The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1685

ISSUED MAY95

Issued 1995-05

Submitted for recognition as an American National Standard

CLASSIFICATION SYSTEM FOR AUTOMOTIVE ACRYLONITRILE/BUTADIENE/STYRENE (ABS) AND ABS + POLYCARBONATE BLENDS (ABS+PC) BASED PLASTICS

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

***1. Scope*—**This SAE Recommended Practice provides a system for classification and specification for limited number of acrylonitrile/butadiene/styrene (ABS) and blends with polycarbonate (ABS+PC) plastics used in the Automotive Industry. Based upon ASTM D 4673, Classification System for (ABS) Molding Materials, it calls for additional descriptive characteristics and properties commonly used in the Automotive Industry.

This practice applies to natural, non-color matched black, and plating gray compounds only. Color matched compounds shall be defined by the proprietary OEM standards.

This practice allows for the use of recycled, reconstituted, and regrind materials provided that the requirements as stated in this document are met, the material has not been altered or modified to change its suitability for safe processing and use, and the material shall be identified as such.

1.1 Purpose—The purpose of this document is to:

a. Standardize the grades of unreinforced and reinforced ABS and ABS+PC used for the Automotive Industry
b. Standardize the test methods used to characterize the properties of these materials
c. Provide a method for specifying these materials by the use of a simple line call-out designation

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J369—Flammability of Automotive Interior Materials-Horizontal Test Method
SAE J1344—Marking of Plastic Parts
SAE J1756—Test Procedure to determine the Fogging Characteristics of Interior Automotive Materials
SAE J1885—Exposure to Interior Xenon-Arc Weatherometer
SAE J1960—Exposure to Exterior Xenon-Arc Weatherometer
SAE J1976—Outdoor Weathering of Exterior Materials

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2.1.2 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 2457-90—Specular Gloss of Plastic Film and Solid Plastics
ASTM D 3763-92—High Speed Puncture Properties Plastics Using Load Displacement Sensors
ASTM D 4673-87—Acrylonitrile-Butadiene-Styrene (ABS) Molding and Extrusion Materials
ASTM D 5279-92—Measuring Dynamic Mechanical Properties of Plastics in Torsion
ASTM E 831-86—Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

2.1.3 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 75-1:1993—Plastics—Determination of temperature of deflection under load—Part 1: General test methods
ISO 75-2:1993—Plastics—Determination of temperature of deflection under load—Part 2: Plastic and Ebonite
ISO 105/A02:1993—Textiles—Grey scale for assessing change in color
ISO 178:1993—Plastics—Determination of flexural properties
ISO 180:1993—Plastics—Determination of Izod impact strength
ISO 188:1982—Rubber—Accelerated aging
ISO/DIS 294-1:1995—Plastics—Injection molding of test specimens of thermoplastic materials
ISO/DIS 294-3:1995—Plastics—Injection molding of test specimens of thermoplastic materials—Part 3: Plates (ISO mold type D)
ISO/DIS 294-4:1995—Plastics—Injection molding of test specimens of thermoplastic materials—Part 4: Determination of molding shrinkage
ISO 295:1991—Plastics—Compression moulding of test specimens of thermosetting materials
ISO 306:1994—Plastics—Thermoplastic materials—determination of Vicat softening temperature
ISO 527-1:1993—Plastics—Determination of tensile properties—Part 1: General principles
ISO 527-2:1993—Plastics—Determination of tensile properties—Part 2: Testing conditions
ISO 1133:1991—Plastics—Determination of melt mass-flow rate (MFR) and the melt-volume rate (MVR) of thermoplastics
ISO 1183:1987—Plastics—Methods for determining the density of non-cellular plastics
ISO 2580-2:1995—Plastics—Acrylonitrile/butadiene/styrene (ABS) molding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 3167:1993—Plastics—Preparation and use of multipurpose test specimen
ISO 3451/1:1981—Plastics—Determination of ash—Part 1: General Methods
ISO 3795:1989—Road vehicles—Determination of burning behavior of interior materials for motor vehicles

2.1.4 AATCC PUBLICATION—Available from AATCC, P.O. Box 12215, Research Triangle Park, North Carolina 27709 and British Standard Institution, 10 Blackfriars Str. Manchester, M3 5TD, England.

AATCC Gray Scale

2.1.5 FMVSS PUBLICATION—Available from The Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

FMVSS 302

3. Description

3.1 This classification system was developed to permit the addition of descriptive characteristics and values commonly used in Automotive Material Specifications for ABS and ABS+PC based materials. All the requirements listed in Section 7 shall apply for initial qualification of the material. The requirements listed in Section 8 shall be required for initial qualification when the particular suffix is included in the line call-out for the material. The requirements listed in Appendix A, Table A1 for initial product certification shall be met with data

representing 3 sigma values per 6.2. Production lots shall meet property control plan as agreed to between material supplier and user of this document.

4. Classification

4.1 Acrylonitrile/butadiene/styrene (ABS) and ABS+PC based plastics are classified into "groups" based on the chemical type and processing method. These groups are subdivided into "classes" and "grades" as shown in Appendix A, Table A1.

4.2 An example of this classification system is as follows:

The designation ABS0121 would indicate:

ABS	=	acrylonitrile/butadiene/styrene, generic symbol according to SAE J1344
01	=	unreinforced, injection molding ABS
2	=	high impact
1	=	requirements as given in Appendix A, Table A1

5. Line Call-outs

5.1 A line call-out, which is a specification, shall contain this document's identification number and a material designation from Table 1 as illustrated in 4.2.

TABLE 1—STANDARDIZED AUTOMOTIVE GRADES OF ABS AND ABS+PC BLENDS BASED PLASTICS(1),(2)

Group	Description	Designation
01	ABS, Injection Molding, Unreinforced	
	Medium Impact (3)	0111
	High Impact	0121
	High Heat	0131
	High Heat	0132
	Plating	0141
04	ABS+PC Blends, Injection Molding, Unreinforced	
	Medium Impact[3]	0411
	High Impact	0412
	High Impact	0421
	High Heat, High Impact	0431
	High Heat, High Impact	0432
14	Plating	0441
	ABS+PC, Injection Molding, Reinforced	
	10% Glass Fiber	1411
	10% Mineral	1421

1. Grades commonly used in Automotive Industry. Additional grades may be included in the future as agreed to by the SAE Plastics Committee.
2. Low gloss grades will be defined by use of Suffix Z5 (8.4)
3. Grades commonly described as "general purpose"

5.2 The line call-out specifies material meeting all requirements of this document. Note additional characterization in Section 7 and Section 8 - suffixes.

The following is an example of a line call-out:

SAEJ1685ABS0121

The above specification would indicate:

SAE J1685 Classification System for automotive ABS and ABS+PC Blends Plastics

ABS	=	acrylonitrile/butadiene/styrene, generic symbol according to SAE J1344
01	=	unreinforced, injection molding ABS
2	=	high impact
1	=	requirements as given in Appendix A, Table A1

5.3 The following definitions for tables in Appendix A, Table A1 of this document apply to ABS and ABS+PC blends.

a. Group 01 Unreinforced, injection molding acrylonitrile/butadiene/styrene (ABS)

Class 1 Medium Impact
Class 2 High Impact
Class 3 High Heat
Class 4 Plating

b. Group 04 Unreinforced, injection molding acrylonitrile/butadiene/styrene + polycarbonate blends (ABS+PC)

Class 1 Medium Impact
Class 2 High Impact
Class 3 High Heat, High Impact
Class 4 Plating

The fourth digit in groups 01 and 04, when listed, will define specific grade requirements in the designated class.

c. Group 14 Reinforced/filled, injection molding ABS+PC Blends

Class 1 Glass fiber reinforced
Class 2 Mineral filled

The fourth digit in group 14 will define the amount of reinforcement/filler. The following numeral will designate:

1 = 8 to 12%

6. Testing and Conditioning

6.1 **Test Specimens—**Test specimens shall be prepared as specified in Table 2. Unless otherwise specified all tests shall be carried out on injection molded one-end gated test specimens.

The following specimens are required:

TABLE 2—TEST SPECIMENS

	Defined by:	Molded According to:
A. 150 minimum x 10 x 4.0 ± 0.2 mm	ISO 3167, Type A	ISO/DIS 294-1
B. 60 x 60 x 2.0 ± 0.1 mm	ISO/DIS 294-3	ISO/DIS 294-3
C. 100 mm diameter x 3.2 ± 0.2 mm		Not Available
D. 355 x 100 x 2.0 ± 0.1 mm	FMVSS 302	ISO/DIS 294-1 (injection)
		ISO 295 (compression)

Test specimen A shall be molded using molding conditions defined in ISO 2580-2. Specimens with shorter dimensions shall be cut from the center portion of the test specimen A. No annealing allowed.

6.2 Statistical Data—Statistical data shall be derived from testing a minimum of 30 lots. The statistical data shall be submitted with initial characterization data (Section 7) of the material. The following properties are affected: melt flow rate, tensile strength, flexural modulus, Izod impact, Vicat softening temperature, and heat deflection temperature.

The user of this document shall define requirements for provisional approval prior to completion of 30 lot testing.

6.3 Conditioning and Test Conditions—All test values indicated herein are based on material conditioned in a controlled atmosphere of 23 °C ± 2 °C and 50% ± 5% relative humidity for not less than 24 h prior to testing and tested under the same conditions unless otherwise specified.

7. Initial Characterization of Automotive Materials—The following test results shall be submitted as initial characterization of the material.

7.1 Infrared Spectrophotometry and/or Thermal Analysis—Infrared and/or thermal analysis spectra shall constitute the reference standard for the material supplied to a specification based on this classification system and shall be available on request.

7.2 Shear Modulus—A plotted curve, as described as follows, shall constitute the reference standard for the material supplied to a specification based on this classification system and shall be available on request.

Shear modulus versus temperature curve shall be plotted for –50 to +50 °C temperature range, at 5 °C intervals.

7.2.1 TEST METHOD—ASTM D 5279, forced constant amplitude, fixed frequency of 1 Hz ± 15%, strain level below 1%. 60 x 10 x 4.0 mm specimen, cut from the center of tensile specimen (specimen A). Specimen length between clamps 35 to 40 mm. Soak time at each temperature interval 3 min minimum.

7.3 Density

7.3.1 TEST METHOD—ISO 1183, Method A. Report density in g/cm^3.

7.4 Heat Aging Performance—After aging for 1000 h at the appropriate temperature, listed as follows, the tensile strength and Izod impact strength must retain at least 75% of their original values.

7.4.1 TEST METHOD—ISO 188, 150 air changes/h ± 50 air changes/h. Unaged property values shall be determined at the time of the aged properties determination. Impact strength test specimens shall be notched before heat aging. Oven aging temperatures: 80 °C for ABS and 90 °C for ABS+PC.

7.5 Heat Deflection Temperature at 1.80 MPa

7.5.1 TEST METHOD—ISO 75-1 and ISO 75-2, 80 x 10 x 4.0 mm specimen (use center section of specimen A), test flatwise at standard deflection of 0.34 mm ± 0.01 mm. Report minimum temperature in °C.

7.6 Impact Strength, Multiaxial—Applicable to grades 0121, 0421, 0431, and 0432 only.

7.6.1 TEST METHOD—ASTM D 3763, 100 mm diameter x 3.2 mm thick smooth surface injection-molded specimen (specimen C).

Impact velocity—2.2 m/s for exterior, 6.6 m/s for interior applications.

Test at –40 °C ± 2 °C, or –30 °C ± 2 °C, or –15 °C ± 2 °C, or 0 °C ± 2 °C, and 23 °C ± 2 °C. Present all data at the temperature at which ductile failure was observed.

Test specimens must be conditioned for a minimum of 6 h at test temperature prior to impact testing. Low temperature testing shall be conducted within the same environmental chamber as the clamp mechanism of the impact device. No transfer through ambient conditions is permitted.

Test a minimum of 10 specimens from 3 individual lots at a single condition.

Report should include the:

a. Detailed description of specimen preparation
b. Molding conditions; melt and mold surface temperatures, and average injection velocity
c. Number of samples tested per lot per temperature
d. Numbers of lots tested
e. Number of samples with ductile failure per each test condition
f. Representative force versus deflection curve for each impact event
g. Number of cracks and maximum length

Summarize testing at each condition by providing the energy in Joules (mean value) at maximum load (all the high and low values should be reported).

Report energy in Joules (mean value) at maximum load at 23 °C ± 2 °C and at the lowest temperature that yields ductile failure, the standard deviation attained for that test run, and the impact velocity of the test.

A ductile failure is defined by describing the size, length, and type of cracks produced while testing a specimen to failure. Ductile failure will be defined and qualified by the individual users of this document.

7.7 Impact Strength, Izod At –40 °C

7.7.1 TEST METHOD—ISO 180/1A, 80 x 10 x 4.0 mm specimen (use center section of specimen A), test at –40 °C ± 2 °C. The test specimen must be conditioned for a minimum of 6 h at the previously specified temperature prior to impact test. Low temperature testing shall be done within the cold chamber, if not possible, test may be conducted outside, but within 5 s.

7.8 Flammability

7.8.1 TEST METHOD—ISO 3795/SAE J369, 100 mm/minute maximum burn rate, 355 x 100 x 2.0 mm smooth surface injection, extrusion, or compression-molded specimen (specimen D).

7.9 Coefficient of Linear Thermal Expansion

7.9.1 TEST METHOD—ASTM E 831 (TMA), –30 to +30 °C.

Report average value x E-5/ °C, for both the flow and cross-flow directions.

7.10 Mold Shrinkage

7.10.1 TEST METHOD—ISO/CD 294-4, 60 x 60 mm x 2.0 mm smooth surface injection-molded specimen (specimen B).

Report values in percent (%) for both the flow and cross-flow directions, under the following conditions:

a. Mold Shrinkage after storage at 23 °C ± 2 °C at 50% ± 5% relative humidity
b. Post Shrinkage after 48 h at 80 °C

8. Initial Characterization of Automotive Materials—Suffixes—The following requirements are available in addition to the basic call-out by use of suffixes Z1, Z2, Z3, Z4, and Z5.

All test results shall be submitted with initial characterization, when specified.

8.1 Suffix Z1—UV Light Resistant, Interior Xenon-Arc Exposure—Applicable to color matched unpainted compounds only.

8.1.1 TEST METHOD—SAE J1885, 263.2, or 300.8, or 601 kJ/m^2 minimum exposure (as specified by the standard user). 60 x 60 mm minimum x 2.0 mm, smooth surface, low-gloss injection-molded specimen (specimen B). SPI #1 mold finish. Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02).

8.2 Suffix Z2—UV Light Resistant, Under Glass, Interior Florida Exposure—Applicable to color matched unpainted compounds only

8.2.1 TEST METHOD—1 year, 5 degrees south, under PPG Herculite K, tempered safety glass, 3 mm thick. Applicable method shall be specified by the user of this document. 60 x 60 mm minimum x 2.0 mm, smooth surface, low-gloss injection-molded specimen (specimen B). SPI #1 mold finish. Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02).

No objectional color change or surface defects allowed.

8.3 Suffix Z3—UV Light Resistant, Exterior—Applicable to color matched unpainted compounds only.

8.3.1 XENON-ARC EXPOSURE—SAE J1960, 2500 kJ/m^2 minimum exposure. 60 x 60 mm minimum x 2.0 mm, smooth surface, low-gloss injection-molded specimen (specimen B). Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02).

8.3.2 FLORIDA AND ARIZONA EXPOSURE—SAE J1976, 2 years, 5 degrees south, direct exposure. 60 x 60 mm minimum x 2.0 mm, smooth surface, low-gloss injection-molded specimen (specimen B). Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02).

No objectional color change or surface defects allowed.

8.4 Suffix Z4—Fogging—Use only for interior application materials.

8.4.1 TEST METHOD—SAE J1756, Temperatures used for testing shall be specified by the user of this document. Report minimum Fog Number.

8.5 Suffix Z5—Gloss—Use only for interior application materials.

8.5.1 TEST METHOD—ASTM D 2457, 60 degree glossmeter, 5 measurements minimum on grained surface. Grain surface and maximum Gloss Level shall be specified by the user of this document.

8.6 The following is an example of a line call-out for a low gloss, UV light resistant, color matched interior application material requiring use of suffixes Z1, Z2, Z4, and Z5:

SAEJ1685ABS0123Z1Z2Z4Z5

Z1 = UV Resistant, Interior, Xenon-Arc Exposure
Z2 = UV Resistant, Under Glass, Interior, Florida Exposure
Z4 = Fog Number 80 minimum
Z5 = Gloss 2 to 3%

9. Test Methods—All requirements, with exception of Melt Flow Rate requirement, are listed in Appendix A, Table A1.

9.1 Melt Flow Rate

9.1.1 TEST METHOD—ISO 1133, 220 °C, 10 kg load for ABS and 265 °C, 5 kg load for ABS+PC blends.

Report Melt Flow Rate range in g/10 min.

9.2 Tensile Strength

9.2.1 TEST METHOD—ISO 527-1 and ISO 527-2, 150 minimum x 10 x 4.0 mm specimen (specimen A), test speed: 50 mm/min (unreinforced and/or materials without yield point with elongation equal or greater than 10%), and 5 mm/min (reinforced and/or materials without yield point with elongation below 10%). Report type of stress (yield and/or break).

9.3 Flexural Modulus

9.3.1 TEST METHOD—ISO 178, 80 x 10 x 4.0 mm specimen (use center section of specimen A), 2 mm/min test speed, 64 mm support span.

9.4 Impact Strength, Izod

9.4.1 TEST METHOD—ISO 180/1A, 80 x 10 x 4.0 mm specimen (use center section of specimen A), test at 23 °C ± 2 °C. Minimum of 10 specimens for each test.

9.5 Vicat Softening Temperature

9.5.1 TEST METHOD—ISO 306, Method B, 50 N load, silicone oil bath, 10 x 10 x 4.0 mm specimen (use center section of specimen A).

9.6 Filler Content (Reinforced Materials Only)

9.6.1 TEST METHOD—ISO 3451/1, Method A.

Report the temperature of calcination if different from from ISO 3451/1.

PREPARED BY THE SAE PLASTICS COMMITTEE

APPENDIX A

TABLE A1—REQUIREMENTS FOR STANDARDIZED AUTOMOTIVE GRADES OF ABS AND ABS+PC BLENDS BASED PLASTICS

GROUP	CLASS Description	GRADE Description	Statistical Data Tensile Strength[1] MPa, min	Statistical Data Flexural Modulus[1] MPa, min	Statistical Data Izod Impact Resistance at 23 °C[1] kJ/m^2, min	Statistical Data Vicat Softening Temperature[1] at 50.0 N °C, min	Initial Characterization Izod Impact Resistance at −40 °C[1],[2] kJ/m^2, min
01							
ABS, Unreinforced	**1** Medium Impact	**1**	32	1600	9	85	3
	2 High Impact	**1**	30	1600	23	85	8
	3 High Heat	**1**	34	1700	8	93	2
		2	32	1800	6	100	2
	4 Plating	**1**	34	2200	10	88	3
04							
ABS+PC Blends,	**1** Medium Impact	**1**	40	1900	9	100	2
Unreinforced	**2** High Impact	**1**	45	2000	32	114	10
		2	48	2100	35	105	8
	3 High Heat,	**1**	45	2000	40	123	10
	High Impact	**2**	45	2000	40	115	20
	4 Plating	**1**	37	1900	41	103	20
14							
ABS+PC Blend,	**1** Glass fiber reinforced	**1** 8 to 12%	45	3500	8	125	3
Reinforced [3]	**2** Mineral filled	**1** 6 to 10%	55	3000	20	125	5

All values in the table are based on a limited ISO statistical data base (see 6.2) and will be revised as more data becomes available. Presently, certification of individual materials will be carried out through the Control Plan process.

1. All test methods are defined in Section 9
2. Values reported are for initial characterization of materials
3. Filler content determination based on ISO 3451/1, Method A (see 9.5)