

Classification System for Thermoplastic Elastomers

- 1. Scope**—This SAE Standard provides a system for specifying significant material properties of thermoplastic elastomers (TPEs) that are intended for, but not limited to, use in automotive applications.

NOTE 1—For the purposes of this document a TPE is defined as a polymeric material that, without further chemical modifications, is capable of recovering from deformations quickly and forcibly and is also capable of being repeatedly softened by heating and hardened by cooling within a temperature range characteristic of the material.

NOTE 2—When the TPE product is to be used for purposes where the requirements are too specific to be completely prescribed by this classification system, it is necessary for the purchaser to consult the supplier in advance to establish the appropriate properties, test methods, and specification test limits.

In all cases where provisions of this classification system would conflict with those of the detailed specifications for a particular product, the latter shall take precedence.

This classification is based on SI units.

- 1.1 Purpose**—The purpose of this classification system is to provide a method by which TPEs may be specified by the use of a simple line call-out designation. To allow line call-outs, the system includes a symbol for the type of TPE to be used and letters and numbers for each level of property or characteristic.

EXAMPLE—A thermoplastic vulcanizate might be specified as follows:

SAE J2558 TPV (A35445, BS2440, DA55, EL290, G15, SGA970, TS4)

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2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version 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 J1545—Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim

SAE J1756—Determination of Fogging Characteristics of Interior Automotive Materials

SAE J1885—Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Water Cooled Xenon-Arc Apparatus

SAE J1960—Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Water Cooled Xenon-Arc Apparatus

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

FMVSS 302—Flammability of Interior Materials—Passenger Car, Multi-Purpose Passenger Vehicles

2.1.3 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 34—Rubber, vulcanized—Determination of tear strength (trouser, angle and crescent test pieces)

ISO 37—Rubber, vulcanized or thermoplastic—Determination of tensile stress-strain properties

ISO 188—Rubber, vulcanized—Accelerated aging or heat resistance tests

ISO 812—Rubber, vulcanized—Determination of low-temperature brittleness

ISO 815—Rubber, vulcanized or thermoplastic—Determination of compression set at ambient, elevated or low temperature

ISO 868—Plastics and ebonite—Determination of indentation hardness by means of a durometer (Shore hardness)

ISO 1183—Plastics—Methods for determining the density and relative density of non-cellular plastics

ISO1431-1—Rubber, vulcanized or thermoplastic—Resistance to ozone cracking—Part 1: Static strain test

ISO 1817—Rubber, vulcanized—Determination of the effect of liquids

ISO 3384—Rubber, vulcanized—Determination of stress relaxation in compression at ambient and at elevated temperatures

ISO3795—Road vehicles, and tractors and machinery for agriculture and forestry—Determination of burning behaviour of interior materials

ISO3865—Rubber, vulcanized or thermoplastic—Methods of test for staining in contact with organic material third edition

ISO 8013—Rubber, vulcanized—Determination of creep in compression or shear

2.1.4 AATCC PUBLICATION—Available from American Association of Textile Chemists and Colorists 1 Davis Drive, P.O. Box 12215, Research Triangle Park, NC 27709-2215.

AATCC Evaluation Procedure 1 - Gray Scale Color Change

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 UL PUBLICATION—Available from Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL-94—Test for Flammability of Plastic Materials for Parts, Devices, and Appliances

3. General Classification

- 3.1 TPEs shall be identified by a symbol following the SAE J2558 specification number based on family type as found in Table 1.

TABLE 1—SYMBOLS FOR TPE FAMILIES

Symbol	TPE Family Name
TECEA	Thermoplastic Elastomer – Chlorinated Ethylene Alloy
TEEE	Thermoplastic Elastomer, Ether-Ester
TES	Thermoplastic Elastomer Styrenic
TPO	Thermoplastic Polyolefin
TPV	Thermoplastic Vulcanizate
TPU	Thermoplastic Polyurethane

4. Compound Properties

- 4.1 **Suffix Letters**—The suffix letters, which indicate additional tests, together with their meaning, appear in Table 2.

TABLE 2—MEANING OF SUFFIX LETTERS

Suffix Letter	Test Required
A	Heat Resistance
B	Compression Set Resistance
C	Ozone Resistance
D	Hardness
EA	Fluid Resistance (Aqueous)
EF	Fluid Resistance (Fuels)
EO	Fluid Resistance (Oils and Lubricants)
EL	Elongation
F	Low Temperature Resistance
G	Tear Resistance
H	Fogging Characteristics
J	Abrasion Resistance
M	Flammability Resistance
P	Staining Resistance
SR	Stress Relaxation
SG	Specific Gravity
T	Creep Resistance
TM	Tensile Stress at a Given Elongation
TS	Tensile Strength
WE	UV Resistance (Exterior)
WI	UV Resistance (Interior)
Z	Special Requirements

- 4.2 Heat Resistance (Suffix Letter A)**—As determined by ISO 188. The first digit following the suffix letter A, in Table 3, shall designate the test time. The second digit following the suffix letter A, in Table 3, shall designate the test temperature.

TABLE 3—HEAT RESISTANCE SUFFIX NUMBER DESIGNATIONS

1st Digit	Time (h)	2nd Digit	Temperature (°C)
1	22	1	23
2	70	2	70
3	168	3	100
4	1008	4	125
		5	150

The third, fourth and fifth digits are obtained from Suffix Table 4 and indicate changes in hardness, tensile strength, and elongation following heat aging.

TABLE 4—PROPERTY CHANGE TABLE

	Property	0	1	2	3	4	5	6
3rd Digit	Hardness change, Shore pts	Unspecified	±2	±3	±4	±5	±8	±10
4th Digit	Tensile, % change max	Unspecified	±5	±10	±20	±30	±40	±50
5th Digit	Elongation, % change max	Unspecified	±5	±10	±20	±30	±40	±50

EXAMPLE—A44535 = 1008 h at 125 °C, ±8 max hardness change, ±20 max tensile change, ±40 max elongation change.

- 4.3 Compression Set (Suffix Letter B)**—As determined by ISO 815 Type A. Specimen type shall be denoted by means of the letter S (solid) or P (plied) following the B symbol. The test time shall be designated by the first digit following the suffix letters (BS or BP symbol) in Table 5. The second digit following the suffix letters in Table 5 shall designate the test temperature. The percent compression set value shall be no more than the numerical value expressed by the third and fourth digits following the suffix letters (BS or BP symbol).

TABLE 5—COMPRESSION SET SUFFIX NUMBER DESIGNATIONS

1st Digit	Time (h)	2nd Digit	Temperature (°C)
1	22	1	23
2	70	2	70
3	168	3	100
4	1008	4	125
		5	150

EXAMPLE—BS2325 = 25% max compression set after 70 h at 100 °C.

- 4.4 Ozone Resistance (Suffix letter C)**—As determined by ISO 1431-1. The ozone concentration shall be specified by the first digit following the C symbol in Table 6. The percent elongation shall be designated by the second digit following the C symbol in the table below. No cracking shall be allowed following testing according to Procedure A.

TABLE 6—OZONE RESISTANCE SUFFIX NUMBER DESIGNATIONS

1st Digit	Partial Pressure O ₃	2nd Digit	% Elongation	2nd Digit	% Elongation
1	25 MPa ± 5 MPa	1	5 ± 1	6	40 ± 2
2	51 MPa ± 5 MPa	2	10 ± 1	7	50 ± 2
3	101 MPa ± 10 MPa	3	15 ± 2	8	60 ± 2
4	201 MPa ± 20 MPa	4	20 ± 2	9	80 ± 2
		5	30 ± 2		

- 4.5 Hardness (Suffix letter D)**—Shall be determined by ISO 868 using either the Type A or Type D scale as indicated by the amending letter. The hardness shall be shown by the numerical value following the amending letter with a tolerance of ±5 points for Type A values and ±3 for Type D values.

EXAMPLE—DA60 = 60 ± 5 Type A
DD40 = 40 ± 3 Type D

- 4.6 Fluid Resistance (Suffix letters EA - Aqueous, EF - Fuels, and EO - Oils and Lubricants)**—As determined by ISO 1817. The first digit following the suffix letters EA, EF or EO in Table 7 shall designate the test time. The second digit following the suffix letters EA, EF, or EO in Table 7 shall designate the test temperature.

TABLE 7—FLUID RESISTANCE SUFFIX NUMBER DESIGNATIONS

1st Digit	Time (h)	2nd Digit	Temperature (°C)
1	22	1	23
2	70	2	70
3	168	3	100
4	1008	4	125
		5	150

The third, fourth, fifth, and sixth digits are obtained from Suffix Tables 8, 9, and 10, depending on fluid type, and indicate changes in hardness, tensile strength, elongation, and volume swell following fluid aging.

TABLE 8—FLUID RESISTANCE PROPERTY CHANGE TABLE (AQUEOUS)

	Property	0	1	2	3	4	5	6
3rd Digit	Hardness change, Shore pts	Unspecified	± 2	±3	±4	±5	±8	±10
4th Digit	Tensile, % change max	Unspecified	±5	±10	±20	±30	±40	±50
5th Digit	Elongation, % change max	Unspecified	±5	±10	±20	±30	±40	±50
6th Digit	Change in Volume, % max	Unspecified	+2	+4	+6	+8	+10	+15

The type of aqueous fluid is designated by the letter symbol following the sixth digit as indicated as follows.

- A. Distilled water
- B. Distilled Water / Ethylene glycol (reagent grade) 50/50 by volume.

EXAMPLE—EA332336B = Age 168 hours at 100 °C in distilled water/ethylene glycol, max changes hardness ±2 points, tensile ±20%, elongation ±20%, volume +15%.

TABLE 9—FLUID RESISTANCE PROPERTY CHANGE TABLE (FUELS)

	Property	0	1	2	3	4	5	6
3rd Digit	Hardness change, Shore pts	Unspecified	−5	−10	−15	−20	−25	−30
4th Digit	Tensile, % change max	Unspecified	±5	±10	±20	±30	±40	±50
5th Digit	Elongation, % change max	Unspecified	±5	±10	±20	±30	±40	±50
6th Digit	Change in Volume, % max	Unspecified	+10	+20	+40	+60	+80	+100

The type of fuel is designated by the letter symbol following the sixth digit as indicated as follows (from ISO 1817, Annex Table 1).

- | | |
|-----------------------|-----------------------|
| A. Reference Liquid A | E. Reference Liquid E |
| B. Reference Liquid B | F. Reference Liquid F |
| C. Reference Liquid C | |

EXAMPLE—EF214565C = Age 70 hours at 23 °C in Reference Liquid C, max changes hardness −20 points, tensile ±40%, elongation ±50%, volume +80%.

TABLE 10—FLUID RESISTANCE PROPERTY CHANGE TABLE (OILS)

	Property	0	1	2	3	4	5	6
3rd Digit	Hardness change, Shore pts	Unspecified	−5	−10	−15	−25	−35	−45
4th Digit	Tensile, % change max	Unspecified	±5	±10	±20	±30	±40	±50
5th Digit	Elongation, % change max		±5	±10	±20	±30	±40	±50
6th Digit	Change in Volume, % max	Unspecified	±15	+30	+60	+90	+120	+140

The type of oil is designated by the letter symbol following the sixth digit as indicated as follows.

- A. Oil No. 1
- B. IRM 902
- C. IRM 903

EXAMPLE—EO245665C = Age 70 hours at 125 °C in IRM 903 oil, max changes hardness −35 points, tensile ±50%, elongation ±50%, volume +120%.

- 4.7 Elongation (Suffix Letters EL)**—As determined by ISO 37 the percent elongation shall be no less than the numerical value following the EL symbol.

EXAMPLE—EL430 = 430% minimum

- 4.8 Low Temperature Brittleness (Suffix F)**—As determined by ISO 812, Procedure A. The value required shall be a maximum temperature express by the numerical value multiplied by −1 following the F symbol designated in degrees Celsius.

EXAMPLE—F40 = −40 °C max brittleness temperature.

- 4.9 Tear Strength (Suffix Letter G)**—As determined by ISO 34-1 the test methods shall be specified by the letter symbol following the G symbol as designated as follows. The value required shall be no less than the numerical value following the second letter after the G symbol in kN/m.

Test Methods (second letter)

- A. Method A: trouser test piece
- B. Method B, procedure (a): angle test piece without nick
- C. Method B, procedure (b): angle test piece with nick
- D. Method C: crescent test piece

EXAMPLE—GB30 = 30 kN/m minimum, Method B, procedure (a).

- 4.10 Fogging Characteristics (Suffix letter H)**—As determined by SAE J1756. The second letter P designates the photometric procedure and the second letter G designates the gravimetric procedure. The first digit following the second letter shall designate the test time as indicated in Table 11. The second digit shall designate the test temperature. The required fogging number for the photometric method shall be no less than the value indicated by the third and fourth two digit numerical number following the P symbol. The required fog deposit for the gravimetric procedure shall be no more than the value indicated by the third and fourth digit following the G symbol, multiplied by 0.1 mg,

TABLE 11—FOGGING SUFFIX NUMBER DESIGNATIONS

1st Digit	Time (h)	2nd Digit	Temperature (°C)
1	3	1	85
2	6	2	90
3	10	3	95
4	24	4	100
		5	110

EXAMPLE 1—HP3470 = 3 hours at 100 °C, 70 minimum fogging number

EXAMPLE 2—HG3420 = 3 hours at 100 °C, fog deposit 2.0 mg max

Requirements for special observations, e.g., large droplets, dry or oily films, unusual deposits, and/or build-up of crystals, shall be determined between the contractual parties.

- 4.11 Abrasion Resistance**—Specific classification designations are to be determined. Requirements and conditions shall be set according to agreement between contractual parties.
- 4.12 Flammability Resistance (Suffix Letter M)**—As determined by ISO 3795 / FMVSS 302 / SAE J369 the maximum burn rate shall be 100 mm/ minute. The test method shall be designated by the letter following the M symbol as indicated as follows.

- A = ISO 3795
- B = FMVSS 302
- C = SAE J369

EXAMPLE—MA = Burn rate 100 mm/minute maximum following testing according to ISO 3795.

4.13 Staining Resistance (Suffix P)—As determined by ISO 3865. The letter P shall designate the test method, or letter and number following the P symbol as indicated as follows.

A1 = Contact Stain
 A2 = Migratory Stain
 B = Extraction Stain
 C = Penetration Stain

The symbol P alone indicates that all methods are required. The symbol PA indicates that both contact and migratory staining are required.

Evaluation of staining may be in accordance with one of the following methods.

Qualitative - Make a visual assessment - No Staining allowed. The letter V following the test methods shall be designated.

American Association of Textile Chemists and Colorists (AATCC) Evaluation Procedure 1 Gray Scale for Color Change (ISO 105-A02). After exposure the material shall show no color change in excess of the specified Gray Scale rating. This method is specified by adding the letter G following the test methods. A single digit following the letter G shall specify the Gray Scale rating minimum.

EXAMPLE—PAV = No contact or migration staining, visual evaluation.

PA2G4 = Gray scale rating 4 minimum following migratory staining tests.

4.14 Specific Gravity—As determined by ISO 1183, Method A, shall be within the tolerance indicated by the letter following the SG suffix (Table 12), and the value shall be as indicated by the numerals following the SG suffix times the factor of 0.001.

TABLE 12—SPECIFIC GRAVITY SUFFIX LETTERS AND TOLERANCES

Suffix	Tolerance	Suffix	Tolerance
SGA	±0.02	SGF	±0.003
SGB	±0.03	SGG	±0.004
SGC	±0.05	SGH	±0.005
SGD	±0.001	SGJ	Minimum
SGE	±0.002	SGK	Maximum

EXAMPLE—SGA970 = 0.97 ± 0.02

4.15 Stress Relaxation (Suffix SR)—As determined by ISO 3384. Specific classification designations are to be determined. Requirements and conditions shall be set according to agreement between the contractual parties.

4.16 Creep Resistance (Suffix T)—As determined by ISO 8013. Specific classification designations are to be determined. Requirements and conditions shall be set according to agreement between the contractual parties.

4.17 Tensile Stress at a Given Elongation (Suffix Letters TM)—As determined by ISO 37. The letter following the TM symbol as follows shall express the % elongation value.

A = 100% B = 200% C = 300%

The value required shall be no less than the numerical value following the TM symbol in MPa.

EXAMPLE—TMA3 = Tensile stress at 100% elongation = 3 MPa minimum.