

L-P-511

December 2, 1964

(see 6.4)

FEDERAL SPECIFICATION

**PLASTIC SHEET, LAMINATED, THERMOSETTING,
COTTON FABRIC BASE, PHENOLIC-RESIN,
POST-FORMING**

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE

1.1 This specification covers the requirements for one grade of thermosetting, laminated plastic material intended for forming into compound shapes.

2. APPLICABLE SPECIFICATIONS AND STANDARDS

2.1 The following specifications and standards, 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:

Federal Specifications:

- UU-P-268—Paper, Kraft, Untreated, Wrapping.
- PPP-B-636—Box, Fiberboard.
- PPP-B-640—Boxes, Fiberboard, Corrugated, Triple Wall.

Federal Standards:

- Fed. Std. No. 102—Preservation, Packaging, and Packing Levels.
- Fed. Std. No. 123—Marking for Domestic Shipment (Civilian Agencies).
- Fed. Test Method Std. No. 406—Plastics: Methods of Testing.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly sup-

plements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standards:

- MIL-STD-105—Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129—Marking for Shipment and Storage.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Materials. The material shall consist of a suitable cotton fabric impregnated with a thermosetting phenolic type resin and pressed into a sheet.

3.2 Finish. Unless otherwise specified, the material shall have a semi-gloss finish.

3.3 Marking. Each plastic sheet shall be legibly and durably marked with the speci-

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fication number, nominal thickness, and manufacturer's name or approved code designation. Markings shall not damage the material.

3.4 Color. Unless otherwise specified, the color of the material shall be natural.

3.5 Machining. The material shall be capable of being drilled, sawed, or machined in any thickness, without splitting, cracking, chipping, or delaminating.

3.6 Mechanical and physical properties (before post-forming). The material shall conform to the physical properties specified in table I.

TABLE I—*Mechanical and physical properties*

Property	Requirement
Tensile strength, ultimate, minimum, pounds per square inch (p.s.i.)	7500
Tensile, modulus of elasticity, initial, minimum, p.s.i.	0.90 x 10 ⁶
Compression strength, ultimate, minimum, p.s.i. (flatwise)	30,000
Shear strength, minimum, p.s.i.	11,000
Flexural strength (flatwise), minimum, p.s.i.	16,000
Impact strength—Izod edgewise (100% failure in notch) minimum, ft. lbs. per inch of notch	1.5
Afterglow, seconds, maximum:	
Up to 1/4 inch thickness, inclusive;	
As received	4
After conditioning for 168 hours at 107° ± 3° C. (225° ± 5° F.)	15
1/4 inch to 1/2 inch thickness;	
As received	15
After conditioning for 168 hours at 107° ± 3° C. (225° ± 5° F.)	25

3.7 Specific gravity. The specific gravity of the material in the as-received condition shall not exceed 1.40.

3.8 Water absorption. Water absorption, after 24 hours immersion in water, shall not exceed that specified in table II.

TABLE II—*Water absorption*

Thickness (inch)	Percentage change in weight, maximum
1/32, 3/64	7.5
1/16	4.4
3/32	3.2
1/8	2.5
3/16, 7/32	1.9
1/4, 5/16	1.6
3/8	1.4

3.9 Hot bendability. The material shall be capable of being bent to an angle of 90 degrees over a radius as specified in table III after having been treated in accordance with the manufacturer's instructions. After it has cooled to room temperature, the bend shall not exceed 93 degrees of angle. After cooling, the bent specimen shall show no defects, such as blisters, delamination, cracks, or tears. Rippling of the surface which follows the weave of the fabric shall not be considered a defect.

TABLE III—*Hot bendability*

Sheet thickness (inch)	Bend radius (inches)
1/32	1/32
3/64	1/16
1/16	3/32
3/32	3/16
1/8	5/16
3/16	9/16
7/32	3/4
1/4	1
5/16	1-9/16
3/8	2-1/4

3.10 Drawing. The material, when drawn as specified in 4.3.9, shall exhibit a satisfactory draw as specified in table IV.

TABLE IV—*Drawing requirements*

Thickness (inch)	Depth of draw (inches)
1/32	1-3/8
3/64	1-3/8
1/16	1-1/4
3/32	1-1/8
1/8	3/4

3.11 Bending. The material shall not split, crack, craze, or delaminate when bent as specified in 4.3.10.

3.12 Warp and twist. The warp or twist of standard laminated thermosetting sheets shall not exceed the values specified in table V.

TABLE V—Warp or twist

Form	Thickness (inch)	Max. warp or twist, percent (on basis of 36" dim.) ¹
Sheets ²	1/32 to under 1/16	5
	1/16 to under 1/8	2.5
	1/8 to under 5/16	1

¹ For warp, the percentage is stated in terms of the lateral dimensions (length or width). For twist, the percentage is stated in terms of the dimensions from one corner to the opposite corner, diagonally.

² This does not apply to cut pieces, but only to sheet sizes as manufactured.

3.13 Dimensions and tolerances.

3.13.1 *Dimensional stability.* Specimens formed successfully as specified in 3.9 shall be heated by immersing in water at 180°F. for one hour. After removing from water and cooling unrestrained, the amount of spring back shall not exceed the values shown in table VI.

TABLE VI—Spring back

Nominal thickness	Spring back (degrees) (maximum)
1/32	30
3/64	27
1/16	25
3/32	20
1/8	15
5/32	12
3/16	9
7/32	7
1/4, 5/16, 3/8	6

3.13.2 *Thickness.* Unless otherwise specified, the standard thicknesses and the thickness tolerances shall be as specified in table VII.

3.13.3 *Length and width.* The lengths and width of sheets shall be as specified in the individual order. Manufacturer's standard sheet sizes between 36 and 48 inches in width and length will be acceptable if other

TABLE VII—Thickness tolerances

Thickness (inch)	Tolerance (inch)
1/32	±0.0065
3/64	±0.0075
1/16	±0.0075
3/32	±0.009
1/8	±0.010
5/32	±0.011
3/16	±0.0125
7/32	±0.014
1/4	+0.030, -0.000
5/16	+0.035, -0.000
3/8	+0.040, -0.000

dimensions are not specified. Unless otherwise specified, the length and width may vary, plus or minus one inch, from the manufacturer's standard size. Unless otherwise specified, where small pieces are ordered to be cut from standard size sheets the tolerances in length or width shall be as specified in table VIII.

TABLE VIII—Permissible variation in size of pieces cut from standard sheets

Thickness	Tolerance in length or width (inch) (plus or minus)		
	6 inches and under	Over 6 to 24 inches, incl.	Over 24 inches
All	0.010	0.015	0.031

3.14 *Manufacturer's instructions.* Unless otherwise specified, the manufacturer shall furnish complete instructions for forming conditions in each shipping container of materials. These instructions shall cover any characteristics of the material which may be peculiar to it alone and shall include complete instructions for use, limitations and variations in temperature or conditions required for changes in thickness with any specific process.

3.15 *Workmanship.* All details of workmanship shall be in accordance with high grade manufacturing practice for the production of laminated sheet plastics. Control shall be maintained of the quality and impregnation of the fabric, and of the drying and pressing of the impregnated fabric in order to obtain a uniform material. The material shall be essentially free from blisters, cracks, wrinkles, solvent area, pockets of free resin, ducts, and scratches.

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4. SAMPLING, INSPECTION, AND TEST PROCEDURES

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, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 that supplies and services conform to prescribed requirements.

4.2 Sampling for inspection and acceptance. Sampling for inspection and acceptance shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated hereinafter. For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same thickness submitted for delivery at one time.

4.2.1 Inspection of materials and components. In accordance with 4.1, the supplier is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with the requirements of referenced subsidiary specifications and standards to the extent specified, or, if none, in accordance with this specification. In the event of conflict, this specification shall govern.

4.2.2 Inspection of the end item.

4.2.2.1 Examination of the end item. Examination of the end item shall be made in accordance with the classification of defects, inspection levels, and acceptable quality levels (AQLs) set forth below. The lot size, for purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of plastic sheets for examination in 4.2.2.1.3.

4.2.2.1.1 Examination of the end item for defects in appearance, color, finish, and

workmanship. The sample units for the examination specified in table IX shall be in accordance with 4.2.2.1.4.

TABLE IX—*Examination of the end item for defects in appearance, color, finish, and workmanship*

Examine	Defect
Appearance and workmanship	Not uniform. Presence of foreign matter, dirt, grit, or abrasive. Any separation of plies or layers. Any crack, break, bulge, chip, wrinkle, pockets of free resin, or scratches. Laminations not as specified. Ragged or rough edges or sides.
Color	Not natural color, or not as specified.
Finish	Not semi-gloss or not as specified.
Marking	Individual sheets not marked as specified (see 3.3).

4.2.2.1.2 Examination of the end item for defects in dimensions. The sample unit for the examination specified in table X shall be in accordance with 4.2.2.1.4.

TABLE X—*Examination of the end item for defects in dimension*

Examine	Defect
Length & width of sheets	Not as specified.
Manufacturer's standard size sheets	Varies by more than \pm one inch from the standard size specified.
Cut sheets	Length and width varies by more than tolerances specified in table VIII.
Thickness	Varies from thickness specified by more than the \pm tolerances specified in table VII.

4.2.2.1.3 Examination of preparation for delivery. An examination in accordance with table XI shall be made to determine that the packaging, packing, and markings comply with the requirements of section 5 of this specification. The sample unit for this examination shall be one shipping container, fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects.

TABLE XI—*Examination for defects in preparation for delivery*

Examine	Defect
Packaging	Unit package not packaged as specified.
	Not separated by size and thickness.
	Individual sheets not interleaved or protected on both surfaces by a suitable paper.
Packing	Not in accordance with contract requirements.
	Instructions (when specified) missing, illegible, incomplete, or erroneous (see 3.14).
	Any non-conforming component, component missing, damaged, or otherwise defective affecting serviceability.
	Container not as specified, closures not accomplished by specified or required methods or materials.
	Inadequate application of components, such as incomplete closures of case liners, container flaps, loose or inadequate strappings, bulged or distorted containers.
Count	Less than specified or indicated quantity.
Weight	Gross weight exceeds specified requirements.
Markings	Interior or exterior markings (as applicable) omitted, illegible, incorrect, incomplete, or not in accordance with contract requirements.
Manufacturer's instructions	Not included, when specified.

4.2.2.1.4 Inspection levels and acceptable quality levels (AQLs) for examinations. The inspection levels for determining the sample size and the acceptable quality levels (AQLs) expressed in defects per 100 units, shall be as follows:

Examination paragraph	Inspection level	AQL
4.2.2.1.1	I	1.5
4.2.2.1.2	S-2	2.5
4.2.2.1.3	S-2	4.0

4.2.3 Testing of the end item. The end item shall be tested for the applicable characteristics as listed in table XII from each lot presented for examination. The sample unit shall be one standard size sheet (minimum of 9 sq. ft.). The inspection level for determining the sample size shall be S-1. The lot size shall be expressed in units of plastic sheets. The acceptable quality level (AQL) shall be 4.0, expressed in defects per 100 units. Unless otherwise specified hereinafter for a particular test, temperature and humidity conditions for testing shall be as specified in Fed. Test Method Std. No. 406.

4.3 Test methods. The average value developed by the specimens tested shall be used to determine conformance with physical requirements listed in table I. The average test values for the specimens tested shall be taken for water absorption and spe-

TABLE XII—*Instructions for testing (sample unit)*

Characteristic	Specification reference		Rqmts. appl. to:		Number of determinations per sample unit	Results reported as	
	Requirement	Test method	Indiv. unit	Lot average		Pass or fail ¹	Numerically to nearest ²
Machining ability	3.5	4.3.1	X		1	X	
Physical properties	Table I						
Tensile strength		4.3.2	X		Avg. of 4 (2 in each direction)		100 p.s.i.
Tensile, modulus of elasticity		4.3.2	X		Avg. of 4 (2 in each direction)		100 p.s.i.
Compression strength (flatwise)		4.3.3	X		Avg. of 4		100 p.s.i.
Shear strength		4.3.4	X		Avg. of 6 (3 in each direction)		100 p.s.i.

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TABLE XII—Instructions for testing (sample unit) (cont'd.)

Characteristic	Specification reference		Rqmts. appl. to		Number of determinations per sample unit	Results reported as	
	Requirement	Test method	Indiv. unit	Lot average		Pass or fail ¹	Numerically to nearest ²
Flexural strength, (flatwise)		Method 1031, Fed. Test Method Std. No. 406	X		Avg. of 3		100 p.s.i.
Impact strength (edgewise)		4.3.5	X		Avg. of 6 (3 in each direction)		0.1 ft. lb./in notch
Afterglow	Table I						
as received		4.3.12	X		Avg. of 3		second
after conditioning		4.3.12	X		Avg. of 3		second
Specific gravity	3.7	4.3.6	X		Avg. of 3		0.01
Water absorption	Table II	4.3.7	X		Avg. of 3		0.1 percent
Hot bendability	3.9						
Lengthwise		4.3.8	X		3	X	
Crosswise		4.3.8	X		3	X	
Drawing	3.10	4.3.9	X		Avg. of 5		1/32 inch
Bending	3.11	4.3.10	X		1	X	
Warp & twist	3.12	4.3.11	X		1		0.1 percent

NOTE: ¹ If failure is indicated report description of failure.² Test reports shall include all values on which results are based.

cific gravity. Strength values shall be reported to the nearest 100 pounds per square inch. Water absorption values shall be reported to the nearest 0.1 percent, and specific gravity to the nearest 0.01 unit. Impact strength values shall be reported to the nearest 0.1 foot pound.

4.3.1 Machining. The sample sheet, or specimens cut therefrom in any convenient size and shape, shall be drilled, sawed and machined, if 1/8 inch thick or less, in accordance with the manufacturer's recommendations to determine whether the material splits, cracks, chips, burrs or delaminates.

4.3.2 Ultimate tensile strength. A total of four specimens, two lengthwise and two crosswise, shall be prepared from the sample sheet. The specimens shall be selected at random over any area of the sheet. The test for tensile properties shall be conducted as specified in method 1011, Fed. Test Method Std. No. 406.

4.3.3 Compressive strength. A total of four specimens shall be prepared from the sample sheet. The specimens shall be selected at random over any area of the sheet. The method of test shall follow that of Fed. Test Method Std. No. 406, method No. 1021, tested flatwise.

4.3.4 Shear strength. Six rectangular specimens, three lengthwise and three crosswise, conforming to the requirements of Fed. Test Method Std. No. 406, method 1041, shall be prepared from the sample sheet. The specimens shall be selected at random from any area of the sheet. The test shall be conducted as specified in Fed. Test Method Std. No. 406, using the Johnson-type shear tool.

4.3.5 Izod impact strength. A total of six specimens, three consisting of material taken in the lengthwise direction and three consisting of material taken in the crosswise direction, shall be prepared to conform to the specimen described in Fed. Test Method Std. No. 406, method 1071. Material over 1/4 inch in thickness shall be machined to

1/4 inch in order that the laminated specimens will consist of two equal thicknesses. The test shall be conducted in accordance with Fed. Test Method Std. No. 406.

4.3.6 Specific gravity. Three specimens of not less than 1/8 cubic inch volume shall be selected at random over any area of the sheet. The specific gravity shall be determined by weighing the specimen at 73.4°F. (23°C.) in air and in water. The specific gravity of the material shall be calculated from the following formula:

$$\text{Specific gravity at } 73.4^\circ \text{ F. (23}^\circ \text{ C.)} = \frac{\text{Weight in air}}{\text{Weight in air} - \text{Weight in water}}$$

4.3.7 Water absorption. Three specimens, 1 inch by 3 inches, shall be selected at random over any area of the sample sheet in both the lengthwise and crosswise directions. The thickness shall be measured at the center of each specimen. The test shall be conducted as specified in Fed. Test Method Std. No. 406, method 7031. The thickness of the water absorption specimen shall be the thickness of the sheet.

4.3.8 Hot bendability. Six specimens, three lengthwise and three crosswise, shall be cut from the sample sheet. The size of the specimen shall be 6 inches by 2 inches by the thickness of the sheet. The specimen shall be treated according to the manufacturer's instructions and immediately bent in the bending fixture shown in figure 1. The specimen shall be placed in the bending fixture so that the two-inch dimension will be parallel to the minimum dimension of the fixture.

4.3.9 Drawing. Specimens 6 inches in diameter shall be heated in accordance with the manufacturer's time-temperature curve for each thickness. The manufacturer shall determine the optimum heating time and temperature on his product as that particular combination which produces the maximum physical properties and formability. After heating, the specimens shall be drawn

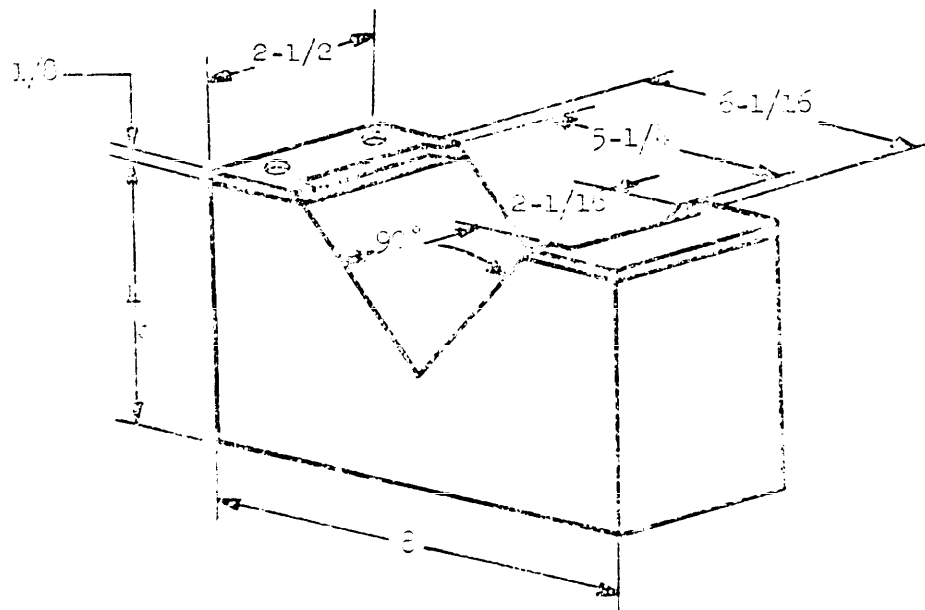
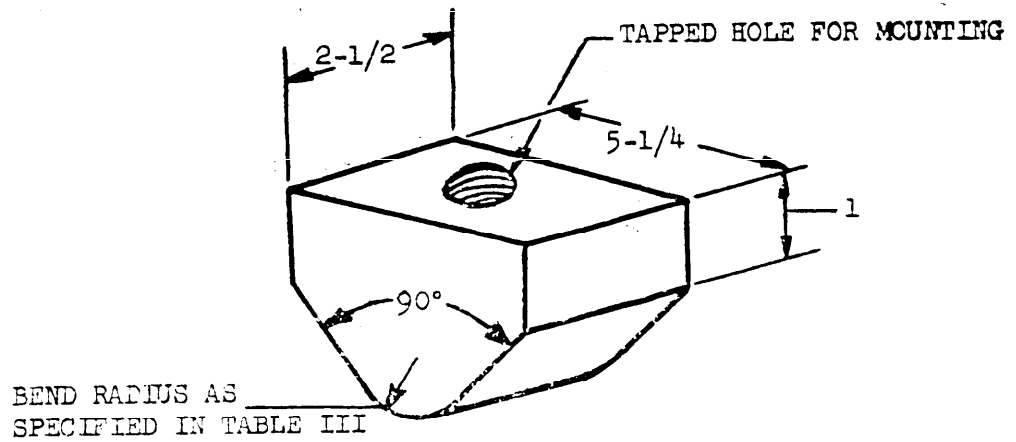
in a suitable jig having a steel mandrel and draw ring. The mandrel (male die) shall consist of a 3-inch diameter cylinder with a 1-1/2 inch spherical radius on the contact end and arranged so as to move at a rate of 60 inches per minute. The draw ring (female die) shall have a cylindrical hole (diameter equal to 3 inches plus 2-1/2 times thickness of sheet) through which the mandrel travels in making the draw. The draw ring shall be maintained at a temperature of 275° to 300°F. (135° to 149°C.). A draw radius of 1/8 inch shall be provided on the inside of the draw ring. The specimen shall be clamped at 15-20 p.s.i. against the draw ring before the draw begins. The mandrel shall travel in such a direction as to force the laminate against the draw ring radius. The time elapsed from removal of the sheet from the heating device shall not exceed ten seconds. Under these conditions, the sheet shall produce draws in compliance with 3.10.

4.3.10 Bending. A one-inch specimen cut from any direction of sheet shall be bent at room temperature through an angle of 180 degrees around a diameter equal to 40 times the nominal thickness of the sheet. Permanent set of specimen is permissible. The specimen shall be examined for splitting, cracking, crazing, and delamination.

4.3.11 Warp and twist. The warp and twist shall be determined as specified in Fed. Test Method Std. No. 406, method 6051.

4.3.12 Afterglow. Three specimens, 6 inches by 1/2 inch, shall be placed in a shielded area of subdued light, such as an unlighted fume hood, and mounted horizontally in a flatwise cantilever arrangement secured at one end. A Meker or similar large top burner with a flame 1 inch long shall be placed so that the tip of the flame contacts the plastic, and 1 inch of the plastic is covered by the flame. The specimens shall be heated 15 seconds for each 1/32 inch of thickness and fraction thereof. At the end of the ignition period, the burner shall be removed and the flame on the specimen

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DIMENSIONS IN INCHES

NOTE: BOTH MEMBERS TO BE MADE OF FABRIC BASE LAMINATE, CAST RESIN, WOOD OR OTHER MATERIAL OF SUITABLY LOW THERMAL CONDUCTIVITY.

FIGURE 1. Bending fixture.

shall be blown out. The duration of visible glow shall then be noted.

5. PREPARATION FOR DELIVERY

(For civil agency procurement, the definition and applications of the levels of packaging and packing shall be in accordance with Fed. Std. No. 102).

5.1 Preservation and packaging. Preservation and packaging shall be level A or C as specified, (see 6.2).

5.1.1 Level A. Laminated materials shall be wrapped individually, or interleaved to protect them from abrasion, using not less than 30-pound basis weight kraft paper conforming to grade B of UU-P-268.

5.1.2 Level C. Laminated materials shall be packaged to afford the minimum degree of protection necessary to prevent deterioration or damage during shipment under normal environmental conditions and commercial modes of transportation.

5.2 Packing. Packing shall be level A, B, or C as specified, (see 6.2).

5.2.1 Level A. Laminated material, packaged as specified, shall be packed in overseas type containers conforming to PPP-B-636, class 2 or PPP-B-640, class 2, at the option of the contractor. Shipping containers shall be closed, strapped or banded in accordance with the applicable box specification or appendix thereto. Fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification.

5.2.2 Level B. Laminated material, packaged as specified, shall be packed in domestic type containers conforming to PPP-B-636, class 1 or PPP-B-640, class 1, at the option of the contractor. Shipping containers shall be closed in accordance with the applicable box specification or appendix thereto. Fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification.

5.2.3 Level C. Laminated material that requires overpacking by the carrier shall be packed in exterior type shipping containers in a manner that will insure safe transportation at the lowest rate to the point of delivery, and shall meet, as a minimum, the requirements of the rules and regulations applicable to the mode of transportation selected.

5.3 Marking.

5.3.1 Civil agencies. In addition to any special marking required by the contract or order, interior packages and exterior shipping containers shall be marked for shipment in accordance with Fed. Std. No. 123.

5.3.2 Military agencies. In addition to any special marking required by the contract or order, interior packages and exterior shipping containers shall be marked for shipment in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The laminated plastic sheet covered by this specification is intended for forming into compound shapes for mechanical applications on aircraft, and for use in other applications. The plastic material is not intended for electrical insulation applications.

6.2 Ordering data. Purchasers should exercise any desired options offered herein and procurement documents should state the number of pieces, length and width in inches, thickness required, finish and color (see 3.2 and 3.4), whether instructions for forming are required (see 3.14), and levels of packing and packaging desired (see section 5). Sizes and thicknesses specified should conform to commercial practice, where practicable (see section 3).

6.3 Transportation description. The transportation descriptions and minimum weights applicable to this commodity are:

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Rail:

Laminated plastic, sheets.

Carload minimum weight 30,000
pounds.

Motor:

Sheeting, other than cellular, plastic.
Truckload minimum weight 30,000
pounds, subject to Rule 115, Na-
tional Motor Freight Classifica-
tion.

6.4 Supersession data. This specification
includes the requirements of MIL-P-8655A,
dated July 27, 1954.

MILITARY CUSTODIANS:

Army—MR

Navy—Weps

Air Force—11

MILITARY INTERESTED ACTIVITIES:

Review:

Army—EL, MI, MR, WC

Navy—WEPS

Air Force—11, 69

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