxygen media (see **3.1.2** and **3.1.5**) at service pressures above 11.4 MPa (1650 ~~psi~~); psi) that require batch testing.

4.2.2 *Type II* for use in (1) air and oxygen media (see at 3.1.2 and 3.1.5) at service pressures below 11.4 MPa (1650 ~~psi~~); psi), or at service pressures above 11.4 MPa (1650 psi) that do not require batch testing); or (2) inert and reactive media up to the pressures specified in 3.1.4 and 3.1.7.

4.2.3 *Type III* for use in ~~inert~~ media other than air, oxygen, GHe, GN₂, ammonia, GH₂, and reactive LH₂ media (see, at service **3.1.4** and pressures specified **3.1.6**); by the cognizant engineering organization.

4.2.4 *Type IV* for use in other media specified by the cognizant engineering organization.

5. Ordering Information

5.1 All parts covered by this specification shall be ordered by Specification D7194-type, Type, as listed in Section 4., or as listed on the procurement drawing when Type is not specified explicitly.

6. Materials and Manufacture

6.1 Parts shall be made from polymers as-polymerized resin meeting all requirements of Classification System **D1430**. Type *I, II, III*, and *IV* parts shall be fabricated from polymers as-polymerized resin classified as meeting Classification System **D1430**, Group 01, Class 1, Grade 3.

³ Available from the U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: DE, Washington, DC 20401.

6.2 Parts shall be made from virgin, unplasticized, ~~100%~~ 100 % polychlorotrifluoroethylene (PCTFE) homopolymer.

6.3 No recycled polymer or regrind shall be permitted.

6.4 The base material shall be free of all defects or contaminants that would be detrimental to final fabrication or performance of the finished parts.

7. Property Requirements

7.1 Specification values listed in this specification are minimum specification values. Any additional requirement for specific tests or data shall be specified at the time of the order.

8. General Requirements

NOTE 2—Unless otherwise specified in the purchase contract or order, the molder producing the semifinished article from which finished parts are made will be responsible for insuring the requirements in ~~8.108.6~~ are met. All other requirements listed in Section 8 pertain to the finished part, and therefore, will be the responsibility of the supplier of the finished, machined part.

8.1 Finished parts shall have a natural translucent appearance. The color shall be white or gray with no yellowing or other unnatural color.

8.2 Finished parts shall be free of voids, scratches, fissures, inclusions, or entrapped air bubbles that will affect serviceability. No particles (for example, black specks) shall be visible to the naked eye.

8.3 All finished parts are to be supplied after being annealed in accordance with ~~12.812.4~~.

8.4 No dimension of a finished part shall change more than 0.003 mm/mm (0.003 in./in.) measured at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) 2°C ($73 \pm 4^\circ\text{F}$) before and after being held for 48 ± 5 h at $71 \pm 5^\circ\text{C}$ 5°C ($160 \pm 9^\circ\text{F}$), 9°F , as determined by the method in ~~12.912.5~~.

8.5 The specific gravity variation, sp. gr. $23/23^\circ\text{C}$ for finished parts when determined by ~~12.1~~ shall not exceed ± 0.01 (the weight percent crystallinity, W^c , of a given finished part shall not vary more than $\pm 10\%$).

8.6 The melting point of finished parts shall be determined to be in the range of 210 to 220°C (410 to 428°F) as determined by the method in ~~12.2~~.

8.7 The minimum tensile strength and percent elongation of the semifinished article from which the finished part was made shall be 33.1 MPa (4800 psi) and 100% , respectively, as determined by the methods in ~~12.3~~.

8.8 The maximum allowable deformation under load will be 10% as determined by the method in ~~12.4~~.

8.5 Finished parts shall be made from semifinished articles having a zero strength time (ZST_{stock}) of 300 to 450 s (Grade 3) when determined in accordance with ~~12.512.1~~.

8.6 The maximum allowable ZST drop, ZST, shall be $<20\%$ as determined in ~~12.5.412.1.4~~.

8.7 For nonmandatory requirements; namely, specific gravity variation, melting point range, and minimum tensile strength, that can be imposed to help ensure lot-to-lot consistency, especially in regards to controlling the crystallinity of PCTFE semi-finished articles and parts machined therefrom subject to this Specification, refer to Nonmandatory [Appendix X1](#).

9. Specific Requirements

9.1 Specific requirements for *Type I, H, III, and IV* material are summarized in [Table 1](#).

9.2 *Type I*—Each batch or lot of parts, or semifinished articles from which the finished parts are made, shall meet the test and criteria of ~~12.612.2~~ or ~~12.712.3~~ in accordance with ~~NASA-STD-600~~ [NASA-STD-6001B](#) and Test Methods [D2512](#) and [G86](#) according to the discretion of the procuring agency. Finished parts meeting the criteria of ~~12.612.2~~ or ~~12.712.3~~ shall be assigned a unique dash number or part number.

9.3 *Types II and III*—No requirements exist either for mechanical impact testing and assigning of a unique dash number or part number.

10. Number of Tests

10.1 When the number of test specimens is not stated in the test method, a single determination may be made. If more than single determinations and separate portions of the same sample are made, the results shall be averaged. The final result shall conform to the requirements prescribed in this specification.

11. Test Conditions

11.1 *Standard Temperature*—The tests shall be conducted at the standard laboratory temperature of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) 2°C ($73 \pm 4^\circ\text{F}$) and $50 \pm 5\%$ relative humidity. 10% relative humidity per Practice [D618](#).

12. Test Methods

~~12.1 Specific Gravity (Sp. Gr.)~~

TABLE 1 Type I, II, III, and IV Material Requirements^A

Type	Service Pressure (MPa (psi))	Media	Mechanical Impact Test Required	Assign Unique Part Number or Dash Number for the Finished Part
I	>11.4 (1650)	oxygen, air	yes	yes
II	<11.4 (1650)	oxygen, air	no	no
III	all	N ₂ , He, H ₂ , ammonia	no	no
IV	all	other (for example, nitrox)	no	no

TABLE 1 Type I, II and III Material Requirements^A

Type	Service Pressure (MPa (psi)) and affected parts	Media	Mechanical Impact Test Required	Assign Unique Part Number or Dash Number for the Finished Part
I	>11.4 (1650): only parts for which mechanical impact testing is required	oxygen, air	yes	yes
II	oxygen, air: < 11.4 (1650): all parts > 11.4 (1650): only parts for which no mechanical impact testing is required He: inert, reactive: pressures specified in 3.1.4 and 3.1.7: all parts	oxygen, air, inert, reactive	no	no
III	all pressures ^B and parts	other (for example, nitrox)	no	no

^AFinished parts made from Type I, II, III, and IV material will be in an annealed condition, have specific gravity variation no greater than $\pm 0.01 \text{ g/cm}^3$, have a melting point from 210 to 220°C, have a ZST_{stock} from 300 to 450 s, and have a ZST drop no greater than 20%, have a deflection under load no greater than 40%, and have a minimum tensile strength of 33.1 MPa (4800 psi) and a minimum tensile elongation of 100%±20%.

^B As specified by the cognizant engineering organization.

12.1.1 Specific gravity of finished parts shall be determined in accordance with Test Methods D792, Method A, with the following modifications. The submersion medium (deionized 18 M cm water) is boiled; then one to two drops of Zonyl-fluorosurfactant⁵ (or equivalent) wetting agent is added per 100 mL of water. A magnifying glass is used to insure further that no air bubbles cling to submerged parts during weighings. Specimens shall also be free of internal voids in accordance with 8.2. The test temperature shall be $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$).

12.1.2 Weight percent crystallinity, W^c , shall be calculated as:

⁴ The sole source of supply of the wetting agent known to the committee at this time is E. I. Du Pont de Nemours and Company, DuPont Corporate Information Center, Chestnut Run Plaza 705/GS38, Wilmington, DE 19880-0705. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.