



Designation: D7194 – 19

# Standard Specification for Aerospace Parts Machined from Polychlorotrifluoroethylene (PCTFE)<sup>1</sup>

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 ( $\epsilon$ ) 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 high molecular weight, good molecular weight retention during processing, dimensional stability, controlled crystallinity, and tightly controlled engineering tolerances.

1.2 This specification establishes requirements for parts machined from virgin, unplasticized, 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 media.

1.7 *Application*—PCTFE components covered by this specification are virgin, 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

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.15](#) on Thermoplastic Materials.

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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), and pressures up to 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 [13](#), 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

- [D618 Practice for Conditioning Plastics for Testing](#)
- [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](#)
- [D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheet or Film at Elevated Temperature](#)
- [D1430 Classification System for Polychlorotrifluoroethylene \(PCTFE\) Plastics](#)

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D1600** Terminology for Abbreviated Terms Relating to Plastics
  - D1708** Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
  - D2512** Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Techniques)
  - D3045** Practice for Heat Aging of Plastics Without Load
  - 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 Standards*<sup>3</sup>
- NASA-STD-6001B** Flammability, Offgassing, and Compatibility Requirements and Test 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 (GN<sub>2</sub>) up to 103.4 MPa (15,000 psig).
- 3.1.5 *oxygen media, n*—liquid oxygen (LOX) and gaseous oxygen (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 (NH<sub>3</sub>) up to 3.5 MPa (500 psig), gaseous hydrogen (GH<sub>2</sub>) up to 46.2 MPa (6700 psig), and liquid hydrogen (LH<sub>2</sub>) up to 2.8 MPa (400 psig).

### 4. Significance and Use

4.1 Given the thermal instability of PCTFE in the melt, the primary intention of this specification is to ensure adequate molecular weight retention during molding, whereby as-

polymerized resin, typically powder or coarse granular material, is thermoformed into semi-finished rod or sheet stock, typically by extrusion or compression molding.

4.2 Given the relatively low glass transition temperature of PCTFE ( $T_g \approx 55^\circ\text{C}$  (130°F)), the second intention of this specification is to ensure good dimensional stability of finished articles subjected to temperature excursions during service that approach or exceed the  $T_g$ .

4.3 Because the crystallinity can vary widely in PCTFE, which in turn can affect the performance of a finished PCTFE part in its intended application, nonmandatory guidance is given in **Appendix X1**. This guidance cites recommended ASTM Test Methods that measure the specific gravity (**X1.1.4**), melting point (**X1.1.5**), and tensile properties (**X1.1.6**) of PCTFE. Control of these properties is used to establish consistency between different lots of finished parts where either the starting resin, molding method, thickness of the semifinished article, or machining method change.

4.4 Finished parts are categorized based on whether annealing of the finished parts is not performed (*Method A*), or is performed (*Methods B and C*), depending on the dimensional stability of a statistical sample of unannealed finished parts.

### 5. Classification

- 5.1 Part shape and size shall be defined by the applicable purchase order.
- 5.2 The type of product shall be categorized by the intended use category:
  - 5.2.1 *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) that require batch testing.
  - 5.2.2 *Type II* for use in (1) air and oxygen media (at service pressures below 11.4 MPa (1650 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**.
  - 5.2.3 *Type III* for use in media other than air, oxygen, GHe, GN<sub>2</sub>, ammonia, GH<sub>2</sub> and LH<sub>2</sub>, at service pressures specified by the cognizant engineering organization.

### 6. Ordering Information

6.1 All parts covered by this specification shall be ordered by Specification D7194, Type, as listed in Section 5, or as listed on the purchase contract or order when Type is not specified explicitly.

### 7. Apparatus

7.1 *Oven*—A convection oven capable of maintaining a temperature of 100 to 200 ± 2°C.

### 8. Materials and Manufacture

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

<sup>3</sup> Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

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

8.3 No recycled polymer or regrind shall be permitted.

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

### 9. Property Requirements

9.1 Numerical values listed in this specification for properties or property changes are minimum values.

9.2 All requirements stipulated in Sections 9 and 10 shall be met, unless otherwise specified in the purchase contract or order. Any exceptions to the requirements stipulated in Sections 9 and 10 shall be noted in 14.2.1.12.

9.3 Any nonmandatory tests or data, such as those cited or alluded to in the nonmandatory Appendix X1, shall be specified at the time of the order.

### 10. 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 is responsible for insuring the requirements in 10.4 are met. All other requirements listed in Section 10 pertain to the finished part, and therefore, are the responsibility of the supplier of the finished, machined part.

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

10.2 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.

10.3 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 13.1.

10.4 The maximum allowable ZST drop,  $\Delta ZST$ , shall be <20 % as determined in 13.1.4.

10.5 No critical engineering dimension in a finished part shall change by more than 0.01 mm/mm (0.01 in./in.) when measured at  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) after being held for a predetermined time at  $100 \pm 2^\circ\text{C}$  ( $212 \pm 3.6^\circ\text{F}$ ) as determined in accordance with 13.2.

10.6 Finished parts meeting the general requirements of 10.1 to 10.5 shall be categorized as parts suitable for Method A (no annealing required).

10.7 Finished parts meeting the general requirements of 10.1 to 10.4, but which fail general requirement 10.5 ( $\Delta L > 1.0$  %), shall be categorized as Method B parts (annealing required to achieve best dimension stability) or Method C parts (annealing required to achieve best engineering tolerances). Annealing for Methods B and C parts shall be performed in accordance with 13.3.

10.8 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 crystallin-

ity of PCTFE semi-finished articles and parts machined therefrom subject to this specification, refer to Nonmandatory Appendix X1.

### 11. Specific Requirements

11.1 Specific requirements for Type I, II and III material are summarized in Table 1.

11.2 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 13.4 or 13.5 in accordance with NASA-STD-6001B and Test Methods D2512 and G86 according to the discretion of the procuring agency. Finished parts meeting the criteria of 13.4 or 13.5 shall be assigned a unique dash number or part number.

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

### 12. Test Specimens and Number of Tests

12.1 In cases where measured values depend on orientation, for example, tensile properties and dimensions of test specimens made from extruded material, the extrusion direction relative to the measurement direction shall be tracked.

12.2 When the number of test specimens is not stated in the test method, a single determination may be made. If more than a single determination or determinations on separate portions

TABLE 1 Type I, II and III Material Requirements<sup>A</sup>

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	oxygen, air, inert, reactive	no	no
III	He: inert, reactive: pressures specified in 3.1.4 and 3.1.7: all parts all pressures <sup>B</sup> and parts	other (for example, nitrox)	no	no

<sup>A</sup> Finished parts made from Type I, II and III material will be in an annealed condition, have a  $ZST_{stock}$  from 300 to 450 s, and have a ZST drop no greater than 20 %.

<sup>B</sup> As specified by the cognizant engineering organization.