



## Standard Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings<sup>1</sup>

This standard is issued under the fixed designation D 3965; 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 (ε) indicates an editorial change since the last revision or reapproval.

### 1. Scope \*

1.1 This specification covers materials made from only virgin ABS polymers and blends of ABS polymers suitable for use in the extrusion of pipe and molding of fittings.

1.2 The requirements of this specification are applicable only to the ABS polymers and blends of ABS polymers as classified and do not address the requirements of the finished pipe or fittings. The applicable ASTM standard specification for pipe or fittings should be consulted for their requirements.

1.3 This specification excludes ABS polymers and blends of ABS polymers made from reprocessed, regrind, reclaimed, or recycled materials. ABS rework, generated in-house by the original plastic manufacturer, may be used by that original manufacturer, provided the ABS product shipped meets the physical and mechanical properties required by its callout in Table 1 of this specification.

1.4 This specification provides a means for describing ABS materials used in the manufacture of pipe and fittings. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastics field after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the inherent properties of the material other than those covered by this specification, and the economics.

1.5 This specification provides for the classification of ABS polymers and blends of ABS polymers into groups based on five properties: Izod impact strength at room temperature, Izod impact strength at low temperature, deflection temperature under load, tensile stress at yield point, and modulus of elasticity in tension. The properties included in this specification are those required to identify the ABS material by the cell classifications.

NOTE 1—Other requirements necessary to identify particular characteristics of ABS polymers and blends of ABS polymers will be added as test methods become available or the need is identified.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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NOTE 2—Due to pipe and fitting standards requirements a separate standard is planned for recycled materials.

NOTE 3—This specification and ISO 7245-1984 are not equivalent.

1.6 The values stated in SI units, as detailed in Practice E 380, are to be regarded as the standard. The practices of Practice E 380 are incorporated herein. The values given in parentheses are for information only.

1.7 The following safety hazards caveat pertains only to the test methods portion, Section 13, of this specification: *This standard does not purport to address all of the safety concerns, 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:

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials<sup>2</sup>

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>

D 638 Test Method for Tensile Properties of Plastics<sup>2</sup>

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load<sup>2</sup>

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement<sup>2</sup>

D 883 Terminology Relating to Plastics<sup>2</sup>

D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>

D 1898 Practice for Sampling of Plastics<sup>2</sup>

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>3</sup>

D 3892 Practice for Packaging/Packing of Plastics<sup>3</sup>

D 4000 Classification System for Specifying Plastic Materials<sup>3</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>

E 380 Practice for Use of the International Systems of Units

<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

\*A Summary of Changes section appears at the end of this standard.

**TABLE 1 Physical Property Requirements for ABS Pipe and Fitting Materials**

NOTE—The minimum property value for any material will determine the cell number although the maximum expected value may fall within the next higher cell.

| ASTM<br>Test Method                                                                                  |                                                        | Cell Limits  |           |           |           |           |           |
|------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--------------|-----------|-----------|-----------|-----------|-----------|
|                                                                                                      |                                                        | 0            | 1         | 2         | 3         | 4         | 5         |
| Izod impact, min:                                                                                    | D 256, Test Method A, Cantilever Beam (Izod-Type) Test |              |           |           |           |           |           |
| at 23°C (73°F), J/m                                                                                  |                                                        | <sup>A</sup> | 110       | 160       | 210       | 320       | 430       |
| (ft-lbf/in. of notch)                                                                                |                                                        | <sup>A</sup> | (2)       | (3)       | (4)       | (6)       | (8)       |
| at -30°C (-22°F), J/m                                                                                |                                                        | <sup>A</sup> | 50        | 110       | 160       | 210       | 270       |
| (ft-lbf/in. of notch)                                                                                |                                                        | <sup>A</sup> | (1)       | (2)       | (3)       | (4)       | (5)       |
| Deflection temperature under load, min, 1.82 MPa, (264 psi) annealed, 3.18 mm (0.125 in.) thickness: | D 648                                                  |              |           |           |           |           |           |
| °C                                                                                                   |                                                        | <sup>A</sup> | 76        | 82        | 88        | 93        | 99        |
| (°F)                                                                                                 |                                                        | <sup>A</sup> | (170)     | (180)     | (190)     | (200)     | (210)     |
| Tensile stress at yield point, min:                                                                  | D 638                                                  |              |           |           |           |           |           |
| MPa                                                                                                  |                                                        | <sup>A</sup> | 24        | 31        | 38        | 45        | 52        |
| (psi)                                                                                                |                                                        | <sup>A</sup> | (3500)    | (4500)    | (5500)    | (6500)    | (7500)    |
| Modulus of elasticity in tension, min:                                                               | D 638                                                  |              |           |           |           |           |           |
| MPa                                                                                                  |                                                        | <sup>A</sup> | 1380      | 1650      | 1930      | 2210      | 2480      |
| (psi)                                                                                                |                                                        | <sup>A</sup> | (200 000) | (240 000) | (280 000) | (320 000) | (360 000) |

<sup>A</sup> Unspecified.

(SI) (the Modernized Metric System)<sup>4</sup>

F 412 Terminology Relating to Plastic Piping Systems<sup>5</sup>

2.2 *Military Standard:*

MIL-STD-105D Sampling Procedure and Tables for Inspection by Attributes<sup>6</sup>

2.3 *ISO Standard:*

ISO 7245-1984 Pipes and Fittings of Acrylonitrile-Butadiene-Styrene (ABS)—General Specification for Moulding and Extrusion Materials<sup>7</sup>

### 3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminologies D 883 and F 412 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated. The abbreviation for acrylonitrile-butadienestyrene plastic is ABS.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *blend*—a homogenous mixture of polymers prepared by melt compounding or physical combination.

3.2.2 *lot*—a unit of manufacture; may consist of a blend of two or more production runs or batches of material.

3.2.3 *natural material*—a polymer as it exists when initially made by the original producer without addition of colorants.

3.2.4 *reprocessed plastic*—a thermoplastic prepared from usually melt-processed scrap or reject parts by a plastics processor or from purchased nonstandard or nonuniform virgin material.

3.2.5 *original plastic manufacturer*—a company that produces ABS resin by polymerization of monomers or com-

pounding of virgin styrene-acrylonitrile plastic (SAN) and virgin polybutadiene rubber, which meets the requirements of this specification.

### 4. Classification

4.1 ABS polymers and blends of ABS polymers shall be classified in accordance with Table 1. Each ABS polymer and blend of ABS polymers is given a five-digit cell classification representing the physical properties in the order in which they are listed in Table 1.

NOTE 4—The manner in which selected materials are identified by this classification system is illustrated by an ABS Class 44222 material having the following requirements:

*Property and Minimum value:*

Izod impact, 23°C, J/m  
Izod impact, -30°C, J/m  
DTUL, 1.82 MPa  
Tensile stress at yield point, MPa  
Modulus of elasticity in tension, MPa

|                                       |      |   |   |   |   |
|---------------------------------------|------|---|---|---|---|
|                                       | 4    | 4 | 2 | 2 | 2 |
| Izod impact, 23°C, J/m                | 320  |   |   |   |   |
| Izod impact, -30°C, J/m               | 210  |   |   |   |   |
| DTUL, 1.82 MPa                        | 82°C |   |   |   |   |
| Tensile stress at yield point, MPa    | 31.0 |   |   |   |   |
| Modulus of elasticity in tension, MPa | 1650 |   |   |   |   |

4.2 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination of the properties exists or can be obtained.

4.3 Mechanical properties of pigmented or colored materials can differ from the mechanical properties of natural material, depending on the choice of colorants and the concentration. The main property affected is ductility, as illustrated by a reduction in Izod impact strength and tensile elongation values. ABS polymers and blends of ABS polymers containing colorants or color concentrates, or both, shall meet the minimum ABS material cell classification from Table 1 for the pipe and fitting products specified.

<sup>5</sup> Annual Book of ASTM Standards, Vol 08.04.

<sup>6</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>7</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

## 5. Materials and Manufacture

5.1 The ABS material shall be produced by polymerization of the monomers, acrylonitrile, butadiene, and styrene, or their closely related chemical derivatives, or from a blend of ABS polymers from those monomers. The blend of ABS polymers can be intimately mixed by melt compounding, or it can be a homogenous physical mixture of discrete ABS polymers.

5.2 The ABS polymer and each ABS polymer component of a blend shall be uniform in physical properties, as defined by a cell classification, and shall be of composition, size, and shape as specified by its product specification or purchase order or contract. The color of the ABS plastic material with added colorants shall be as required in the product specification.

## 6. Chemical Composition

6.1 The ABS material shall contain a minimum of 15 % acrylonitrile, 6 % butadiene, and 15 % styrene, or 15 % of a combination of styrene and substituted styrene. Additive(s) necessary for compounding, impact modification, and coloring may be present. The final composition of the ABS material shall meet the minimum ABS cell class from Table 1 for the product specified.

6.2 The specific gravity shall be in the range from 1.00 to 1.08.

## 7. Suffix Requirements

7.1 When requirements are needed that supersede or supplement the property table or cell table requirements, they shall be specified through the use of suffixes. In general, the first suffix letter indicates the special requirement needed and the second letter indicates the condition or test method, or both, with a three-digit number indicating the specific requirement. The suffixes that may be used are listed in the Suffix Symbols and Requirements table of Classification System D 4000.

## 8. Basic Requirements

8.1 Basic requirements from Table 1 as they apply are always in effect unless these requirements are superseded by specific suffix requirements, which always take precedence.

## 9. Sampling

9.1 Sample the materials in accordance with the sampling procedure prescribed in Practice D 1898. Statistical sampling shall be considered as an acceptable alternative.

## 10. Number of Tests and Retests

10.1 One set of specimens as prescribed in the test methods shall be considered sufficient for each lot. The average result for the specimens tested shall meet the requirements of Table 1 when tested in accordance with the test methods listed in Section 13.

10.2 *Retest*—If the results of any test(s) do not meet the requirements of this specification, the test(s) may be conducted again in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirement of the specification, or modify a test method, or change the specification limits. In retesting, the product requirements of this specification shall be followed. If,

upon retest, failure occurs, the quantity of product represented by the test(s) shall be rejected.

## 11. Specimen Preparation

11.1 The test specimens shall be injection molded in accordance with Practice D 3641 with melt temperature  $215 \pm 15^\circ\text{C}$  and mold temperature  $40 \pm 15^\circ\text{C}$ . Average injection velocity shall be  $200 \pm 100$  mm/s as defined by the following formula:

$$AIV = \pi d^2 V_a / 4 ns \quad (1)$$

where:

$AIV$  = average injection velocity,

$d$  = screw diameter, mm,

$V_a$  = screw advance speed, mm/s,

$n$  = number of mold cavities, and

$s$  = cross-sectional area of the test specimen.

Other molding conditions shall be as specified by the manufacturer. Test specimens shall be molded in one piece and shall not be a composite of thinner sections.

## 12. Conditioning

12.1 Anneal the molded test specimen for use with Test Method D 648 for a minimum of 16 h but not more than 24 h at  $85^\circ\text{C}$  for materials in Cells 1 through 4, and at  $95^\circ\text{C}$  for materials in Cells 5 and 6. Condition all other molded test specimens in accordance with Procedure A of Practice D 618, prior to testing.

12.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of  $23 \pm 2^\circ\text{C}$  and  $50 \pm 5$  % relative humidity, unless otherwise specified in Table 1.

## 13. Test Methods

13.1 *Impact Testing*—Determine the impact strength of the material in accordance with the Cantilever Beam (Izod-Type) Test of Test Methods D 256, employing a  $3.18 \pm 0.38$ -mm ( $0.125 \pm 0.015$ -in.) thick specimen.

13.2 *Deflection Temperature Under Load*—Determine the deflection temperature under load, in accordance with Test Method D 648, employing a 3.18 by 12.7 by 127-mm ( $\frac{1}{8}$  by  $\frac{1}{2}$  by 5-in.) specimen and a load of 1.82 MPa (264 psi).

13.3 *Tensile Stress at Yield Point*—Determine the tensile stress at yield in accordance with Test Method D 638, employing a 3.2-mm ( $\frac{1}{8}$ -in.) thick Type I specimen. Test the specimen at a speed of 5.1 to 6.4 mm (0.20 to 0.25 in.)/min.

NOTE 5—Most ABS plastics exhibit a true yield point. Tensile stress at yield generally is greater than tensile stress (nominal) at break.

13.4 *Modulus of Elasticity in Tension*—Determine the modulus of elasticity in tension in accordance with Test Method D 638, employing the same specimen size and test speed as for tensile stress indicated in 13.3.

13.5 *Specific Gravity*—Determine the specific gravity in accordance with Test Method for Solid Plastics in Water in Test Methods D 792.

## 14. Certification and Inspection

14.1 Certification and inspection of the material supplied under this specification shall be for conformance to the requirements specified herein.

14.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of those tests listed in Table 1.

14.3 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance to this material specification, and that the average values for the lot meet the requirements of the line callout specified.

14.4 A report of test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment.

## 15. Packaging and Package Marking

15.1 For packing, packaging, and marking, the provisions of Practice D 3892 apply.

15.2 *Packaging*—The material shall be packaged in standard commercial containers so constructed as to ensure acceptance by common or other carriers for safe transportation at the lowest rate, to the point of delivery, unless otherwise specified in the contract or order.

15.3 *Package Marking*—Unless otherwise agreed upon between the seller and the purchaser, shipping containers shall identify the material and its supplier, the batch or lot number, and the quantity contained.

## 16. Keywords

16.1 ABS; pipe; pipe fittings; plastic materials

## SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 3965 – 99:

(1) Note 1 and Note 2 revised.

(2) In Section 2, D 3641 replaced D 1897 as reference.

(3) Section 6, Chemical Composition, added.

(4) Injection velocity and formula for calculation added as 11.1

(5) In 14.2, updated wording from D 4000/D 5740.

(6) In Section 16, change in Keywords.

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