

MIL-P-6997B(ASG)
8 February 1955

Superseding
MIL-P-6997A(ASG)
12 March 1953

MILITARY SPECIFICATION
PLASTIC; WORKING AND INSTALLATION
OF TRANSPARENT SHEET,
GENERAL SPECIFICATION FOR

This specification has been approved by the Department of the Air Force and by the Navy Bureau of Aeronautics.

1. SCOPE

1.1 This specification covers requirements and precautions which shall be followed in the design, fabrication, and installation of transparent plastic sheet conforming to the specifications specified herein, for use in Military aircraft.

2. APPLICABLE DOCUMENTS

2.1 The following specifications and publications, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

CCC-F-466 Flannel; Outing

Military

MIL-C-6799 Coating; Protective (for Acrylic Plastic Sheet)

MIL-C-8576 Cement, Acrylic Monomer Base for Acrylic Plastic

MIL-P-5425 Plastic, Sheet, Acrylic, Heat Resistant

MIL-P-5952 Plastic Areas, Transparent, Aircraft Optical

(Copies of specifications, standards, drawings, 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.)

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MIL-P-6886	Plastic, Sheet, Acrylic
MIL-P-7524	Plastic, Sheet, Acrylic, Laminated, Heat Resistant
MIL-P-8184	Plastic: Acrylic Sheet, Modified

PUBLICATIONS

Navy Department

Navy Code of Manufacturers' Name

U. S. Air Force

Engineering Handbook

AN-01-1A-12	Maintenance and Repair of Transparent Plastics
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3. REQUIREMENTS

3.1 Materials. The materials referred to in this specification shall conform to the requirements of the applicable specifications listed in Section 2. Materials which are not covered by applicable specifications or which are not specifically described herein shall be of the best quality and suitable for the purpose intended.

3.2 Fabrication.

3.2.1 Handling and surface protection. The original surface of the plastic sheeting, once marred, cannot be refinished to equal the perfection of the original surface. Therefore, all operations shall be performed with caution in order to preserve the original optical surface. The transparent plastic received already formed, or as sheets, shall be suitably protected from damage during all operations, including installation and further processing, until final inspection of the aircraft. A protecting medium satisfactory to the procuring activity shall be kept on the material until all operations possible have been completed, except that it shall be removed during the heating, forming, cementing, annealing, and inspection operations when necessary. Protective coatings conforming to Specification MIL-C-6799 are acceptable for use on fabricated parts. Fifty-pound Kraft paper with suitable adhesive shall be used on both sides of each flat sheet during shipping and storage. When it is necessary to remove the paper, one corner shall be loosened with a fingernail, and the paper rolled off in the form of a tube. If particles of the adhesive cling to the sheet, they can be removed by washing carefully with a soft, clean, grit-free cloth conforming to Specification CCC-F-466, wet with a suitable cleaner as specified in 3.5.2.

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3.2.2 Conditioning. Plastic sheets which have been stored below a temperature of 50°F (10°C) shall be conditioned for at least 4 hours at room temperature prior to use.

3.2.3 Edges and surfaces. All edges and surfaces including holes shall be clean, smooth, and free from cracks, burrs, chipping, etc. Exposed edges and surfaces and any other areas significant for optical purposes shall be smooth finished.

3.2.4 Routed edges. The routed surfaces of all edges so finished shall intersect in a fillet of at least 1/16-inch radius, as shown in Section IV of Engineering Handbook AN-01-1A-12.

3.3 Forming. The transparent plastic material shall not be drawn thinner than indicated on the applicable drawing of the formed part making due allowance for sheet thickness tolerances as specified in the applicable specifications. The cooling of the sheet during the forming process shall be uniform and slow over the entire surface, in order to minimize internal strain. Local heating shall not be used to correct a defect or to make any other corrections. The forming of acrylics shall be as specified in the Engineering Handbook AN-01-1A-12, or as approved by the procuring activity, except that vacuum forming for laminated acrylics shall not be permitted. The temperature and time for the forming of all plastics shall be selected in accordance with the applicable material involved, so as to minimize residual stress and to avoid thermal degradation. Plastic laminates shall be preconditioned in accordance with material manufacturer's recommendations or applicable process specification as necessary to insure against the formation of bubbles, delamination, or other defects during forming.

3.3.1 Cold forming. Cold forming of any transparent plastic sheet specified herein shall not be permitted.

3.4 Cementing. Commercially available cements for joining the transparent plastic sheet may be used provided they are satisfactory to the procuring activity. Cements conforming to Specification MIL-C-8576 are acceptable for acrylic base sheets conforming to Specification MIL-P-6886, MIL-P-5425, and MIL-P-7524. All cements shall be used in accordance with the instructions of the cement manufacturer or the applicable process specification.

3.4.1 Preparation of joints. The surfaces of the parts to be cemented together shall be carefully prepared and fitted as specified in Section IV of the Engineering Handbook AN-01-1A-12, or in accordance with instructions furnished by the cement manufacturers, or the applicable process specifications.

3.4.2 Application of cement. Application of cement shall be as specified herein or in accordance with the cement manufacturer's instructions or applicable process specification. All areas adjacent to the joint shall be masked wherever

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possible to prevent etching or other undesirable effects. This is accomplished by applying suitable masking tape or other material impervious to cement action within 1/8 inch of the joint. If several strips of tape are used, they should overlap about 1/4 inch. In the case of solvent-type cement, a suitable soaking period shall be allowed for the cement to attack the plastic and form a cushion before joining the parts to be bonded. The soaking period, however, shall be not longer than necessary to attain the required strength in the finished bond.

3.4.3 Clamping. In assembling, the parts shall be pressed together firmly, applying only enough pressure to force out the air bubbles and excess cement, and to assure uniform contact throughout the joint. Excess cement shall be scraped onto the protecting tape as soon as possible in order to avoid the need of excessive sanding, polishing, etc, in finishing the joint; but care should be taken not to remove an amount which might result in a depressed area after subsequent shrinkage during curing.

3.4.4 Quality of cemented joints. All cemented joints shall be firmly bonded over the entire area of the joint surfaces. Approximately 10 percent of the joint may have bubbles or dry spots, except that no such openings shall appear continuously over a 2-inch length at an edge, corner, intersection, or end of the joint. Air bubbles may easily be eliminated from a joint by providing excess cement at the middle of a joint with the outer edges relatively starved, because this will promote flow to the boundary. If, on the other hand, the middle is relatively starved, pressure usually will not eliminate bubbles.

3.4.5 Drying or curing. Wherever possible, applicable, or beneficial, joints shall be heat cured to improve strength as a part of the annealing process (see 3.6) or as a separate operation.

3.5 Finish.

3.5.1 Defects. The finished parts shall be free from such optical defects as would render the parts unfit for the purpose intended. The optical quality for the purpose intended shall be as defined in applicable drawings, and specifications approved by the procuring activity, which describes sighting, scanning, non-vision (to inspect surfaces of the aircraft only) and blind areas (areas which can be opaque). Explanation of the terms in the previous sentence can be found in Specification MIL-P-5952. Repairs may be permitted in those areas indicated on the approved applicable drawings or specifications, provided they do not affect the design strength and optical requirements of the part.

3.5.2 Cleaning materials. Special precautions must be exercised in the use of cleaners on acrylics. Approved cleaning materials for acrylics are listed in Engineering Handbook AN-01-1A-12, and shall be used otherwise authorized by the procuring activity. Transparent polyester plastic sheets may be cleaned with toluol, alcohol, or soap and water.

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3.5.3 Buffing and polishing. Except for nonstructural parts which are not optically critical (not used for sighting or scanning), plastic components shall not be power buffed or polished. Light hand polishing is permitted to remove fine "cob-web" type scratches, provided structural and optical properties are not reduced below applicable requirements. Unless otherwise authorized by the procuring activity buffing and polishing compounds for use on acrylic plastics shall be selected from among those listed in Engineering Handbook AN-01-1A-12. During buffing and polishing, the surface of the plastics shall not be allowed to become warm to the touch.

3.5.4 Waxing. Unless otherwise authorized by the procuring activity, waxes employed on acrylic surfaces shall be selected from among those listed in Engineering Handbook AN-01-1A-12.

3.6 Annealing. Unless otherwise specifically approved by the procuring activity formed components shall be annealed to produce structures as free as possible from residual stresses incurred during fabrication. The annealing operation shall consist of subjecting the transparent parts or assemblies to elevated temperatures in a forced draft oven followed by slow cooling. Except as may be otherwise authorized by the procuring activity, annealing of solid acrylic parts shall be accomplished in accordance with 3.6.1. For plastics other than acrylics, (i.e., the polyesters, and the acrylic laminates), the annealing operation, when required, shall be as prescribed by the material manufacturer, or applicable process specification.

3.6.1 Annealing schedule for solid acrylic parts. The annealing temperature shall be the highest in the applicable range that can be tolerated without unacceptable distortion of the part as assembly as determined by experience. The heating period for acrylics, including the time required to bring the part or assembly up to oven temperature shall be not less than the period shown in table I for the selected temperature. The rate of cooling after heating shall be uniform and shall not exceed the value shown in table II for the nominal thickness of the part or assembly.

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TABLE I

Recommend annealing of solid acrylics

Thickness (inches)	Heating time (including period required to bring part up to annealing temperature) in hours at the indicated temperatures							
	Acrylic Specification MIL-P-6886				Acrylic Specifications MIL-P-5425 and MIL-P-8184			
	176°F (80°C)	158°F (70°C)	140°F (60°C)	122°F (50°C)	212°F (100°C)	194°F (80°C)	176°F (80°C)	158°F (70°C)
0.060 through 0.150	3	5	10	24	3	5	10	24
0.187 through 0.375	3-1/2	5-1/2	10-12	24	3-1/2	5-1/2	10-1/2	24
0.500 through 0.750	4	6	11	24	4	6	11	24
0.875 through 1.130	4-1/2	6-12	11-1/2	24	4-1/2	6-1/2	11-1/2	24
1.25 through 1.50	5	7	12	24	5	7	12	24

TABLE II

Recommend cooling rates for solid acrylics subject to annealing temperatures

Thickness (Inches)	Cooling time in minutes from the indicated annealing temperature at the maximum permissible rate to the maximum removal temperature of 122°F (50°C) for Specification MIL-P-6886 and 158°F (70°C) for Specifications MIL-P-5425 and MIL-P-8184.							
	Maximum Cooling rate		Acrylic Specification MIL-P-6886			Acrylic Specifications MIL-P-5425 and MIL-P-8184		
	°C/hr	°F/hr	176°F (80°C)	158°F (70°C)	140°F (60°C)	212°F (100°C)	194°F (90°C)	176°F (80°C)
0.060 through 0.150	67	120	30	20	10	30	20	10
0.187 through 0.375	27	49	70	45	20	70	45	20
0.500 through 0.750	14	25	130	90	45	130	90	45
0.875 through 1.30	10	18	190	125	60	190	125	60
0.125 through 1.50	7	13	270	180	90	270	180	90

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3.7 Installation. Transparent plastic elements shall be installed in strict accordance with applicable drawings and process specifications. Care shall be exercised to insure that frames are free of burrs or other fabrication irregularities which could notch or otherwise damage the plastic surface that the contours of the plastic assembly and the frame match snugly yet preclude forcing or distortion of either member; that the plastic assembly is not damaged in any way in the course of mounting; that packing and fastenings are accurately located; and that fastenings are taken up uniformly in order to avoid local or gross distortion and provide optimum distribution of applied loads. Section VII of Engineering Handbook AN-01-1A-12 shall be referred to for recommended installation procedures.

3.7.1 Gasket and mastic materials. Unless otherwise authorized by the procuring activity, only gasket and mastic materials listed in Engineering Handbook AN-01-1A-12 shall be employed in contact with acrylic components.

3.7.2 Tapping and threading. The use of internal or external threads in transparent plastics for mounting or attaching shall not be permitted.

3.7.3 Rivets. Rivets shall not be employed through plastic assemblies.

3.8 Marking. Each transparent plastic assembly employed as a turret dome, cabin enclosure, window, canopy, etc, shall be durably and legibly marked by the contractor with his approved code symbol, as contained in the Navy Code of Manufacturers' Names, with the month and year of manufacture, and type of plastic material, in a manner that will not impair the structural integrity of the part. Markings shall not be obliterated after installation. The methods used shall not cause distortion of the plastic surface beyond 1/8 inch from the edges of the markings. The mark shall be no higher than 3/16 inch and not less than 3/32 inch, located as close to the edge of the part as possible in order to insure visibility after installation into the specified mounting channel and yet not interfere with through vision. The location of the mark shall be specified on the applicable drawing of the part. The requirements of this paragraph are not intended to apply to cemented ribs, retaining strips, etc, which are integral nondetachable components of a larger transparent assembly.

3.9 Workmanship. The workmanship shall be in accordance with the highest grade practice for this type of work. Optical quality is of paramount importance because of the use to which these materials are put in aircraft enclosures. The ability to locate and identify other aircraft in flight, to land safely at high speeds, to maintain position in formation, and in some cases to sight accurately through plastic enclosures, depends upon surface clarity and freedom from distortion of the plastic. These factors in turn depends entirely upon the amount of care which is exercised in the handling and fabrication of the material.

4. QUALITY ASSURANCE PROVISIONS

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4.1 General. All transparent plastic enclosures and all installations thereof manufactured in accordance with this specification shall be subjected to inspection by authorized Government Inspectors.

4.2 Examination of product. Transparent plastic enclosures, and installations thereof, shall be carefully examined for conformance with applicable detail specifications and drawings. In addition, parts and installations shall be examined for indications of poor workmanship, such as scratched, cracked, or otherwise unsatisfactory material, poorly cemented joints, improperly mounted enclosures, or other defects indicating nonconformance with all specification and drawing requirements.

5. STORAGE

5.1 Storage conditions. Transparent plastics shall be stored in a cool dry location away from solvent fumes, hot water pipes, radiators, etc, and out of the direct rays of the sun. With formed sections, such as turrets, it is especially important to avoid all sources of heat.

5.2 Flat sheets. Transparent plastic sheets should be stored on edge with the masking paper in place. The sheets when racked vertically, shall be supported to prevent sagging. If sheets must be stored horizontally, care shall be taken to avoid chips and dirt between the sheets. Stacks shall not be over 18 inches high. Small sheets shall be stacked on larger ones to avoid unsupported overhang.

5.3 Formed sections. Formed sections, such as canopies, domes, etc, shall be stored in such a manner that there is no tendency for them to lose their shapes. Simple frames may be used to relieve such parts of any external pressure.

6. NOTES

6.1 Intended use. This specification is intended for use in the design, fabrication, installation, and handling of transparent plastics for aircraft.

6.2 When technical problems are encountered which are not covered in detail by this specification and the applicable detailed instructions, the procuring activity should be consulted.

6.3 Fabrication, maintenance and repair. For information regarding fabrication, maintenance, and repair of transparent acrylic plastic sheet, reference may be made to Engineering Handbook AN-01-1A-12. For information on the fabrication, maintenance, and repair of transparent materials other than those conforming to Specifications MIL-P-6886 and MIL-P-5425, reference should be made to the material manufacturers.

Custodians:

Navy - Bureau of Aeronautics
Air Force