

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS-P-83310

Issued

MAR 1998

Plastic Sheet, Polycarbonate, Transparent

NOTICE

This document has been taken directly from U.S. Military Specification MIL-P-83310, and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-P-83310. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Any material relating to qualified product lists has not been adopted by SAE. This material was part of the original military specification and is reprinted here for historic reference only.

1. SCOPE AND CLASSIFICATION:

1.1 SCOPE:

This specification covers transparent flat polycarbonate plastic sheet material suitable for aerospace transparent enclosures requiring excellent optical properties.

1.2 Classification:

The sheet material shall be full finish, transparent. A sheet, as defined for this specification, shall be of monolithic construction, or a multi-ply fusion bonded polycarbonate transparency.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1998 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:
TO PLACE A DOCUMENT ORDER:
SAE WEB ADDRESS:

(724) 772-7154
(724) 776-4970
<http://www.sae.org>

FAX: (724) 776-0243
FAX: (724) 776-0790

1.3 Safety- Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take the necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications, 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.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-P-116	Preservation, Methods of
MIL-E-9500	Ethylene Glycol, Technical
MIL-L-10547	Liners, Case, and Sheet, Overwrap, Water-Vaporproof or Waterproof, Flexible
MIL-B-13239	Barrier Material, Waterproofed, Flexible All Temperature
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-1186	Cushioning, Anchoring, Bracing, Blocking and Waterproofing, with Appropriate Test Methods
NN-P-530	Plywood, Flat Panel
PPP-B-585	Boxes, Wood, Wirebound
FPP-B-591	Boxes, Fiberboard, Wood-Cleated
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
FED-STD-406	Plastics; Methods of Testing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D2863-70 Flammability of Plastics Using the Oxygen Index Method

2.3 Consolidated Classification Committee:

Available from Consolidated Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.

Uniform Freight Classification Rules

3. REQUIREMENTS:

3.1 Preproduction:

The plastic sheet material furnished under this specification shall be a product which has been tested and has passed the preproduction tests specified herein.

3.2 Materials:

The manufacturer is given a wide range in the selection of raw polycarbonate type material and in the process of manufacture, provided the sheet material furnished is a transparent plastic conforming to all requirements of this specification and is suitable for the intended use.

3.3 Dimensions:

The dimensions of the sheets shall be as specified by the applicable drawings, specifications or purchase orders.

3.3.1 Length and width: Unless otherwise specified by the procuring activity, a tolerance of ± 0.06 inch shall be allowed on linear dimensions of trimmed sheets.

3.3.2 Thickness: The actual thickness of the sheet at any point shall be within the tolerance specified in table I. Thickness variations of sheets not included in table I shall not exceed tolerances for the next great thickness sheet listed in table I.

3.4 Color:

The material shall not contain any added pigment or dyes. Added colorant, when specified by the procuring agency, shall not alter the physical, mechanical, or chemical, properties of the sheet material.

3.5 Ultraviolet stabilizers:

The polycarbonate sheet shall be ultraviolet stabilized.

3.6 Tensile strength and elongation:

The minimum ultimate tensile strength of the material shall be 8,800 psi and the tensile elongation at rupture shall not be less than 80 percent.

3.7 Deflection temperature under load:

The minimum deflection temperature under load regardless of thickness, shall be 127°C (260°F).

3.8 Thermal expansion:

The mean linear coefficient of thermal expansion shall not exceed 0.00010 per degree Celsius (0.000055 per degree Fahrenheit) within the temperature range of -30° to +50°C. (-22° to +122°F).

3.9 Impact strength:

The minimum notched izod impact strength shall be in accordance with table I.

TABLE I. Requirements which vary with thickness

Thickness in.	Tolerance Thickness %	Original Luminous Transmittance % min.	After Accelerated Weather Transmission % min.	Minimum Izod Impact Strength ft/lb/in. of notch
.060	±0.006	88	86	12
.080	±0.008	87	85	12
.100	±0.009	86	84	12
.125	±0.010	86	84	12
.187	±0.015	85	83	12
.250	±0.020	84	82	2.5
.375	±0.030	82	80	2.5
.500	±0.040	80	78	2.2
.750	±0.050	78	76	2.2
1.000	±0.050	75	73	2.2

3.10 Flammability:

The minimum oxygen index value shall be 25 percent when tested according to 4.5.4.3.

3.11 Internal strain:

The mean dimensional change after heating shall not exceed 1 percent.

3.12 Accelerated weathering:

After exposure to the accelerated weathering test, the material shall show no cracking, crazing, or surface instability.

3.13 Specific gravity:

The mean specific gravity shall be 1.20 ± 0.01 .

3.14 Formability:

The material shall be suitable for forming into hemispherical shapes with an outside diameter of 10 inches and a draw of at least 5 inches when tested in accordance with 4.5.6.2.

3.15 Workability:

When processed in accordance with the manufacturer's instructions, the material shall not fail mechanically nor show signs of bubbling, discoloration, or other indication of material instability.

3.16 Instruction sheet:

On direct purchases by the Government, an instruction sheet shall be furnished in each shipping container as specified in 5.5. Specific information or reference shall be made to the limitations of the material and the necessary precautions to be observed in handling, storing, cutting, drilling, machining, forming, bending, cementing, abrading, polishing, and cleaning. The description of all compounds, materials, and equipment mentioned therein shall be given in sufficient detail to permit nonproprietary procurement, using Government specifications when available.

3.17 Additional requirements:**3.17.1 Optical uniformity:**

3.17.1.1 Minor optical defects: The total number of minor optical defects in a sheet which is 0.500 inch or less in thickness shall not exceed a limit determined by dividing the area of the sheet, measured in square feet, by 4. The total number of minor optical defects in a sheet over 0.500 inch in thickness shall not exceed 2 per square foot. Minor defects include any imbedded particles, bubbles, scratches, or internal inhomogeneity which reduce visibility through the plastic, and those localized imperfections which cause a variation in angular deviation of more than 5 minutes within a distance of not more than 20 inches on the screen when tested as specified in 4.5.1.2. It is not intended that the entire sheet be quantitatively surveyed for such variation in deviation but that localized imperfections which are suspected of being detrimental be evaluated by means of this test. Blemishes which do not individually reduce visibility through the plastic shall be disregarded unless they are grouped in an objectionable pattern. Minor defects within 1 inch from the nominal trimmed sheet edge shall be disregarded.

3.17.1.2 Angular deviation: The material shall contain no major defects. Major defects are defined as any variations in the material which cause angular deviations either side of the undeviated position in excess of the following:

SHEET THICKNESS	LIMITS OF PERMISSIBLE DEVIATION
0.060 in. through 0.220 in.	7 minutes at any location more than 1 in. from the edge of the sheet.
Over 0.220 in. through 0.250 in.	7 minutes at any location more than 3 in. from the edge of the sheet. 9 minutes between 3 in. and 1 in. of the edge of the sheet.
Over 0.250 in. through 0.375 in.	7 minutes at any location more than 3 in. from the edge of the sheet. 12 minutes between 3 in. and 1 in. of the edge of the sheet.
Over 0.375 in. through 0.500 in.	7 minutes at any location more than 3 in. from the edge of the sheet. 14 minutes between 3 in. and 1 in. of the edge of the sheet.
Over 0.500 in. through 1.000 in.	12 minutes at any location more than 3 in. from the edge of the sheet. 20 minutes between 3 in. and 1 in. of the edge of the sheet.

(Major defects within 1 inch from the nominal trimmed sheet edge shall be disregarded.)

3.17.2 Original luminous transmittance: The original luminous transmittance shall be not less than the values specified in table 1.

3.17.3 Original haze: The haze value shall not exceed three percent.

3.17.4 Index of refraction: The index of refraction shall be 1.59 ± 0.01 .

3.17.5 Resistance to accelerated weathering:

3.17.5.1 Luminous transmittance after accelerated weathering: After accelerated weathering the luminous transmittance shall be not less than the values specified in table 1.

3.17.5.2 Haze after accelerated -Weathering: After accelerated weathering the haze value shall not exceed four percent.

3.17.6 Crazeing: The material shall show no evidence of crazeing, cracking or other chemical degradation in the area subjected to the action of ethylene glycol as described in 4.5.5.2. Edge crazeing shall be disregarded.

3.18 Identification of product:

The protective covering (see 5.1) of each individual sheet shall be marked with the specification number, nominal thickness, and the manufacturer's code for his approved product.

3.19 Workmanship:

The workmanship shall be in accordance with high-grade practice for this type of product. Since this specification does not apply to formed, molded, or fabricated parts, workmanship beyond the production of polished plane sheet material is not included.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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.

4.2 Classification of tests:

The inspection and testing of the plastic sheet material shall be classified as follows:

- a. Preproduction (4.2.2).
- b. Quality conformance inspection (4.3).

4.2.1 Sampling instructions: The preproduction test sample shall consist of at least 10 square feet of trimmed sheet material in each of the thicknesses for which approval is desired. Individual sheets shall be at least 12 by 18 inches. Samples shall be tested at the contractor's plant or a laboratory designated by the Government, under the inspection of the procuring activity.

4.2.2 Preproduction tests: Prior to actual procurement, the product which this specification covers shall pass the preproduction tests specified herein. If the product is later modified in any way, the modified form shall be subjected to and shall pass the same preproduction tests. Preproduction tests will be repeated, upon request of the procuring agency, on material previously found satisfactory once during each calendar year.

4.2.3 Tests: The preproduction tests shall consist of all the tests specified under 4.5.

4.2.4 Test report: Except for the storage stability test, a statement shall be furnished to the procuring activity certifying that the materials and the test results meet the requirements of this specification. Approval of preproduction inspection shall not relieve the contractor of his obligation to meet the quality conformance inspection.

4.3 Quality conformance inspection:

Quality conformance inspection tests shall consist of:

- a. Examination of product.
- b. Sampling plan and tests.

4.3.1 Sampling plan and tests:

4.3.1.1 Lot: A lot shall consist of all polycarbonate sheets submitted for acceptance at the same time and place, and produced within any one calendar week.

4.3.1.2 Sampling plan: Ten sample sheets of material shall be selected at random per lot 1,000 sheets at the rate of 1 or 2 representative sheets per day. When the lot contains less than 1,000 less than sheets, 1 sample representative sheet for each 100 sheets or fraction thereof shall be selected at random.

4.3.1.3 Tests: Each sample sheet shall be subjected to the tests listed below and described under 4.5:

- a. Angular deviation.
- b. Original luminous transmittance.
- c. Original haze.
- d. Deflection temperature under load.

4.3.1.4 Rejection and retest: Failure of any selected sample to meet the specified tests shall be cause for rejection of the lot represented. If practical, a rejected lot may be 100-percent inspected and the sheets accepted or rejected individually as the results of the tests indicated.

4.4 Test conditions:

4.4.1 Preparation of specimens: Unless otherwise specified herein, all test specimens shall be prepared as described in Federal Test Method Std. No. 406.

4.4.2 Atmospheric conditions: Unless otherwise specified herein, the atmospheric conditions surrounding the specimens prior to and during test shall be as described in Federal Test Method Std. No. 406.

4.5 Test methods:

4.5.1 Examination of product: Each plastic sheet shall be carefully examined to determine conformance to the requirements herein with respect to linear dimensions, thickness, color, identification of product, minor optical defects, workmanship, and any other requirements not covered by tests.

4.5.1.1 Conformance to requirements for linear dimensions shall be determined to the nearest 0.01 inch; thickness, to the nearest 0.001 inch.

4.5.2 Optical tests:

- 4.5.2.1 Angular deviation: The angular deviation shall be determined in accordance with method 3041 of Federal Test Method Std. No. 406.
- 4.5.2.2 Original luminous transmittance: The original luminous transmittance using CIE Illuminant C shall be determined in accordance with method 3022 of Federal Test Method Std. No. 406.
- 4.5.2.3 Original haze: The percentage of original haze using CIE Illuminant C shall be determined in accordance with method 3022 of Federal Test Method Std. No. 406.
- 4.5.2.4 Index of refraction: The index of refraction at $23^{\circ} \pm 1.1^{\circ}\text{C}$ ($73.5^{\circ} \pm 2^{\circ}\text{F}$) for yellow light (sodium D) shall be determined by means of an Abbe Refractometer, or apparatus of equivalent accuracy, in accordance with method 3011 of Federal Test Method Std. No. 406.

4.5.3 Strength tests:

- 4.5.3.1 Tensile strength: Five tensile specimens shall be tested in accordance with method 1011 of Federal Test Method Std. No. 406. Elongation immediately before fracture shall also be determined.
- 4.5.3.2 Impact strength: The notched izod impact strength shall be determined on five specimens in accordance with method 1071 of Federal Test Method Std. No. 406.

4.5.4 Thermal tests:

- 4.5.4.1 Deflection temperature under load: At least two specimens shall be tested from each sample. The length of the test specimens shall be 5 inches, the depth shall be 0.500 ± 0.005 inch, and the width shall be the thickness of the original sheet if it is within the range of 0.250 to 0.500 inch. Thin sheet material shall be arranged to form a composite specimen of convenient thickness. The specimen shall be supported as a simple beam of steel supports 4 inches apart with the 0.500-inch depth vertical and a load applied vertically on the top of the specimen midway between the supports to induce an outer fiber stress of 264 psi in the specimen. The apparatus shall be similar to that described in method 2011 of Federal Test Method Std. No. 406. The load applied, governed by the width of the specimen (sheet thickness), shall be calculated from the following formula.

$$p = 44bd^2$$

where

p = applied load in pounds

b = specimen width in inches

d = specimen depth in inches.

4.5.4.1 (Continued):

During the test the specimens shall be in direct contact with a suitable heat transfer medium, such as liquid petroleum U.S.P., which is agitated. The temperature of the liquid shall be raised from room temperature at a rate of $2^{\circ} \pm 0.5^{\circ}\text{C}$ ($3.6^{\circ} \pm 0.9^{\circ}\text{F}$) per minute. The heat distortion temperature is the temperature at which the specimen has deflected 0.010 inch at the center between the supports.

4.5.4.2 Thermal expansion: The coefficient of thermal expansion between the temperature range of -30° to $+50^{\circ}\text{C}$ (-22° to $+122^{\circ}\text{F}$.) shall be determined in accordance with method 2031 of Federal Test Method Std. No. 406. Two specimens 0.250 inch thick shall be tested. If the results are within 10 percent of the large value, the mean of the two values shall be reported. If not, the test shall be repeated until three values are obtained within this tolerance, and the mean reported.

4.5.4.3 Flammability: The flammability of the material shall be determined in accordance with ASTM D2863-70. Three specimens shall be tested.

4.5.4.4 Internal strain: Two conditioned 12- by 18-inch sheets shall be tested. Each sheet shall be considered as a 12- by 12-inch specimen supported by the remainder of the sheet. Two finely scribed lines shall be scribed at right angles crossing the center of the 12- by 12-inch area. Finely scribed gage marks are then placed 2 inches from the edge of the 12- by 12-inch area on each of these lines. The distance between each pair of these gage marks shall be measured to the nearest 0.01 inch and the data recorded. Each sheet shall be hung by one short edge in a circulating air oven at $135^{\circ} \pm 5^{\circ}\text{C}$ ($275^{\circ} \pm 9^{\circ}\text{F}$) for the time specified below:

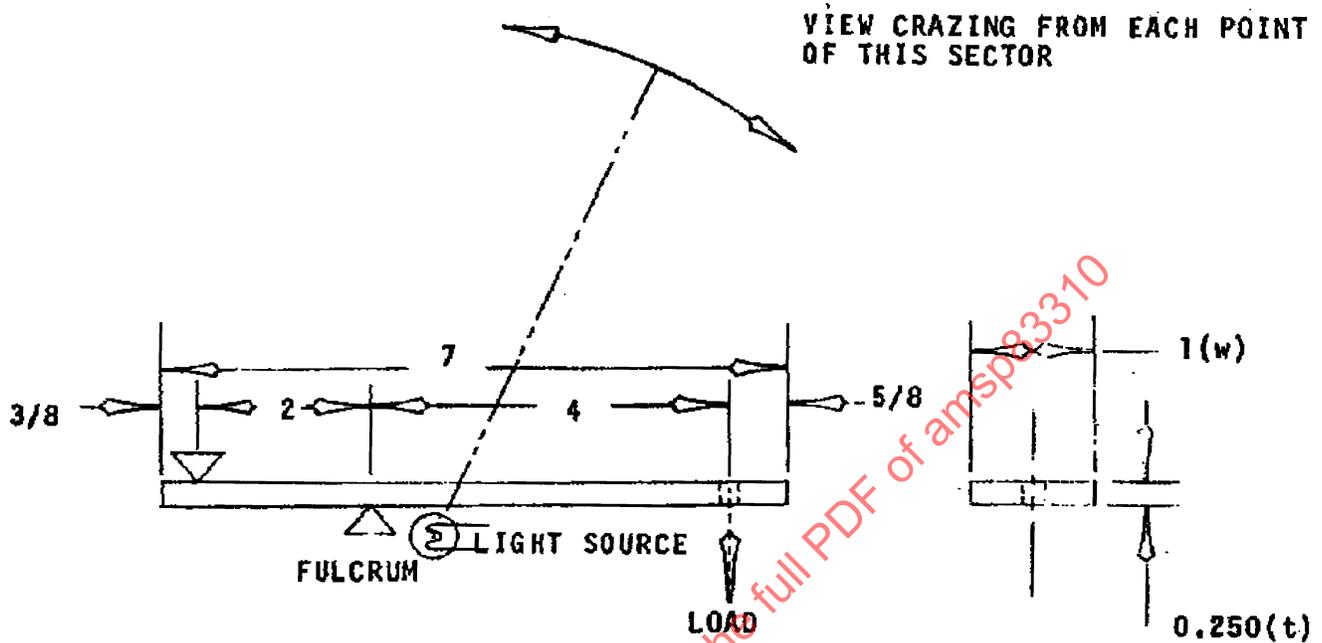
NOMINAL SHEET THICKNESS (INCHES)	HEATING TIME (RANGE IN MINUTES)
0.250 and less	16 - 20
0.375	25 - 30
0.500	33 - 38
0.750	55 - 60
1.00	79 - 84

After removal from the oven, the specimens shall be permitted to cool to standard testing temperature while hanging vertically. The distance between each pair of gage marks shall be remeasured. The dimensional change is the percent change in distance between the gage marks based on the first measurement.

4.5.5 Permanence tests:

4.5.5.1 Resistance to accelerated weathering:

- 4.5.5.1.1 Procedure: Two specimens shall be tested for resistance to accelerated weathering in accordance with method 6022 of Federal Test Method Std. No. 406 for 1,000 hours.
- 4.5.5.1.2 Evaluation: The specimens shall be examined for any cracking, crazing, surface instability, or any other defect significantly reducing viability through the material.
- 4.5.5.1.3 Luminous transmittance: After the accelerated weathering test, the specimens shall be immersed momentarily in distilled water and the surface moisture carefully removed. The luminous transmittance using CIE illuminant C shall then be determined in accordance with method 3022 of Federal Test Method Std. No. 406.
- 4.5.5.1.4 Haze: After the accelerated weathering test, the specimens shall be immersed momentarily in distilled water and the surface moisture carefully removed. The haze using CIE illuminant C shall then be determined in accordance with method 3022 of Federal Test Method Std. No. 406.
- 4.5.5.2 Crazing: Five specimens, 1 by 7 by 0.250 inch, shall be conditioned for 2 hours at 120°C (248°F) followed 48 hours at standard testing conditions. Each specimen shall then be set up as a cantilever beam under load as shown in figure 1. After application of the load for 10 minutes and while still under load, ethylene glycol shall be applied to the specimens in accordance with MIL-E-9500. The solvent shall be applied to the tension side of the specimens and centered directly above the fulcrum by means of 1/2-inch square filter paper patches soaked with the liquid. The patches shall be removed after 30 minutes and the specimens examined for evidence of crazing, cracking, or other chemical degradation.
- 4.5.6 Miscellaneous tests:
- 4.5.6.1 Specific gravity: The specific gravity shall be determined on three, polished specimens of cubical or other regular shape and of not less than 0.2 cubic inch in accordance with method 5011 of Federal Test Method Std. No. 406.
- 4.5.6.2 Formability: Two specimens shall be formed to determine conformance to 3.14. Forming conditions shall be in accordance with the manufacturer's instructions.
- 4.5.6.3 Instruction sheet: The instruction sheet shall be approved on the basis of clearness and completeness
- 4.5.7 Packaging, packing, and marking: Preparation for delivery shall be inspected for conformance to section 5.



LOAD - OUTER FIBER STRESS OF 2,000 PSI

$$\text{FORMULA: LOAD (POUNDS)} = \frac{w \times t^2 \times 2,000}{24}$$

w = Width of panel (measured to nearest 0.001 inch)

t = Thickness of panel (measured to nearest 0.001 inch)

Dimensions in inches. Tolerances on all dimensions ± 0.030 inch, except thickness dimension which shall be ± 0.025 inch.

FIGURE 1. Loading condition for cantilever beam