

**Polycarbonate Sheet and Parts
Optical Grade, Coated**

1. SCOPE:

1.1 Form:

This specification covers an optical-quality, transparent, polycarbonate plastic, to which a hard protective surface coating has been applied, supplied in the form of flat sheet or formed parts made from flat sheet.

1.2 Application:

These products have been used typically for parts, such as vehicle windows, requiring optical quality and serviceability under adverse environmental conditions, but usage is not limited to such applications.

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 necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

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2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM D 673	Mar Resistance of Plastics
ASTM D 1003	Haze and Luminous Transmittance of Transparent Plastics
ASTM D 1044	Resistance of Transparent Plastics to Surface Abrasion
ASTM D 1499	Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics
ASTM D 2134	Softening of Organic Coatings by Plastic Compositions
ASTM D 3029	Impact Resistance of Flat Rigid Plastic Specimens by Means of a Tup (Falling Weight)
ASTM D 4141	Conducting Accelerated Outdoor Exposure Tests of Coatings
ASTM G 23	Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials
ASTM G 26	Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

2.2 U.S. Government Publications:

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

MIL-P-83310	Plastic Sheet, Polycarbonate, Transparent
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Material:

- 3.1.1 Basic Polycarbonate: The polycarbonate sheet shall conform to MIL-P-83310.
- 3.1.2 Hard Coating: The hard coating shall be formulated for, and processed onto, the polycarbonate base sheet such that the total product will meet the requirements specified herein.
- 3.1.3 Storage Life: The product shall meet the requirements of this specification when tested at any time up to 12 months from date of manufacture when stored in the original shipping container. The protective covering applied to the coated optical surfaces shall be removable without special handling or cleaning.

3.2 Properties:

Coated sheet shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with specified test methods:

- 3.2.1 Abrasion Resistance: Specimens shall show not more than 5% arithmetic increase in haze measurement (for example, 1.8% haze before and 6.8% haze after) after being abraded by one of the methods specified in Table 1, using separate specimens for each test. Haze measurements shall be determined, before and after abrasion, in accordance with ASTM D 1003, Procedure A.

TABLE 1 - Abrasion Resistance Parameters

Method	Minimum Number of Cycles	Test Method	Test Conditions
Taber Abraser	300	ASTM D 1044	CS-10F calibrase wheel with 500 gram load
Goodyear Abrader	1000	4.5.1	0.75 psi (5.2 kPa) shoe pressure; water lubricant

- 3.2.2 Mar Resistance: Specimens shall show not more than 5% increase in haze measurement after being subjected to the mar resistance test in accordance with 4.5.2. Haze measurements shall be determined, before and after testing, in accordance with ASTM D 1003, Procedure A.
- 3.2.3 Chemical Resistance: Specimens shall show no crazing when subjected to contact with methyl ethyl ketone (MEK) for 30 minutes \pm 1, determined in accordance with 4.5.3.
- 3.2.4 Coating Porosity: Not more than one specimen from each set of five specimens for each test fluid shall show evidence of crazing, determined in accordance with 4.5.4.
- 3.2.5 Adhesion: The coating shall not separate from the polycarbonate substrate, determined by the "snap tape" test in accordance with 4.5.5.
- 3.2.6 Hardness: The coated specimen shall exhibit an initial hardness value of not less than 35, determined in accordance with ASTM D 2134-66.
- 3.2.7 Impact Resistance: The coating shall not separate from the polycarbonate substrate, determined by the "snap tape" test of 4.5.5 after impact loading in accordance with 4.5.6.
- 3.2.8 Light Transmission and Haze: Specimens shall show light transmission greater than 82% with haze not exceeding 2%, determined in accordance with ASTM D 1003, Procedure A, both percentages being based on 0.25-inch (6.4-mm) thick specimens.

3.2.9 Optical Integrity:

- 3.2.9.1 Coating: Foreign material, such as lint or dust particles, or processing imperfections, such as bubbles or scratches, within the specified optical area shall not exceed four imperfections of 0.06 inch (1.5 mm) or less in diameter or fiber inclusions of 0.250 inch (6.35 mm) or less in length, or a combination of both, determined in accordance with 4.5.7. Inclusions or imperfections greater than specified above are not acceptable. The optical area shall be defined as the central 75% area of an untrimmed sheet, the entire formed and coated part except the peripheral 1.0 inch (25 mm), or as specified on the applicable part drawing.
- 3.2.9.2 Overall: The overall optical integrity shall conform to the requirements of MIL-P-83310.
- 3.2.10 Humidity: The coating shall not separate from the polycarbonate substrate, determined by the "snap tape" test of 4.5.5 after humidity exposure in accordance with 4.5.8.
- 3.2.11 Artificial Ultraviolet Exposure: The coating shall not separate from the polycarbonate substrate, determined by the "snap tape" test of 4.5.5 after exposure to ultraviolet light in accordance with 4.5.9.
- 3.2.12 Artificial Weathering: The coating shall conform to the requirements for abrasion resistance (3.2.1), adhesion (3.2.5), impact resistance (3.2.7), light transmission and haze (3.2.8), optical integrity (3.2.9), and quality (3.3) after exposure to the environment of a carbon- or xenon-arc weatherometer for not less than 1000 hours in accordance with ASTM D 1499, ASTM G 23, or ASTM G 26.

3.3 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the product.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The manufacturer of the product shall supply all samples for required tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Tests for adhesion (3.2.5), hardness (3.2.6), light transmission and haze (3.2.8), optical integrity (3.2.9), and quality (3.3) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of the product to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient product shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all sheet or parts produced from the same batches of raw materials in a single production run under the same fixed conditions and presented for manufacturer's inspection at one time. A lot shall be not more than 2500 pounds (1134 kg).

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and manufacturer, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and manufacturer.

4.4 Approval:

4.4.1 Sample product shall be approved by purchaser before product for production use is supplied, unless such approval be waived by purchaser. Results of tests on production product shall be essentially equivalent to those on the approved sample.

4.4.2 Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection on production-product which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample product. Production product made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Abrasion Resistance Test:

4.5.1.1 Test Apparatus: Shall be an abrader in accordance with Figure 1, identified as a "Goodyear Abrader."

- 4.5.1.2 Test Specimens: Shall be the as-received thickness cut to 4.0 x 8.0 inches (102 x 203 mm).
- 4.5.1.3 Abrading Materials: Shall be as follows:
- 4.5.1.3.1 Pad material shall be chloroprene-base rubber, 10 Durometer A hardness, 0.125 inch \pm 0.016 (3.18 mm \pm 0.41) thick.
- 4.5.1.3.2 Abrasive film shall be aluminum oxide lapping film, 12 micron (12 μ m) grit.
- 4.5.1.3.3 Lubricant shall be water.
- 4.5.1.4 Procedure: Shall be as follows:
- 4.5.1.4.1 Prepare a number of abrading shoes equal to the number of specimens to be tested. Add weight to each abrading shoe to provide a total weight of 6.00 pounds \pm 0.01 (2722 grams \pm 4) on the shoe area of 8.0 square inches \pm 0.1 (51.6 cm² \pm 0.6) per shoe, or a shoe pressure of 0.75 psi (5.2 kPa). Mount the specimens and the abrading shoes.
- 4.5.1.4.2 Thoroughly wet the surface of the specimens with distilled water and maintain continuous surface wetting from the dripping orifice.
- 4.5.1.4.3 Set the cycle counter to zero and the machine speed to 20 cycles per minute (cpm) before starting the testing machine.
- 4.5.1.4.4 Start the testing and stop testing at the completion of 1000 cycles.
- 4.5.1.4.5 Wash the specimens free of abrasion dust and chips with distilled water and air dry, taking care not to scratch or alter the abraded area.
- 4.5.1.4.6 Report the percentage increase in haze for each specimen and the average of all specimens.
- 4.5.2 Mar Resistance Test: Specimens suitable for haze determination in accordance with ASTM D 1003, Procedure A, shall be subjected to the mar resistance test of ASTM D 673, using 1000 grams \pm 10 of No. 80 silicon carbide grit.
- 4.5.3 Chemical Resistance Test: Chemical resistance shall be determined in accordance with the crazing test defined in MIL-P-83310 except that the test fluid, MEK, shall be applied to a 0.5 x 0.5 inch (12.7 x 12.7 mm) piece of filter paper placed on each of the five specimens used. After 30 minutes \pm 1 exposure of the specimens in an unstressed condition, the filter paper patches shall be removed, the affected surfaces flooded with demineralized water, and air dried and the specimens placed in the test fixture with the treated area centered on the tangent line of the 2000 psi (13.8 MPa) outer fiber stress. The chemical resistance stress-craze test shall then proceed under load for 30 minutes \pm 1 in a dry state.

4.5.4 Coating Porosity Test: Coating porosity shall be determined in accordance with the crazing test defined in MIL-P-83310 except that specially prepared test fluids shall be applied to a 0.5 x 0.5 inch (12.7 x 12.7 mm) piece of filter paper placed on each specimen. Five specimens shall be used for each of two test fluids prepared as follows; percentages are by volume:

Test Fluid A: 95% glacial acetic acid and 5% water

Test Fluid B: 90% aliphatic naphtha and 10% methyl ethyl ketone (MEK)

4.5.4.1 The test shall be continued for not less than 30 minutes with the specimens loaded to an outer fiber stress of 2000 psi (13.8 MPa) and the filter paper patches constantly wet with the applicable test fluid.

4.5.5 Adhesion Test: The "snap tape" adhesion test shall be performed on specimens not less than 12.0 x 12.0 inches (305 x 305 mm) in size, cut from a coated panel in the as-received condition and after being subjected to impact, humidity, and artificial ultraviolet exposure as specified. Test procedure shall be as follows:

4.5.5.1 Clean the surface to be tested with a clean flannel cloth or soft paper towel saturated with isopropyl alcohol and air dry with a filtered airstream. Allow the specimen to stand for not less than 30 minutes in a clean environment, after drying, before continuing the test.

4.5.5.2 Scribe a four-line grid (nine squares) through the coating over an area approximately 0.5 x 0.5 inch (12.7 x 12.7 mm).

4.5.5.3 Apply a strip of paper-backed tape, 1-inch (25-mm) wide, 3M No. 250 or equivalent, not over six months from date of manufacture, centered over and completely covering the grid pattern and press firmly without wrinkles or bubbles in the test area.

4.5.5.4 Immediately pull or "snap" the tape quickly at a 90-degree angle from the surface and along the tape centerline until the tape has been completely removed.

4.5.5.5 Determine the extent of coating removal by lightly rubbing the test area with No. 000 steel wool until the bared substrate has become hazy and less transparent.

4.5.5.6 Removal of the coating to any extent is not acceptable.

4.5.5.7 Report any evidence of non-adhesion.

4.5.6 Impact Resistance: Impact resistance of the coating, in distinction to the impact resistance of the substrate polycarbonate, shall be determined by no loss of adhesion, tested as specified in 4.5.5, after impact loading as follows:

4.5.6.1 Impact load specimens, of as-received thickness by 12.0 x 12.0 inches (305 x 305 mm), in accordance with ASTM D 3029, Procedure A, with the coated side down (tup striking on the opposite side). Increase the weight on the tup on each specimen to produce failure in the polycarbonate substrate (may require approximately 20 specimens).

4.5.6.2 Report the results in accordance with ASTM D 3029. Evidence of coating separation, determined as specified in 4.5.5, is not acceptable.

4.5.7 Optical Integrity: Each coated sheet or part shall be examined at low viewing angles of 15 to 45 degrees with back-lighting in order to identify and evaluate coating imperfections.

4.5.8 Humidity Test: Specimens, suitable for adhesion testing, shall be subjected to the humidity cycling of MIL-STD-810, Method 507, Procedure I, for three cycles. Immediately at the conclusion of the humidity test, perform the adhesion test in accordance with 4.5.5.

4.5.9 Artificial Ultraviolet Exposure Test: Specimens, approximately 4.0 x 4.0 inches (102 x 102 mm), shall be subjected to not less than 1000 hours of ultraviolet light exposure in equipment specified in ASTM D 4141, or equivalent, modified to retain only the ultraviolet light exposure features. Immediately at the conclusion of the ultraviolet exposure, perform the adhesion test in accordance with 4.5.5.

4.6 Reports:

The supplier of the product shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3614B, manufacturer's identification, date of manufacture, form, size or part number, and quantity.

4.7 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Each coated surface shall be protected by a suitable non-abrasive material such as soft plastic films, clean flannel cloths, or adhesive-backed tapes. Adhesive that will leave a residue, become tacky under hot storage or transportation conditions, or chemically attack the polycarbonate coating shall not be used.