A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

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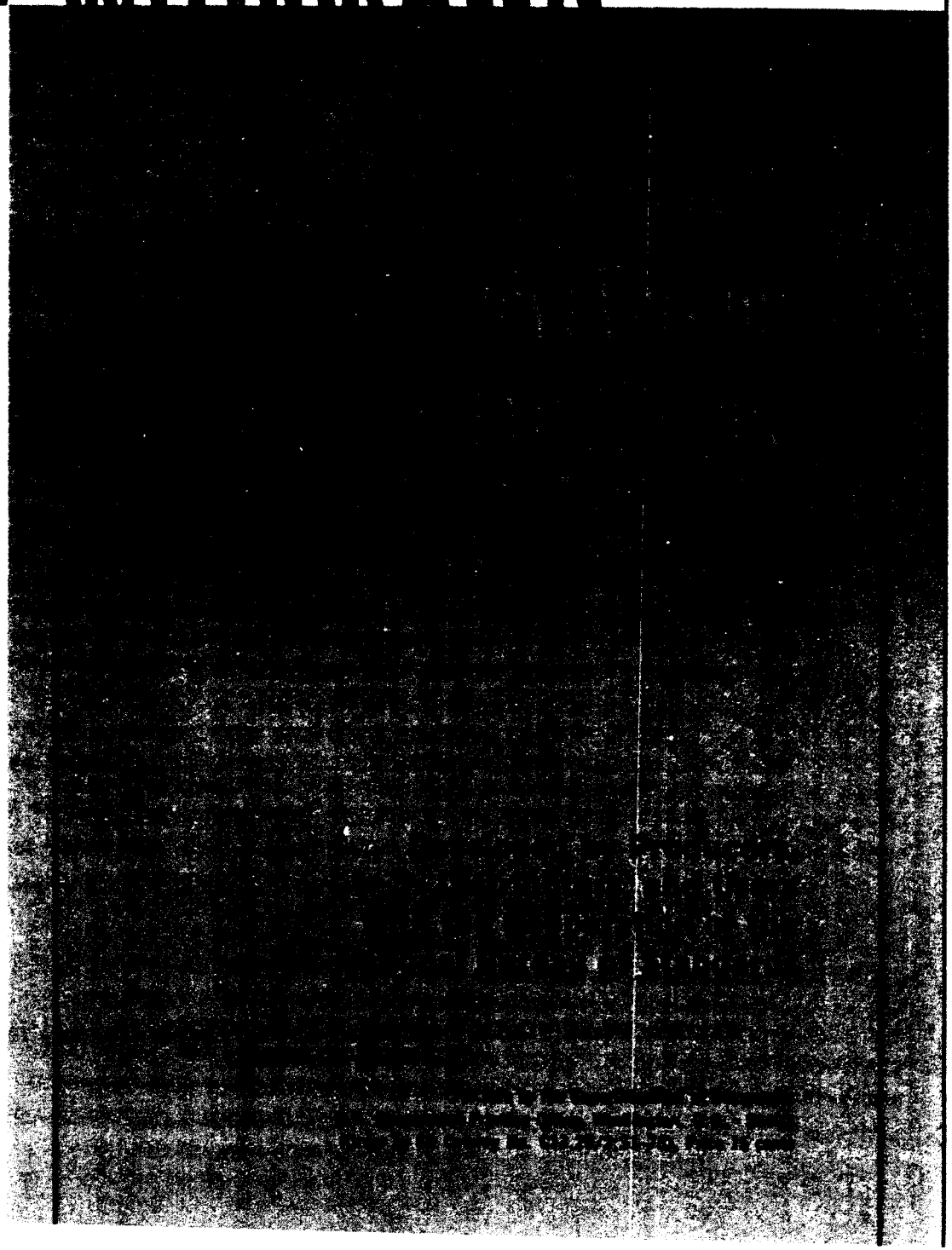
NBS Voluntary Product Standard

WITHDRAWN PS 31-70



U.S. DEPARTMENT OF COMMERCE

National Bureau of Standards

Voluntary Product Standard

(PS 31-70)

Polystyrene Plastic Sheet

Technical Standards Coordinator: L. H. Breden

Abstract

This Voluntary Product Standard covers requirements and methods of test for dimensions, and mechanical and physical properties of hot-melt extruded polystyrene plastic sheet. The standard does not cover polystyrene foam or biaxially oriented sheet.

Key words: Impact resistance, plastic sheet; oriented sheet; plastic sheet; polystyrene plastic sheet; sheet, plastic.

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Contents

VOLUNTARY PRODUCT STANDARDS

Voluntary Product Standards are standards developed under procedures established by the Department of Commerce (15 CFR Part 10, as amended, May 28, 1970). The standards may include (1) dimensional requirements for standard sizes and types of various products, (2) technical requirements, and (3) methods of testing, grading, and marking. The objective of a *Voluntary Product Standard* is to establish requirements which are in accordance with the principal demands of the industry and, at the same time, are not contrary to the public interest.

Development of a VOLUNTARY PRODUCT STANDARD

The Office of Engineering Standards Services of the National Bureau of Standards has been assigned by the Department of Commerce the responsibility to work closely with scientific and trade associations and organizations, business firms, testing laboratories, and other appropriate groups to develop *Voluntary Product Standards.* The Bureau has the following role in the development process: It (1) provides editorial assistance in the preparation of the standard; (2) supplies such assistance and review as is required to assure the technical soundness of the standard; (3) acts as an unbiased coordinator in the development of the standard; (4) sees that the standard is representative of the views of producers, distributors, and users or consumers; (5) seeks satisfactory adjustment of valid points of disagreement; (6) determines the compliance with the criteria established in the Department's procedures cited above; and (7) publishes the standard.

Industry customarily (1) initiates and participates in the development of a standard; (2) provides technical counsel on a standard; and (3) promotes the use of, and support for, the standard. (A group interested in developing a *Voluntary Product Standard* may submit a written request to the Office of Engineering Standards Services, National Bureau of Standards, Washington, D.C. 20234.)

A draft of a proposed standard is developed in consultation with interested trade groups. Subsequently, a Standard Review Committee is established to review the proposed standard. The committee, appropriately balanced, includes qualified representatives of producers, distributors, and users or consumers of the product being standardized. When the committee approves a proposal, copies are distributed for industry consideration and acceptance. When the acceptances show general industry agreement, and when there is no substantive objection deemed valid by the Bureau, the Bureau announces approval of the *Voluntary Product Standard* and proceeds with its publication.

Use of a VOLUNTARY PRODUCT STANDARD

The adoption and use of a *Voluntary Product Standard* is completely voluntary. *Voluntary Product Standards* have been used most effectively in conjunction with legal documents such as sales contracts, purchase orders, and building codes. When a standard is made part of such a document, compliance with the standard is enforceable by the purchaser or the seller along with other provisions of the document.

Voluntary Product Standards are useful and helpful to purchasers, manufacturers, and distributors. Purchasers may order products that comply with *Voluntary Product Standards* and determine for themselves that their requirements are met. Manufacturers and distributors may refer to the standards in sales catalogs, advertising, invoices, and labels on their product. Commercial inspection and testing programs may also be employed, together with grade labels and certificates assuring compliance, to promote even greater public confidence. Such assurance of compliance promotes better understanding between purchasers and sellers.

Polystyrene Plastic Sheet

Effective August 1, 1970 (See section 6.)

(This voluntary Standard, initiated by The Society of the Plastics Industry, Inc., has been developed under the *Procedures for the Development of Voluntary Product Standards*, published by the Department of Commerce. See Section 7, *History of Project*, for further information.)

1. PURPOSE

The purpose of this Voluntary Product Standard is to establish nationally recognized types, classes, dimensional tolerances, and significant quality requirements for commercially available polystyrene plastic sheet. The information contained in this Voluntary Product Standard is intended to be helpful to producers, distributors, and users and to promote understanding between buyers and sellers.

2. SCOPE AND CLASSIFICATION

2.1. Scope—This Voluntary Product Standard covers requirements and methods of test for dimensions, and mechanical and physical properties of hot-melt extruded polystyrene plastic sheet. Methods of labeling to indicate compliance with this Standard are included. The Standard does not cover polystyrene foam or biaxially oriented sheet.

2.2. Classification—This Voluntary Product Standard covers six types of polystyrene sheet based on impact resistance and six classes of polystyrene sheet based on orientation rating as determined by an immersion shrink test method.

2.2.1. Types

Type I	Low impact resistance
Type II	Improved impact resistance
Type III	Medium impact resistance
Type IV	High impact resistance
Type V	Extra high impact resistance
Type VI	Super high impact resistance

2.2.2. Classes

Class AA	Extra low orientation
Class A	Very low orientation
Class B	Low orientation
Class C	Medium orientation
Class D	High orientation
Class E	Very high orientation

3. REQUIREMENTS

3.1. General—All polystyrene sheeting represented as complying with this Voluntary Product Standard shall meet all of the requirements specified herein.

3.2. Material—The polystyrene sheet shall be made from homopolymers of styrene, copolymers of styrene, or styrene resins modi-

fied with minor proportions of other polymers or monomers. The polymers may or may not contain additives such as pigments, stabilizers, or modifying agents.

3.3. Dimensions and tolerances

3.3.1. Thickness—The tolerances for various thicknesses of sheet shall be as specified in table 1 when measured in accordance with 4.2.

TABLE 1. *Thickness tolerances for polystyrene sheet*

Nominal thickness	Tolerance
inch	*percent*
0.005 to 0.010 incl.	±15
over .010 to .020 incl.	± 8
over .020 to .030 incl.	± 7
over .030 to .040 incl.	± 5
over .040	± 4

3.3.2. Length and width—The polystyrene sheet may be finished in rolls or single sheets. The nominal length and width of the material shall be as agreed upon by buyer and seller. The material shall be continuous in any one roll or sheet with no splices. The tolerance on the nominal width of the material in rolls or sheets shall be plus or minus ⅛ inch. The tolerance on the nominal length of the material in sheets shall be plus ½ inch, minus 0 inch. The tolerance on the nominal length of the material in rolls shall be as agreed upon by buyer and seller. All measurements of length and width shall be determined in accordance with 4.3.

3.4. Water absorption—The maximum water absorption for the polystyrene sheet shall be 0.10 percent for types I, II, III, and IV and 0.20 percent for types V and VI when determined in accordance with 4.4.

3.5. Impact resistance—The polystyrene sheet shall meet the impact resistance requirements specified in table 2 when tested in accordance with 4.5.

TABLE 2. *Impact resistance of polystyrene sheet*

Type	Description	DIF [a] value
I	Low impact resistance	50 and under
II	Improved impact resistance	over 50 to 100 incl.
III	Medium impact resistance	over 100 to 250 incl.
IV	High impact resistance	over 250 to 400 incl.
V	Extra high impact resistance	over 400 to 600 incl.
VI	Super high impact resistance	over 600 to 1000 incl.

[a] The energy in ft –lb/in of thickness required to cause 50 percent of the specimens to fail in the dart impact test described in 4.5. DIF is an abbreviation for dart impact failure.

3.6. Orientation—The polystyrene sheet shall conform to the orientation requirements listed in table 3 when determined by the immersion shrink method described in 4.6. The maximum allowable variation in shrinkage shall be plus or minus 30 percent of the average shrinkage.

TABLE 3. *Orientation rating chart for polystyrene sheet*

Sheet thickness [a]	Average percent shrinkage [b]									
inch	0–5	6–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
0.005–0.010	AA	AA	AA	A	A	B	B	C	D	E
0.011–0.020	AA	AA	A	A	A	B	B	C	D	E
0.021–0.030	AA	A	A	A	B	B	C	D	E	
0.031–0.040	A	A	A	B	B	C	D	E		
0.041–0.050	A	A	A	B	B	C	D	E		
0.051–0.060	A	A	B	B	C	D	E			
0.061–0.070	A	A	B	B	C	D	E			
0.071–0.080	A	A	B	B	C	D	E			
0.081–0.090	A	B	B	C	C	D	E			
0.091–0.100	A	B	B	C	D	E				
0.101–0.125	A	B	B	C	D	E				
0.126–0.150	A	B	C	C	D	E				
0.151–0.175	A	B	C	D	E					
0.176–0.200	A	B	C	D	E					

[a] Values for sheet thickness shall be rounded to nearest 0.001 inch.
[b] Values for average percent shrinkage shall be rounded to nearest whole number. The maximum allowable variation in shrinkage shall be 30 percent of the average value. Example: If the average shrinkage is 20 percent, the individual values must fall within 14-26 percent.

3.7. **Workmanship**—The polystyrene sheet shall be free of surface blisters, streaks, pinholes, particles of foreign matter, and undispersed raw material that might interfere with its intended use or serviceability. There shall be no defects such as crow's-feet, peel marks, chatter, or flow marks. The edges shall be free of nicks, cuts, and burrs visible to the unaided eye.

4. INSPECTION AND TEST PROCEDURES

4.1. **General**—The inspection and test procedures contained in this section are to be used to determine the conformance of products to the requirements of this Voluntary Product Standard. Each producer or distributor who represents his products as conforming to this Standard may utilize statistically based sampling plans which are appropriate for each particular manufacturing process but shall keep such essential records as are necessary to document with a high degree of assurance his claim that all of the requirements of this Standard have been met. Additional sampling and testing of the product, as may be agreed upon between purchaser and seller, is not precluded by this section.

4.1.1. **Conditioning**—The test specimens shall be conditioned in accordance with procedure A in American Society for Testing and Materials (ASTM) Designation D 618-61, *Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing,*[1] and shall be tested under these conditions.

4.2. **Thickness**—The thickness of the sheet shall be determined with a ratchet micrometer in accordance with the requirements of method A of ASTM D 374–68, *Standard Methods of Test for*

[1] Later issues of all ASTM publications referenced in this Standard may be used, providing the requirements are applicable and consistent with the issue designated. Copies of ASTM publications are obtainable from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

Thickness of Solid Electrical Insulation.[2] Three sets of measurements shall be taken across the width of the sheet on a line perpendicular to the extrusion direction. Each set shall consist of five separate readings, equally spaced across the width. Two sets shall be representative of the ends of the sample, and the third shall be representative of the middle portion. Each set shall be averaged, and each set average and set range shall conform to the tolerances in table 1.

4.3. **Length and width**—Measurements of length and width shall be made with a calibrated steel tape, graduated at intervals of $\frac{1}{8}$ inch. Measurements of length shall be rounded to the nearest $\frac{1}{2}$ inch. Width measurements shall be measured to the nearest $\frac{1}{8}$ inch at not less than 10 locations uniformly distributed along the length of the roll or sheet, and the results shall be averaged.

4.4. **Water absorption**—The water absorption shall be determined in accordance with ASTM D 570-63, *Standard Method of Test for Water Absorption of Plastics,*[2] using three specimens.

4.5. **Impact resistance**—The impact resistance shall be determined by the falling dart method described in 4.5.1. through 4.5.4.

4.5.1. **Apparatus**—The falling dart test apparatus (see figure 1) shall consist of the following components:

(a) A dart with $1\frac{1}{2}$ inch hemispherical hardened steel head, fitted with a $\frac{1}{2}$-inch-diameter steel shaft 18 inches long to accommodate removable weights.

(b) A dart release mechanism capable of holding a total dart weight of 30 pounds. Means shall be provided for positioning and releasing the dart from a suitable drop height measured from the surface of the test specimen.

(c) A 3-inch inside diameter mounting-ring clamping device with a $\frac{1}{4}$-inch lip to hold the test specimen firmly in place beneath the dart. It shall be in perpendicular alinement to insure that the dart hits the center of the test specimen.

(d) Cylindrical steel weights, as required, with center holes to fit the dart shaft. Weight increments will vary according to the level of impact resistance.

(e) Cushioning and shielding devices to protect personnel and to avoid damaging the impinging surface of the dart.

4.5.2. **Test specimens**—Test specimens shall be at least 4 by 4 inches and extend outside the specimen clamp area at all points.

4.5.3. **Procedure**—

(a) Measure and record on the data recording sheet in table 4 the average thickness of each specimen to the nearest 0.001 inch, using the method described in 4.2. Five uniformly distributed readings shall be taken on each specimen. Specimens shall conform to sheet thickness tolerances as specified in 3.3.1.

(b) Place specimen in the clamping device, making sure it is firmly held and properly positioned.

(c) Make preliminary test drops to determine a suitable starting energy. From this, a suitable drop height is determined to the nearest one-eighth of an inch, which shall be kept constant throughout the tests on a given sheet sample. Failure is defined as a break in the specimen. Deformation of the sample is not con-

[2] See footnote 1, page 3.

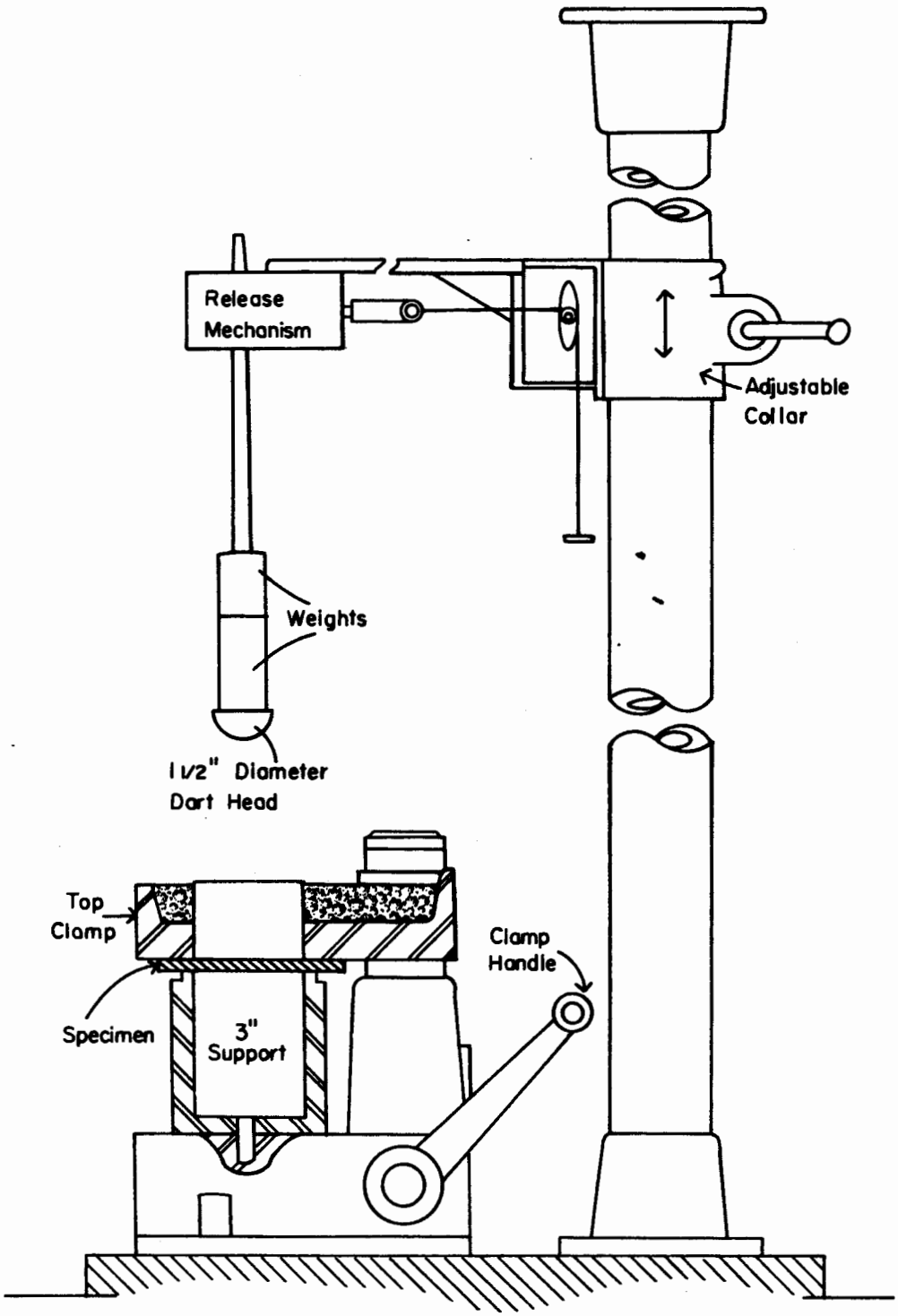


FIGURE 1. *Falling dart impact tester.*

sidered a failure. In cases when the dart bounces off the specimen, avoid multiple impact by catching the dart after the first impact.

(d) Begin testing using a new specimen for each impact. Start with a dart weight at which 50 percent failure is expected. In the event that the specimen fails (or does not fail), decrease (or

increase) the weight until this procedure produces a failure-nonfailure (or nonfailure-failure) sequence (see table 5). At this point, change the weight by equal increments (0.25-lb increments at energy levels of 10 ft-lb or less, and 1-lb increments at energy levels greater than 10 ft-lb) increasing the weight if the previous specimen did not fail or decreasing the weight if the previous specimen failed. Continue the procedure until 30 specimens have been tested after the first consecutive failure-nonfailure (or nonfailure-failure) point has been reached.

4.5.4. Calculation

(a) Keep a running plot of the data as shown in the example of table 5. Use an "x" to indicate a failure and an "o" to indicate a nonfailure at each weight level.

(b) Add the total number of failures for each weight level after the first consecutive failure-nonfailure (or nonfailure-failure) and enter in column 1 of table 4.

(c) Add the total number of nonfailures for each weight level after the first consecutive failure-nonfailure (or nonfailure-failure) and enter in column 2 of table 4.

(d) Add column 1 of table 4 and record the sum as $N(x)$.

(e) Add column 2 of table 4 and record the sum as $N(o)$.

(f) The remaining analysis will depend on the smaller of $N(x)$ and $N(o)$. Record the smaller of the two as N. If $N(o)$ equals $N(x)$, use $N(o)$.

(g) Record the test weight increment as $\triangle W$.

(h) Record as W_L the lowest weight at which failures or nonfailures appear, whichever is being used as determined by step (f).

(i) Transfer the data from the column 1 or 2 of table 4, corresponding to the smaller of $N(x)$ or $N(o)$ to column 3 of table 4, omitting the value corresponding to W_L. The value above W_L should be adjacent to the 1 appearing in column 4 and the remaining values progressively numbered.

(j) Multiply the values in column 3 by the adjacent values in column 4 and record the products in column 5.

(k) Add the values in column 5 and record their sum as A.

(l) Calculate and record the impact failure weight from the following equation:

$$W_F = W_L + \triangle W \left[\frac{A}{N} \pm \frac{1}{2}\right]$$

where:

W_F = Impact failure weight;
W_L = Weight corresponding to the lowest level at which the less frequent event occurs (h);
$\triangle W$ = Test weight increment being used;
N = Number of less frequent events (failures or nonfailures);
A = As defined in step (k);
$\pm$ Use the plus sign when $N(o)$ is being used and the minus sign when $N(x)$ is being used.

(m) Calculate the DIF value from the following equation:

$$DIF = \frac{W_F \times H}{t}$$

where:

DIF = Dart impact failure
W_F = Impact failure weight
H = Dart drop height in feet
t = Average specimen thickness in inches.

TABLE 4. *Data recording and analysis sheet*

Total dart weight	x=failure o=nonfailure	Total number of failures at each dart weight *Column 1*	Total number of nonfailures at each dart weight *Column 2*
—		—	—
—		—	—
—		—	—
—		—	—
—		—	—
Test weight increment ΔW=		Total number of failures ——	Total number of nonfailures ——
		W_L=Lowest weight at which failure and nonfailure occurs.	

Data transferred from column 1 except the values corresponding to W_L and below *Column 3*	Number 1 placed adjacent to value above W_L and then subsequently numbered *Column 4*	Column 3 multiplied by column 4 *Column 5*
—	1	—
—	2	—
—	3	—

Impact failure weight

$$W_F = W_L + \Delta W \left[\frac{A}{N} \pm \frac{1}{2}\right]$$

Lowest weight at which failure and nonfailure occurs

Test weight increment

A=total sum of column 5

N=number of less frequent events—failure or nonfailure.

Dart impact failure

$$DIF = \frac{\text{Impact failure weight } W_F \text{ multiplied by } H}{t \text{ average specimen thickness (in inches)}}$$

Drop height in feet

TABLE 5. *Example of data recording and analysis*

From 4.5.4. (a) through (c)

Total dart Weight	x—failure / o—nonfailure	Col. 1 (x's)	Col. 2 (o's)
lb			
10.0	x	1	0
9.0	o x x x	4	1
8.0	x o x x o o o x x o x x	6	5
7.0	o x o o o o x o o x	3	7
6.0	o o o o	0	3
5.0	o		
	Totals	$N(x)=14$	$N(o)=16$

From 4.5.4. (d) through (h)

$N(x)=14$ $N(o)=16$ $N=14$

$\Delta W=1.0$ lb $W_L=7.0$ lb.

From 4.5.4. (i) through (k)

Total dart weight	Col. 3	Col. 4	Col. 5 (Col. 3) × (Col. 4)
lb			
—	—	6	—
—	—	5	—
—	—	4	—
10.0	1	3	3
9.0	4	2	8
8.0	6	1	6

From 4.5.4. (l) through (m) $A=17$

$$W_F=W_L+\Delta W\left[\frac{A}{N}\pm\frac{1}{2}\right]$$

$$=7.0+1.0\left[\frac{17}{14}-\frac{1}{2}\right]=7.71 \text{ lb}$$

$$\text{DIF}=\frac{W_F\times H}{t}$$

W_F=impact failure weight=7.71 pounds
t=average thickness=0.100 inch
H=drop height=4 feet

$$\text{DIF}=\frac{7.71}{0.100}\times 4=308 \text{ ft -lb/in of thickness}$$

4.6. Orientation—The orientation shall be determined by the immersion shrink test as follows:

4.6.1. Apparatus—The apparatus for the shrink test shall consist of the following components:

(a) Oil bath filled with Humble Primol 355[3] or equal
(b) Thermometer
(c) Interval timer
(d) Multiple layer specimen rack
(e) Micrometer and scale

[3] Reference to this product is solely for the purpose of description; other products equal in performance are acceptable.

be calculated as follows:

$$\text{Shrinkage, percent} = \frac{\text{Decrease in length}}{\text{Original length}} \times 100.$$

The shrinkage for each of the five specimens shall be recorded, as well as the average percent shrinkage for all specimens. The average percent shrinkage value for the individual specimens shall be examined to determine that they are within plus or minus 30 percent of the average shrinkage value.

5. IDENTIFICATION

In order that purchasers may identify products conforming to all requirements of this Voluntary Product Standard, producers and distributors may include a statement of compliance in conjunction with their name and address on product labels, invoices, sales literature, and the like. The following statement is suggested when sufficient space is available:

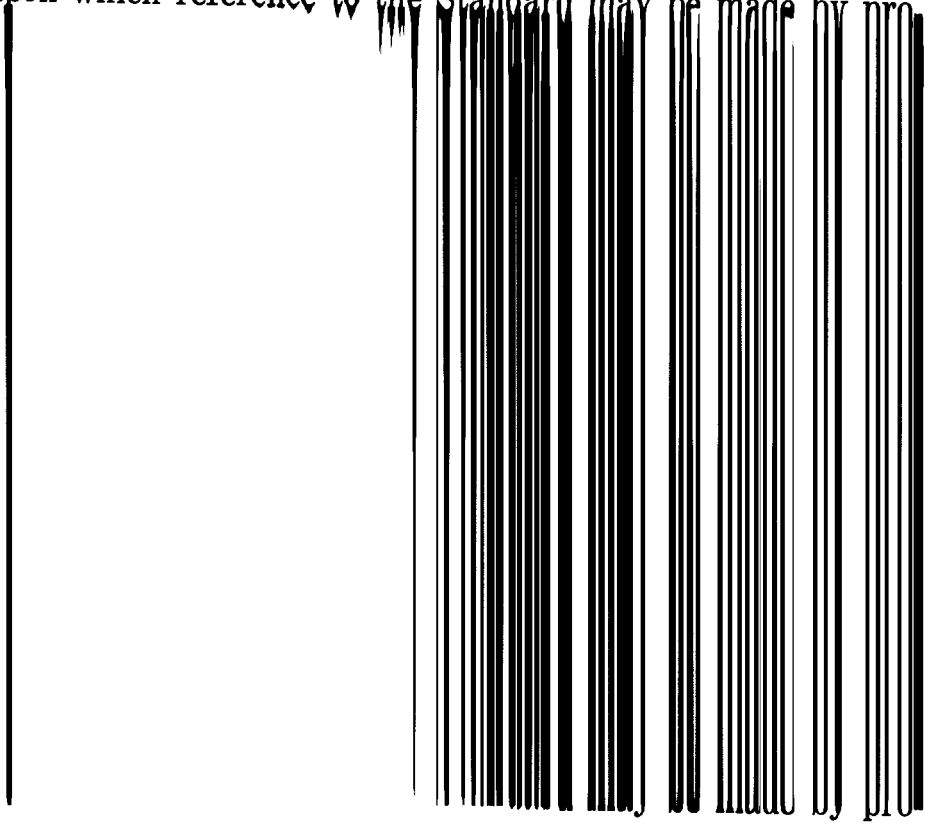
> This polystyrene plastic sheet conforms to all of the requirements established in Voluntary Product Standard PS 31-70, developed cooperatively with the industry and published by the National Bureau of Standards under the *Procedures for the Development of Voluntary Product Standards* of the U. S. Department of Commerce. Full responsibility for the conformance of this product to the standard is assumed by (name and address of producer or distributor).

The following abbreviated statement is suggested when available space on labels is insufficient for the full statement:

> Conforms to PS 31-70, (name and address of producer or distributor).

6. EFFECTIVE DATE

The effective date of this Voluntary Product Standard is the date upon which reference to the Standard may be made by pro-



ducers, distributors, users and consumers, and other interested parties. Compliance by producers with all of the requirements of this Voluntary Product Standard may not actually occur until some time after its effective date. Products shall not be represented as conforming to this Voluntary Product Standard until such time as all requirements established in the Standard are met. The effective date of this Standard is August 1, 1970.

7. HISTORY OF PROJECT

In December 1962, The Society of the Plastics Industry, Inc., (SPI) requested the assistance of the National Bureau of Standards in the development of a Standard for polystyrene sheet and film. In March 1964, a proposed Standard was circulated to representatives of film and sheet producers, distributors, and users and other interested organizations for comment. As a result of this circulation, several organizations submitted substantive comments with regard to the requirements for polystyrene film. A summary of these comments received from the industry was forwarded to SPI in March 1965 for their consideration. In August 1967, after an extensive review, SPI recommended that polystyrene film should be eliminated from the Standard.

A new proposed Voluntary Product Standard, *Polystyrene Plastic Sheet,* was then submitted to the Standard Review Committee. With the approval of the Standard Review Committee, public announcement was made, and the recommended Voluntary Product Standard was widely circulated on December 15, 1969, for consideration and acceptance.

The response to this circulation indicated a consensus, as defined by the Voluntary Product Standards procedures, in favor of the Standard within the producer, distributor, and user segments of the polystyrene plastic sheet industry.

Accordingly, on June 26, 1970, PS 31-70, *Polystyrene Plastic Sheet,* was announced to become effective on August 1, 1970.

Technical Standards Coordinator:
Leslie H. Breden, Product Standards Section
Office of Engineering Standards Services
National Bureau of Standards, Washington, D.C. 20234

8. STANDING COMMITTEE

The individuals whose names are listed below constitute the membership of the Standing Committee for this Standard. The function of the committee is to review all proposed revisions and amendments in order to keep this Standard up to date. Comments concerning this Standard and suggestions for its revision may be addressed to any member of the committee or to the Office of Engineering Standards Services, National Bureau of Standards, Washington, D.C. 20234, which acts as secretary for the committee.

Representing Producers

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Mr. R. P. Kittredge, Fabri-Kal Corporation, 3303 E. Cook Street, Kalamazoo, Michigan 49003
Mr. Dale A. Walker, Plastics Technical Center, Shell Chemical Company, P. O. Box 700, Woodbury, New Jersey 08096
Mr. J. A. Hopple, Hopple Plastics, Inc., 2370 Reading Road, Cincinnati, Ohio 45202

Representing Distributors

Mr. Melvin P. Gordon, Hammond Plastics, Inc., 88-9 Webster Street, Worcester, Massachusetts 01613
Mr. M. A. Metz, Commercial Plastics and Supply Corp., 2022 Chateau Street, Pittsburgh, Pa., 15233
Mr. Jelte Jansons, Read Plastics, Inc., 317 Cedar Street, NW., Washington, D.C. 20012
Mr. William Selvia, Regal Plastic Supply Co., 3985 South Kalamoth St., Englewood, Colorado 80110

Representing Users

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Mr. J. M. Weaver, Froehling and Robertson, Inc., 814 W. Cary Street, Richmond, Virginia 23206
Mr. T. E. Ronay, Marbon Chemical Company, Division of Borg-Warner Corp., Washington, West Virginia 26181
Mr. Leon Weiss, Whirlpool Corporation, Evansville, Indiana 47708

9. ACCEPTORS

The manufacturers, distributors, users, and others listed below have individually indicated in writing their acceptance of this Voluntary Product Standard prior to its publication. The acceptors have indicated their intention to use the Standard as far as practicable but reserve the right to depart from it when necessary. The list is published to show the extent of recorded public support for the Standard.

ASSOCIATIONS
(General Support)

National Association of Home Builders, Washington, D.C.
Society of the Plastics Industry, Inc., The, New York, New York

PRODUCERS

Borg-Warner Corporation, Chemicals & Plastics Group, Washington, West Virginia
Fabri-Kal Corporation, Kalamazoo, Michigan
Gage Industries, Inc., Lake Oswego, Oregon
General Plastics Corporation, Marion, Indiana
Gilman Brothers Company, Gilman, Connecticut
Hammond Plastics, Inc., Worcester, Massachusetts
Hopple Plastics, Inc., Cincinnati, Ohio
McGraw-Edison Company, Boonville, Missouri
Plasticos Celulosicos, S. A., Barcelona, Spain
Polytherm Plastics, Middletown, New York
Raytech Engineering, Inc., Stafford Springs, Connecticut
Seward Luggage Manufacturing Company, Petersburg, Virginia
Shell Chemical Company, Woodbury, New Jersey
Southern Plastics Company, Columbia, South Carolina
Sterling Moulding Materials, London, England
Uniroyal Chemical Division, Naugatuck, Connecticut