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AMERICAN SOCIETY FOR TESTING AND MATERIALS  
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## Standard Specification for Flexible Cellular Materials—Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)<sup>1</sup>

This standard is issued under the fixed designation D 1565; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

*This specification was prepared jointly by the American Society for Testing and Materials and the Society of the Plastics Industry.*

### 1. Scope

1.1 This specification covers flexible cellular products containing interconnecting cells made of a base material known as poly(vinyl chloride) or copolymers thereof.

1.2 It is intended as a general specification and may need to be supplemented by detailed specifications or methods of test for a particular product, in which case the latter would take precedence. Reference to methods for testing poly(vinyl chloride) foam products should specifically state the particular test or tests desired.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens<sup>2</sup>

### 3. Description of Terms Specific to This Standard

3.1 *vinyl or PVC*—abbreviated terms used to designate poly(vinyl chloride) or copolymers thereof.

3.2 *surface skin*—the smooth skin on a foam formed during manufacture by contact with the mold, cover plate, or air.

3.3 *mechanically blown foam*—a foam made by mechanically mixing a gas into a base material so as to develop a foam structure.

3.4 *chemically blown foam*—a foam made by incorporating a chemical agent into the base material which on heating liberates a gas causing foaming of the base materials.

3.5 *flexible*—a descriptive term applied to a cellular organic polymeric material that will not rupture within 60 s when a specimen 200 by 25 by 25 mm is bent around a 25-mm diameter mandrel at a uniform rate of one lap in 5 s in the form

of a helix at a temperature between 18 and 29°C.

3.6 *cellular material*—a generic term for materials containing many cells (either open, closed, or both) dispersed throughout the mass.

### 4. Classification

4.1 Grades of vinyl foam are designated by letters that identify the kind of vinyl foam as follows:

4.1.1 VC—Vinyl foam, cored,

4.1.2 VU—Vinyl foam, uncured, and

4.1.3 VO—Vinyl foam, uncured, extra firm.

4.2 Digits following the letters indicate the degree of firmness, the softer grades being identified with the lower numbers and the firmer grades with the higher numbers (see Table 1).

4.3 *Suffix Letters* may be added singly or in combination after any grade designation to indicate additional requirements beyond the basic requirements specified in Table 1. The approved suffix letters and their significance are as follows:

Suffix Letters

C—Weather Resistance.\*

D—Load Deflection.\*

E—Oil Resistance.\*

F—Low Temperature.\*

G—Tear Resistance.\*

H—Flexing Resistance.

J—Abrasion Resistance.\*

K1—Adhesion to Metal, Made During Moldings.\*

K2—Adhesion, Cemented Bond, Made After Molding.\*

M—Flame Resistance.\*

P—Nonstaining.\*

P1—Compatibility with Other Materials.\*

R—Resilience.\*

W—Density.

Z—Special Requirements.\*

\* Test method and values shall be as agreed upon between the purchaser and the manufacturer.

### 5. Manufacture

5.1 Foam may be produced in sheet, strip, molded, or specific shapes. The foam articles may be solid or cored. Size, shape, and distribution of cores, if any, shall be at the option of the manufacturer, subject to the approval of the purchaser.

### 6. Material and Workmanship

6.1 Vinyl foam shall be manufactured from poly(vinyl

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 14.02.

**TABLE 1 Physical Requirements of Vinyl Foam**

Grade	Basic Requirements <sup>A</sup>					Air Oven Aging, 22 h at 100°C (212°F) Change from Original Indentation or Compression Deflection %, measured after 22 h	Compression Set 22 h at 70°C (158°F), max, % set (% of original height after 2 h recovery at 70°C 158°F)	Requirements Added by Suffix H Dynamic Flexing 250,000 cycles, max, % Set (% of original height after 2 h recovery) height
	Force for 25 % indentation of 3.2 dm <sup>2</sup> (50 in. <sup>2</sup> ) indenter		Compression Deflection (25 % Deflection) read at 60 s					
	lbf	N	kgf/mm <sup>2</sup>	psi	kPa			
Vinyl Foam (Cored)								
VC 5	5 ± 3	23 ± 13	...	...	...	±20	15	10
VC 10	10 ± 3	46 ± 13	...	...	...	±20	15	10
VC 15	15 ± 4	67 ± 18	...	...	...	±20	15	10
VC 20	20 ± 4	89 ± 18	...	...	...	±20	15	10
VC 25	25 ± 5	111 ± 22	...	...	...	±20	15	10
VC 30	30 ± 6	133 ± 27	...	...	...	±20	15	10
VC 40	40 ± 7	178 ± 31	...	...	...	±20	15	10
VC 50	50 ± 8	222 ± 36	...	...	...	±20	15	10
VC 60	60 ± 9	267 ± 40	...	...	...	±20	15	10
VC 70	70 ± 12	311 ± 53	...	...	...	±20	15	10
VC 90	90 ± 14	400 ± 62	...	...	...	±20	15	10
Vinyl Foam (Uncoated)								
VU 10	10 ± 4	44 ± 18	...	...	...	±20	15	10
VU 20	20 ± 5	89 ± 22	...	...	...	±20	15	10
VU 35	35 ± 10	156 ± 55	...	...	...	±20	15	10
VU 55	55 ± 10	245 ± 44	...	...	...	±20	15	10
VU 80	80 ± 15	356 ± 67	...	...	...	±20	15	10
VU 150	150 ± 55	667 ± 245	...	...	...	±20	15	10
VO 11	...	...	(25 ± 11)	3.5 ± 1.5	24 ± 10	±20	15	10
VO 12	...	...	(49 ± 14)	7 ± 2	48 ± 14	±20	15	10
VO 13	...	...	(77 ± 14)	11 ± 2	76 ± 14	±20	15	10
VO 14	...	...	(105 ± 14)	15 ± 2	104 ± 14	±20	15	10

<sup>A</sup>Passing of the static fatigue test, with no cracks, is also a basic requirement.

chloride) and necessary compounding ingredients required to furnish a finished product meeting the requirements of this specification. Any special physical properties that may be desired for specific applications and designated in the individual product specifications may influence the choice of the type of poly(vinyl chloride) or other ingredients used. All materials and workmanship shall be in accordance with good commercial practice, and the resulting foam shall be adequately fused and free of defects affecting serviceability.

6.2 Manufacturing conditions may result in material that may require alteration or repair. This repaired or altered material will be acceptable provided the material used in such repairs or alterations shall be of the same composition and quality as the original product and provided such alterations do not affect the serviceability, size, and shape beyond the tolerances provided herein.

## 7. Color

7.1 Unless otherwise specified, the color of the vinyl foam is optional with the manufacturer.

## 8. Physical Properties

8.1 The various grades of vinyl foam shall conform to the requirements as to basic physical properties prescribed in Table 1, together with any additional requirements indicated.

## 9. Tolerances on Dimensions

9.1 Dimensions of vinyl foam products shall comply with those specified within the tolerances given in Table 2 and Table 3.

## 10. Sampling

10.1 When possible, the test specimens required shall consist of complete units of the finished product, selecting representative samples of the lot under examination.

10.2 When it is necessary or advisable to take test specimens from the article, as in those cases where the entire unit is not required or adaptable for testing, the method of cutting and the exact position from which specimens are to be taken shall be specified. The apparent density and the state of fusion may vary in different parts of the finished product, particularly if the article is of complicated shape or of varying thickness. These features affect the physical properties of the specimens. The apparent density is affected by the number of cut surfaces as opposed to the number of skin-covered surfaces on the test specimen.

10.3 When the finished article does not lend itself to testing or to the taking of test specimens because of complicated shape, small size, metal or fabric inserts, adhesion to metal or other reasons, suitable test slabs shall be prepared, as agreed upon between the manufacturer and the purchaser. When deviations occur from the specified requirements because of difficulties in securing suitable test specimens from the finished article, the manufacturer and the purchaser shall agree upon permissible deviations.

## 11. Measurement of Test Specimens

11.1 Dimensions greater than 100 mm (4 in.) shall be measured with a steel scale or tape graduated in divisions not larger than 1 mm (0.04 in.). Care shall be taken not to distort

**TABLE 2 Tolerances on Dimensions of Vinyl Foam Products for General Applications**

Thickness		Tolerance				Length and Width		Tolerance				
cm	in.	cm		in.		cm	in.	in.		cm		
		plus	minus	plus	minus			plus	minus	plus	minus	
Cored	0 to 7.6, incl	0 to 3, incl	0.3	0.2	1/8	1/16	0 to 15, incl	0 to 6, incl	3/16	1/16	0.5	0.2
	over 7.6 to 12.7, incl	over 3 to 5, incl	0.5	0.3	3/16	1/8	over 15 to 31, incl	over 6 to 12, incl	3/8	1/8	1.0	0.3
	over 12.7	over 5	0.6	0.5	1/4	3/16	over 31 to 61, incl	over 12 to 24, incl	1/2	1/4	1.3	0.6
							over 61 to 92, incl	over 24 to 36, incl	5/8	3/8	1.6	1.0
							over 92 to 122, incl	over 36 to 48, incl	3/4	1/2	1.9	1.3
							over 122 to 153, incl	over 48 to 60, incl	7/8	5/8	2.2	1.6
							over 153 to 183, incl	over 60 to 72, incl	1	3/4	2.5	1.9
						over 183	over 72	1 1/8	7/8	2.9	2.2	
Uncored	0 to 1.3, incl	up to 1 = $f^2$ , incl	0.2	0.2	1/16	1/16	0 to 15, incl	0 to 6, incl	5/16	1/16	0.8	0.2
	over 1.3 to 2.5, incl	over 1 = $f^2$ to 1, incl	0.3	0.2	1/8	1/16	over 15 to 31, incl	over 6 to 12, incl	1/2	1/8	1.3	0.3
	over 2.5	over 1	0.3	0.3	1/8	1/8	over 31 to 61, incl	over 12 to 24, incl	1 1/16	1/4	1.8	0.6
							over 61 to 92, incl	over 24 to 36, incl	7/8	3/8	2.2	1.0
							over 92 to 122, incl	over 36 to 48, incl	1 1/16	1/2	2.7	1.3
							over 122 to 153, incl	over 48 to 60, incl	1 1/4	5/8	3.2	1.6
							over 153 to 183, incl	over 60 to 72, incl	1 3/8	3/4	3.5	1.9
						over 183	over 72	1 1/2	7/8	3.8	2.2	

the foam during measurement. Length and width measurements of rectangular pieces shall be taken along a line perpendicular to the opposing faces of the piece.

11.2 Dimensions between 30 mm (1.2 in.) and 100 mm (4 in.) shall be measured with vernier calipers having graduations not larger than 0.1 mm or 0.005 in. The calipers shall be adjusted by trial to the correct setting. This setting shall be the one in which the faces of the calipers contact the specimen without compressing it when the specimen is passed through the preset calipers.

11.3 Dimensions under 30 mm (1.2 in.) shall be measured with a dial gage graduated in divisions not larger than 0.02 mm (0.001 in.). The gage shall have a circular foot between 650 and 1000 mm<sup>2</sup> in area exerting a pressure of 100 ± 10 Pa. (0.0150 ± 0.0015 psi).

NOTE 1—Dial gages having a foot up to 2000 mm<sup>2</sup> and exerting a pressure up to 500 Pa (0.075 psi) may be used for materials that are not appreciably compressed by the increased pressure.

11.4 The median of three measurements taken at different locations shall be used for the particular specimen dimension.

## 12. General Test Methods

12.1 The requirements specified shall be determined in

accordance with the appropriate tests listed below:

12.1.1 *Indentation-Force Deflection Test*—See Sections 13-17.

12.1.2 *Compression-Force Deflection Test*—(VO Grades only)—See Sections 18-22.

NOTE 2—The compression-force deflection test is ordinarily made on firm VO grades of vinyl foam. The indentation test is usually preferred on the relatively softer VC and VU grades.

12.1.3 *Air Oven Aging Test*—See Sections 23-28.

12.1.4 *Compression Set Under Constant Deflection Test*—See Sections 29-34.

12.1.5 *Static Fatigue Test*—See Sections 35-39.

12.1.6 *Dynamic Flexing Test*—See Sections 40-45.

12.1.7 *Density Test*—See Sections 46-50.

## INDENTATION-FORCE DEFLECTION TEST

### 13. Scope

13.1 This test consists of measuring the load necessary to maintain a 25 % indentation for 60 s in the vinyl foam product.

13.2 The result of this indentation-load test shall be known as IFD value.

**TABLE 3 Tolerances for Special Applications of Vinyl Foam, Such as Automotive Topper Pads, Spring Coverings, etc.**

Thickness		Tolerance				Length and Width		Tolerance				
cm	in.	cm		in.		cm	in.	in.		cm		
		plus	minus	plus	minus			plus	minus	plus	minus	
Cored	0 to 7.6, incl	0 to 3, incl	0.5	0.2	3/16	1/16	0 to 15, incl	0 to 6, incl	0.8	0.2	5/16	1/16
	over 7.6 to 12.7, incl	over 3 to 5, incl	0.6	0.3	1/4	1/8	over 15 to 31, incl	over 6 to 12, incl	1.3	0.3	1/2	1/8
	over 12.7	over 5	0.8	0.5	5/16	3/16	over 31 to 61, incl	over 12 to 24, incl	1.8	0.6	1 1/16	1/4
							over 61 to 92, incl	over 24 to 36, incl	2.2	1.0	7/8	3/8
							over 92 to 122, incl	over 36 to 48, incl	2.9	1.3	1 1/8	1/2
							over 122 to 153, incl	over 48 to 60, incl	3.5	1.6	1 3/8	5/8
							over 153 to 183, incl	over 60 to 72, incl	3.8	1.9	1 1/2	3/4
						over 183	over 72	4.1	2.2	1 5/8	7/8	
Uncored	0 to 1.3, incl	up to 1 1/2, incl	0.2	0.2	1/16	1/16	0 to 15, incl	0 to 6, incl	0.8	0.2	5/16	1/16
	over 1.3 to 2.5, incl	over 1/2, to 1, incl	0.3	0.2	1/8	1/16	over 15 to 31, incl	over 6 to 12, incl	1.3	0.2	1/2	1/8
	over 2.5	over 1	0.3	0.3	1/8	1/8	over 31 to 61, incl	over 12 to 24, incl	1.8	0.6	1 1/16	1/4
							over 61 to 92, incl	over 24 to 36, incl	2.2	1.0	7/8	3/8
							over 92 to 122, incl	over 36 to 48, incl	2.9	1.3	1 1/8	1/2
							over 122 to 153, incl	over 48 to 60, incl	3.5	1.6	1 3/8	5/8
							over 153 to 183, incl	over 60 to 72, incl	3.8	1.9	1 1/2	3/4
						over 183	over 72	4.1	2.2	1 5/8	7/8	