

PPP-C-850d

SUPERSEDING

April 10, 1964

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June 12, 1963

FEDERAL SPECIFICATION**CUSHIONING MATERIAL, POLYSTYRENE,
EXPANDED, RESILIENT (FOR PACKAGING USES)**

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

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers resilient cushioning materials of expanded polymers or copolymers of styrene for use in cushioning and packaging applications.

1.2 Classification.

1.2.1 Types and classes. Cushioning materials covered by this specification, shall be of the following types and classes, as specified:

Type I—Sheet Form

Class 1—Soft

Class 2—Medium

Class 3—Firm

Class 4—Extra firm

Type II—Roll Form

Class 1—Soft

Class 2—Medium

Class 3—Firm

Class 4—Extra Firm

**2. APPLICABLE SPECIFICATIONS
AND STANDARDS**

2.1 The following specifications and standards, of the issues in effect on date of invitation for bids, form a part of this specification:

Federal Specifications:QQ-A-561—Aluminum Alloy 1100 (2S);
Plate and Sheet.UU-P-31—Paper, General Specifications
and Methods of Testing.UU-P-268 — Paper, Kraft, Untreated,
Wrapping.UU-P-271—Paper, Wrapping, Water-
proofed Kraft.

PPP-B-585—Boxes, Wood, Wirebound.

PPP-B-591—Boxes, Fiberboard, Wood-
Cleated.PPP-B-601—Boxes, Wood, Cleated-Ply-
wood.PPP-B-621—Boxes, Wood, Nailed and
Lock-Corner.

PPP-B-636—Box, Fiberboard.

Federal Standards:Fed. Std. No. 102—Preservation, Pack-
aging, and Packing Levels.Fed. Std. No. 123—Marking for Domes-
tic Shipment (Civilian Agencies).

(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 supplements 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.)

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Military Specification:

MIL-A-140 — Adhesive, Water-Resistant, Waterproof Barrier-Material.

Military Standard:

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 Material. Expanded polymers or copolymers of styrene (containing at least 50% styrene polymer) in the form of resilient cushioning material expanded many times in volume. The material shall be uniform containing no large voids, accumulations of unexpanded resin or other inclusions. The material shall be non-abrasive, fungus and mold resistant, free from objectionable odor, and shall contain no free sulfur. The material shall have a useful temperature range of + 165° to -65°F.

3.2 Forms and dimensions. The cushioning material shall be furnished in sheet or roll form. The width, length, and thickness shall be specified in the invitation for bids (see 6.3).

3.2.1 Dimensional tolerances.**3.2.1.1 Sheets.**

3.2.1.1.1 Length and width. Minus 0 to plus 5/16 inch.

3.2.1.1.2 Thickness. 1/8 inch and under—Minus 0 to plus 50%.

Over 1/8 inch to 1/2 inch inclusive—Minus 0 to plus 1/32 inch.

Over 1/2 inch to 1 inch inclusive—Minus 0 to plus 1/16 inch.

Over 1 inch—Minus 0 to plus 1/8 inch.

3.2.1.2 Rolls.

3.2.1.2.1 Width. Minus 0 to plus 5/16 inch;

3.2.1.2.2 Thickness. 1/8 inch and under—Minus 0 to plus 50%.

Over 1/8 inch to 1/2 inch inclusive—Minus 0 to plus 1/32 inch.

Over 1/2 inch to 1 inch inclusive—Minus 0 to plus 1/16 inch.

Over 1 inch—Minus 0 to plus 1/8 inch.

3.2.1.2.3 Length. Minus 0 to plus 8 percent.

3.3 Compressive stiffness. The compressive stiffness, or strain resulting from a given stress, when tested as in 4.4.4 shall be within ± 15 percent of the strain values given in table I.

TABLE I.

Stress (p.s.i.)	Strain (in./in.)			
	Class 1	Class 2	Class 3	Class 4
20 .....	.63	.57	.48	.42
40 .....	.75	.71	.62	.64
50 .....	.79	.75	.66	.70

3.4 Hydrogen ion concentration. The hydrogen ion concentration (pH) of the material shall be not less than 6.0 nor more than 8.0 when tested as in 4.4.5.

3.5 Flexibility. When tested as in 4.4.6, the surface shall show no cracks, tears, nor separations resulting from the test when bent around appropriate mandrels given in tables II and III.

TABLE II.

Mandrel selector (73.4°F.)	
Class	Mandrel diameter (inches)
1	3 x thickness (inches)
2	3 x thickness (inches)
3	9 x thickness (inches)
4	9 x thickness (inches)

TABLE III.

Mandrel selector (-65°F.)	
Class	Mandrel diameter (inches)
1	5 x thickness (inches)
2	4 x thickness (inches)
3	11 x thickness (inches)
4	11 x thickness (inches)

3.6 Thickness loss. The thickness loss when tested in accordance with paragraph 4.4.7 shall not exceed those values given in table IV.

3.7 Thermal stability. When tested in accordance with paragraph 4.4.8, the linear shrinkage shall not exceed those values given in table V.

TABLE IV.

Class	Thickness loss percent
1	15
2	15
3	15
4	15

TABLE V.

Thermal stability at 165°F.	
Class	Linear shrinkage percent
1	0.5
2	1.0
3	1.5
4	1.5

3.8 Dusting and breakdown. When tested in accordance with 4.4.9, the weight loss shall not be in excess of 0.3 percent.

3.9 Water absorption. When tested in accordance with paragraph 4.4.10, the water absorption (by volume equivalent) shall not exceed 5 percent. The requirement shall not apply to materials under one inch in thickness.

3.10 Abrasiveness. When so specified, the material shall produce no objectionable scratches when rubbed on a polished aluminum surface as specified in paragraph 4.4.11, except that polishing or buffing shall not be considered as scratching.

3.11 Mold resistance. When so specified, the contractor shall submit written evidence that the material does not support active mold growth and that it has not been treated with mercurials.

3.12 Density. The contractor shall submit a certificate indicating the nominal density of the material offered in pounds per cubic foot tested as specified in 4.4.12 (see 6.5.2).

3.13 Workmanship. The material shall be of uniform quality and texture, sheets or rolls, and converted pieces shall be manufactured in accordance with good commercial practices.

4. SAMPLING, INSPECTION AND TEST PROCEDURES

4.1 The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services 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 lot acceptance

4.2.1 *Inspection Lot.* A lot shall consist of all cushioning material of the same type and class offered for delivery at the same time.

4.2.2 *Unit of product.* The unit of product shall consist of one sheet of type I material or one roll of type II material.

4.2.3 *Sampling for inspection of preparation for delivery.* The packaging, packing, and marking of cushioning material shall be examined for compliance with the requirements of section 5 of this specification. Random samples shall be selected in accordance with MIL-STD-105, using inspection level S-3 with an AQL of 6.5 percent defective.

4.2.4 *Sampling for examination.* Visual and dimensional examinations of the cushioning material shall be made for compliance with the requirements of paragraph 3.1 and 3.2 of the specification. The dimensional measurements shall be made in accordance with paragraph 4.3.1. A random sample of material shall be selected from each lot offered to the Government in accordance with MIL-STD-105 at inspection level S-2 with an AQL of 6.5 percent defective.

4.2.5 *Sampling for test.* The cushioning material shall be tested for compliance with compressive stiffness 3.3, thickness loss 3.6, and density 3.12. It also shall be tested for compliance with abrasiveness 3.10, when so

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specified in the contract. Random samples of material shall be selected from each lot offered to the Government in accordance with MIL-STD-105 at inspection level S-1 with an AQL of 6.5 percent defective.

4.3 Examination procedures.

4.3.1 Dimensional measurements may be made with any convenient measuring rule on samples selected in accordance with paragraph 4.2.4.

4.4 Test procedures.

4.4.1 *Test conditions.* Unless otherwise specified tests and measurements shall be at room temperature (70° to 90°F.). In case of dispute, the material shall be conditioned at least 24 hours and tested at 73.4 ± 3.6 F, and relative humidity of 50 ± 5 percent.

4.4.2 When measuring the thickness of the sample for test, the entire upper surface of each sample shall be loaded by a plate or machine platen to 0.025 p.s.i. The thickness of the loaded sample shall be measured at the geometric center of the top surface of the sample or shall be the average of the thickness measurements taken on the four corners of the sample with a micrometer gage graduated in 0.001 inches.

4.4.3 When measuring the length and width of the sample for test, a scale graduated to 0.01 inch shall be used. The length and width shall be read from the scale to the nearest 0.01 inch. Each linear dimension of the test sample shall be measured at 3 equally spaced places.

4.4.4 *Stress-strain.* The specimens shall be conditioned for 24 hours and tested at $70^\circ \pm 2^\circ\text{F.}$ and $50 \pm 2\%$ R.H. The length and width of 4-by-4-by-1-inch specimens shall be measured as in 4.4.3. The thickness shall be measured as in 4.4.2. The test specimens shall be placed in a suitable compression machine and loaded at a uniform rate of 0.1 ± 0.01 inch per minute per inch of specimen thickness. The strain shall be calculated to the nearest 0.01 in./in. by the following formula, and the stress shall be recorded at the strain levels given in table I.

$$e = \frac{d}{t}$$

where e = strain (inches per inch)

d = deflection (inches)

t = original thickness (inches)

The stress shall be calculated by the following formula:

$$s = \frac{L}{w \times l}$$

where s = stress (p.s.i.)

L = load (pounds)

w = width of specimen (inches)

l = length of specimen (inches)

4.4.5 *Hydrogen ion concentration (pH).* The hydrogen ion concentration shall be obtained in accordance with UU-P-31, method 200.

4.4.6 *Flexibility.* Two-inch by six-inch specimens shall be cut from the material, the thickness of which shall be 1/4 inch or under. Each strip shall be bent approximately at its center over the approximate mandrel (see tables II and III) through an arc of 180° over a period of about 5 seconds at an approximately uniform speed.

4.4.6.1 *Flexibility at 73.4°F.* The specimen shall be conditioned for 24 hours and tested as in 4.4.6 at $73.4^\circ \pm 1.8^\circ\text{F.}$ and $50 \pm 2\%$ pH over the appropriate mandrel specified in table II.

4.4.6.2 *Flexibility at -65°F.* The specimens shall be conditioned for 30-40 minutes at $-65^\circ \pm 2^\circ\text{F.}$ and tested as in 4.3.6 at that temperature, or if not practical within 5 seconds after removal from the low temperature area, over the appropriate mandrel specified in table III.

4.4.7 *Thickness loss.* The thickness of 4-by-4-by-1-inch specimens shall be measured as in 4.4.2. The overall specimen shall be alternately compressed to 50 ± 2 percent of its original thickness and tested 10 consecutive times within 10 seconds using an arbor press, hydraulic punch press or equivalent equipment which will simulate dynamic loading. If the stroke of the loading

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device cannot be sufficiently controlled, appropriate stops will be used to attain the desired deflection. The final thickness shall be measured 30 minutes after the tenth cycle. The thickness loss shall be calculated as follows:

$$\text{Percent thickness loss} = \frac{t_0 - t_1}{t_0} \times 100$$

where t_0 = original thickness (in.)
 t_1 = final thickness (in.)

4.4.8 Thermal stability. Staples (reference marks) shall be placed, approximately 10 inches apart along the center line of 3- by 12- by 1-inch specimens. (For materials under one inch thick the thickness of the material shall be used.) The distance between the reference marks shall be measured to the nearest 0.01 inch and recorded as l_0 . The specimens shall be aged for 24 hours at 165°F. and then allowed to cool for 2 hours. The distance between the reference marks shall be measured and recorded as l_1 . The linear shrinkage shall be calculated as follows:

$$\text{Percent linear shrinkage} = \frac{l_0 - l_1}{l_0} \times 100$$

where l_0 = original length between reference marks.

l_1 = length between reference marks after aging.

4.4.9 Dusting and breakdown. 4- by 4- by 1-inch specimens shall be weighed to the nearest 0.001 gram. A cylindrical weight of 0.75 ± 0.01 pound, having a diameter of 1.37 ± 0.01 inch shall be dropped from a height of 10 inches above the top surface of the specimen so as to impact flatwise. After a total of 10 such drops the specimen shall be weighed to the nearest 0.001 gram. The weight loss due to dusting and breakdown shall be computed as follows:

$$\text{Percent weight loss} = \frac{W_0 - W_1}{W_0} \times 100$$

where W_0 = original weight (grams)
 W_1 = weight (grams) after impacts

4.4.10 Water absorption. The length and

width of 6- by 6- by 1-inch specimens shall be measured as in 4.4.3 and the thickness shall be measured as in 4.4.2. The specimens shall be weighed to the nearest 0.01 gram. The specimens shall then be submerged horizontally under 1 inch of distilled or demineralized water for 24 hours. Then the specimens shall be removed from the water and stood on end to drain for 10 minutes after which the excess water shall be removed with blotting paper towel and the specimens immediately reweighed. The percent change by volume shall be calculated as follows:

Percent water absorption
 (by volume equivalent)

$$\frac{W_1 - W_0}{l_0 \times W_0 \times t_0 \times 16.4} \times 100$$

where $W_1 - W_0$ is numerically equivalent to the volume (cc's) of water absorbed.

W_1 = weight (grams) after submersion

W_0 = original weight (grams)

l_0 = original length (inches)

w_0 = original width (inches)

t_0 = original thickness (inches)

16.4 c.c. = 1 cu. in.

4.4.11 Abrasiveness. A specimen of the material of any convenient size, and supporting a weight of one pound per square inch, shall be rubbed in a back-and-forth motion, with one face of the material down, with a stroke of approximately 6 inches over the surface of a piece of polished aluminum for 30 seconds at a speed of one back-and-forth motion per second. Aluminum shall be of type H-18 of QQ-A-561 with a standard bright finish.

4.4.12 Density. The specimens shall be conditioned for 24 hours and tested at $73.4^\circ \pm 1.8^\circ\text{F.}$ and $50 \pm 2\%$ R.H. The length and width of 4- by 4- by 1-inch specimens shall be measured as in 4.4.3. The thickness shall be measured in 4.4.2. The specimen shall be weighed to the nearest 0.01 gram on a suitable balance. The density shall be calculated to the nearest 0.01 pound per cubic foot by the following formula:

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$$\text{Density} = \frac{\text{wt.}}{l \times w \times t} \times 3.81$$

where: wt. = weight (grams)

l = length (inches)

w = width (inches)

t = thickness (inches)

3.81 converts grams per cubic inch to pounds per cubic foot.

5. PREPARATION FOR DELIVERY

(The definitions and application of the various levels of packaging and packing for civil agency procurements shall be as specified in Fed. Std. No. 102.)

5.1 Packaging. Packaging shall be level A, B, or C, as specified (see 6.1).

5.1.1 Level A.

5.1.1.1 Rolls. Each roll of cushioning material shall be wrapped in barrier material conforming to UU-P-271, class C-1 or C-2. All folds, laps and seams shall be sealed with water resistant adhesive conforming to MIL-A-140, grade B, type and class optional.

5.1.1.2 Sheets. Sheets of like size, type and class shall be uniformly stacked in quantities not to exceed 40 pounds and each stack wrapped in a bundle in the manner specified in 5.1.1.1.

5.1.2 Level B.

5.1.2.1 Rolls. Each roll of cushioning material shall be wrapped in Kraft paper conforming to UU-P-268, grade B, minimum basis weight of 50 pounds (24 x 36—500).

5.1.2.2 Sheets. Sheets of like size, type, and class shall be uniformly stacked in quantities not to exceed 40 pounds and each stack wrapped in a bundle in the manner specified in 5.1.2.1.

5.1.3 Level C. Cushioning material shall be packaged in accordance with the manufacturers commercial practice which may or may not include individual wrapping of rolls or bundles.

5.2 Packing.

5.2.1 Level A. Cushioning material packaged as specified in 5.1.1.1, and 5.1.1.2 and shall be packed in quantities not to exceed 100 pounds gross weight in snug-fitting nailed wood, cleated plywood, wirebound wood or cleated paper-overlaid veneer boxes conforming to PPP-B-621, class 2; PPP-B-585; and PPP-B-591, overseas types, respectively. The boxes shall be closed and strapped in accordance with the appendix to the applicable box specification.

5.2.2 Level B.

5.2.2.1 Rolls and sheets. Rolls and sheets of cushioning material packaged as specified in 5.1.2.1 and 5.1.2.2 shall be packed in new, snug-fitting fiberboard boxes conforming to PPP-B-636, type I or II, class 1, style RSC. Corners of boxes shall be vertically reinforced with triangular shaped form of fiberboard of not less than 200 pound test, extending the full depth of the box, securely glued or stapled in each corner, or wood strips 3/8 inches by 2 inches by full depth of box may be glued or stapled in each corner. Alternatively, shipping containers shall be not less than 200 p.s.i., provided with a one piece 200 p.s.i. liner around the entire inside and shall be so scored that it will fit tightly in each corner and extended from top to bottom of the shipping container. Flutes of liner shall be perpendicular to flutes of outer container. Closure shall be in accordance with the appendix to PPP-B-636 except that glue must cover not less than 70 percent of contact area between flaps.

5.2.3 Level C. Cushioning material shall be packed in a manner which will insure arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rate. Packages shall comply with rules or other common carrier regulations applicable to the mode of transportation.

5.3 Marking.

5.3.1 Military agencies. In addition to any special marking required by the contract or

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order, shipping containers shall be marked in accordance with the requirements of MIL-STD-129.

5.3.2 *Civil agencies.* In addition to any marking specified in the contract or order, shipping containers shall be marked in accordance with Fed. Std. No. 123.

6. NOTES

6.1 *Intended use.* Material covered by this specification is intended for use as cushioning materials within packages to protect items from damage due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited to packaging problems where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning, to packaging problems in which the cushioning material should also provide temperature insulation, and to packaging problems in which the cushioning material must perform at extremely low temperature.

6.2 *Ordering data.* Purchasers should exercise any desired options offered herein and procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type and class of material required (see 1.2).
- (c) Size and thickness required (see 6.3).
- (d) Level of packaging and level of packing required (see 5.1 and 5.2).

6.3 *Sizes (thickness, width, length).* Resilient expanded polystyrene cushioning material is available in various increments of thickness, widths and lengths in both sheet and roll form. Procurement documents should specify size and thickness required based upon engineering data furnished for specific applications. Typical sizes range from 1-32 inch to 8 inches in thickness, widths up to 48 inches and lengths up to

500 feet. Other commercial sizes are available.

6.4 *Stress strain at various conditions.* After being exposed to -80°F. , 165°F. or high humidity conditions, the stress-strain relationship of resilient expanded polystyrene is substantially the same as at room temperature. The strain (in./in.) does not change by more than 25 percent.

6.5 Design information.

6.5.1 *Static load-bearing capacity.* In selecting and designing with cushioning materials, the static loading (p.s.i.) of the item resting on the material should always be taken into consideration, since all cushioning materials will creep when loaded. Applications of resilient expanded polystyrene should normally be designed so that the deflections do not exceed 15 percent when the load is in place. This value will not be exceeded when the static load is less than the values tabulated below.

Class	Static load bearing capacity
1	1.5 p.s.i.
2	0.7 p.s.i.
3	1.5 p.s.i.
4	4.0 p.s.i.

6.5.2 *Density.* The density of a cushioning material is not an accurate measure of its stiffness or softness and is not a good criterion for selecting a material or predicting its energy-absorption ability. For information only, typical densities of the materials in this specification are as follows:

- Class 1—0.4 to 0.8 pounds per cubic foot
- Class 2—0.6 to 0.9 pounds per cubic foot
- Class 3—0.9 to 1.8 pounds per cubic foot
- Class 4—0.8 to 1.2 pounds per cubic foot

6.6 *Samples.* It is believed that this specification adequately describes the characteristics necessary to procure the desired material, and that normally no samples will be necessary prior to award to determine compliance with this specification. If for any particular purpose, samples with bids are necessary, they should be asked for in the

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invitation for bids.

6.7 Converted forms. Resilient polystyrene cushioning material may be furnished in special converted forms, sizes, and shapes, such as with paperbacking, paperboard backing, cloth backing, pressure-sensitive adhesive surface, die-cut holes, or in the form of corner pads or special shapes. It is not the intent of this specification to preclude the procurement of these special forms.

6.8 Adhesives. Adhering of resilient polystyrene cushioning material can be readily accomplished with various adhesives. Animal glues, hot-melt types, and rubber or resin base types which do not contain solvents that attack polystyrene can be used. Solvents which dissolve or attack polystyrene include aromatic hydrocarbons, chlorinated hydrocarbons, esters, and ketones.

6.9 Transportation description. Transportation descriptions and minimum weights applicable to this commodity are:

Rail:

Plastics, cellular, expanded, sheets or rolls, weighing less than 4 pounds per cu. ft.

Carload minimum weights: 10,000, 20,000 and 30,000 pounds, subject to Rule 34, Uniform Freight Classification.

Motor:

Plastic forms, expanded, cellular, sheets or rolls, less than 2 pounds per cu. ft. density.

Truckload minimum weights: 10,000, 16,000, 21,000 and 30,000 pounds subject to Rule 115, National Motor Freight Classification.

MILITARY INTERESTS:

Army—O E Q C M Sig T

Navy—W Sh S Y MC

Air Force—MOA

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)***1. DOCUMENT NUMBER****2. DOCUMENT TITLE****3a. NAME OF SUBMITTING ORGANIZATION****4. TYPE OF ORGANIZATION (Mark one)**☐ **VENDOR**☐ **USER**☐ **MANUFACTURER**☐ **OTHER (Specify):** _____**b. ADDRESS (Street, City, State, ZIP Code)****5. PROBLEM AREAS****a. Paragraph Number and Wording:****b. Recommended Wording:****c. Reason/Rationale for Recommendation:****6. REMARKS****7a. NAME OF SUBMITTER (Last, First, MI) - Optional****b. WORK TELEPHONE NUMBER (Include Area Code) - Optional****c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional****8. DATE OF SUBMISSION (YYMMDD)**

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