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

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2016

REV. NOV1999

Issued 1989-06
Revised 1999-11

Superseding J2016 JUN1989

Submitted for recognition as an American National Standard

(R) Chemical Stress Resistance of Polymers

1. Scope

1.1 This SAE Recommended Practice provides a screening procedure for evaluating the susceptibility of plastics to environmental stress cracking by testing their resistance to pure solvents or their mixtures. This method can be used to evaluate effect of complex chemical mixtures with unknown or suspect components, which may be encountered in the polymer's environment.

1.2 The list of chemicals in Appendix A is intended only to serve as a guide and does not exclude any chemical that may represent the environment the polymer is subjected to in a specific application. As specific environment and exposure conditions are application dependent and could vary significantly from one application to another, the user of the document is recommended to choose the appropriate solvents relevant to the actual application enviroment and is not under any obligation to test the effect of all the chemicals listed in Appendix A.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein.

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

ISO/DIS 175:1998—Plastics—Determination of the effects of liquid chemicals, including water
ISO 291:1997—Plastics—Standard atmospheres for conditioning and testing
ISO 294-1:1996—Plastics—Injection moulding of test specimens of thermoplastic materials—Part 1: General principles and multipurpose test specimens (ISO type A mould) and bars (ISO type B mould)
ISO 294-2:1996—Plastics—Injection moulding of test specimens of thermoplastic materials—Part 2: Small tensile bars
ISO 2818:1994—Plastics—Preparation of test specimens by machining
ISO 3167:1993—Plastics—Multipurpose test specimens
ISO 6252:1992—Plastics—Determination of environmental stress cracking—Constant tensile stress method
ISO 10724:1994—Plastics—Thermosetting moulding materials—Injection moulding of multipurpose test specimens
ISO 11404-3:1998—Plastics—Acquisition and presentation of comparable multipoint data—Part 3: Environmental influences on properties

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

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

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 for moulding and extrusion materials

3. Definitions

3.1 Environmental Stress Cracking—Susceptibility of the plastic to cracking or crazing under applied tensile stress or strain in presence of an environment that accelerates development of such cracks.

3.2 Indicative Property—A property that has been selected to reveal the influence of the environment on a material through a comparison of measurements of the property before and after exposure.

3.3 Tensile Work to Break—The area under the tensile stress-strain plot, where applied stress is determined from the ratio of the tensile force to the minimum initial cross-sectional area of the specimen. It is expressed in kJ/m^2.

4. Symbols

σ_y	tensile strength at yield
σ_B	tensile strength at break
w_{tB}	tensile work to break
σ_{uo}	Reference value of tensile stength, prior to the exposure to the chemical
$\sigma_{sc}{}^{100}$	stress corresponding to a 25% reduction in the tensile strength after 100 h loading time with exposure to the chemical
$\sigma_{wc}{}^{100}$	stress corresponding to a 50% reduction in the work to break after 100 h loading time with exposure to the chemical
$\sigma_{sc}{}^{1000}$	stress corresponding to a 25% reduction in the tensile strength after 1000 h loading time with exposure to the chemical
$\sigma_{wc}{}^{1000}$	stress corresponding to a 50% reduction in the work to break after 1000 h loading time with exposure to the chemical

***5. Test Specimens*—**For the determination of indicative properties, the ISO 3167 or ISO 10724 multipurpose test specimen with a machined waist region in the central part of the specimen, identical to that in the small tensile specimen in ISO 294-2, as shown in Figure 1, shall be used. The waist region serves to expose interior regions of the specimen to the chemical as well. A minimum of five speicmens shall be used.

In instances where the material is expected to exhibit anisotropy, the specimen should be obtained parallel and perpendicular to the flow direction from a plate.

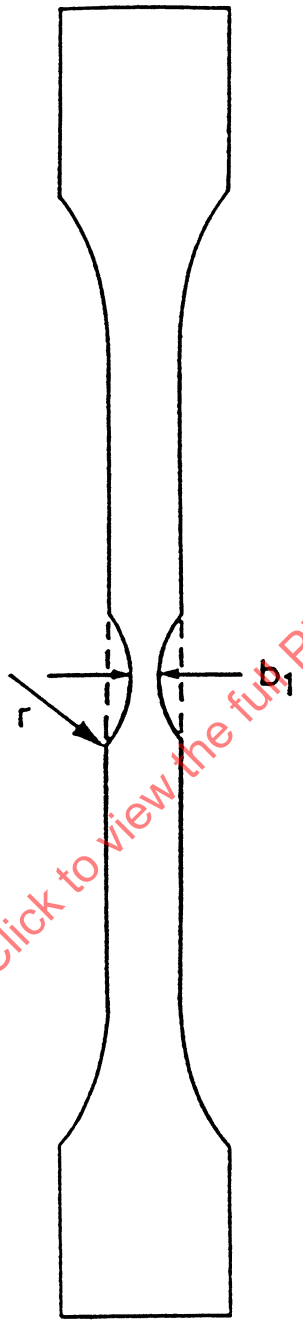

FIGURE 1—TEST SPECIMEN FOR THE MEASUREMENT OF CHEMICAL STRESS RESISTANCE PREPARED BY MACHINING THE MULTIPURPOSE TEST SPECIMEN (ISO 3167 OR ISO 10724) TO OBTAIN A CENTRAL WAIST REGION
(radius, r = 15 mm ± 1 mm and minimum width, b_1 = 3 mm ± 0.2 mm)

6. ***Specimen Preparation—***The test specimens for the evaluation of chemical stress resistance of polymers shall be prepared by injection molding, according to the procedures described in ISO 294-1 or ISO 10724, where possible unless otherwise specified in the Part 2 of the ISO material standards relevant to the material. The central region of the specimen shall be reduced to a width of 3 mm by machining circular notches of radius 15 mm (see Figure 1, ISO 2818). It is recommended that precautions should be taken during machining to avoid introducing stress concentrations in the direction perpendicular to the long axis of the specimen by ensuring that the cutting direction is parallel to the length of the specimen.

The molding conditions will depend on the material being molded and where possible, on molding conditions specified in the Part 2 of the ISO materials standards relevant to the material. For those plastics for which molding conditions have not yet been standardized, the conditions employed shall be within the range recommended by the plastics manufacturer, and shall be the same for each specimen. Where molding conditions are not stipulated in any International Standard, the melt temperature, mold temperature, average injection velocity shall be recorded.

7. ***Conditioning—***Specimen conditioning shall be carried out at 23 °C ± 1 °C and 50% ± 5% RH for a minimum of 88 h (consistent with ISO 291) except where special conditioning or a maximum conditioning time is required by the appropriate Part 2 of the ISO material standard. Unless otherwise stated, specimens of materials that absorb moisture shall be in equilibrium with an atmosphere of 50% ± 5% RH at 23 °C ± 1 °C before exposure to the chemical and for measurement of indicative properties. Reference to the use of any special conditioning shall be recorded.

NOTE—The change from 2 °C to 1 °C tolerance is made to be consistent with ±5% tolerance for the RH in the revised ISO 291 standard.

8. ***Chemicals—***A list of representative chemicals is included in Appendix A.

9. ***Indicative Properties—***The following tensile properties are selected as indicative properties:

a. Tensile strength at yield (σ_y) or tensile strength at break (σ_B) for brittle materials
b. Tensile work to break (w_{tB})

10. ***Procedure***

10.1 Measure the reference values, σ_{uo} (prior to the exposure to the chemical) at 23 °C ± 1 °C using a minimum of 5 test specimens in accordance with ISO 527-1 and ISO 527-2. For polymers that exhibit a strain at break less than 10% at a test speed of 50 mm/min, a test speed of 5 mm/min shall be used. For polymers that exhibit yield or a strain at break ≥10%, the test speed shall be 50 mm/min.

10.2 Condition the test specimens for 24 h at 23 °C ± 1 °C and 50% ± 5% relative humidity.

10.3 Expose the test specimens to the chemical for periods of 100 h and 1000 h at a series of stress levels chosen to give reductions in the tensile strength that are above and below 25% and in the work to break that are above and below 50%. A minimum of 4 stress levels and a minimum of 5 specimens at each stress shall be used.

10.4 Immediately following the exposure time, measure the indicative properties at the same test speeds employed prior to the exposure to chemical.

10.5 Plot the indicative property values against the applied stress and determine the creep stresses (Figure 2).

a. σ_{sc}^{100} and σ_{wc}^{100} that gives a 25% reduction in the tensile strength and a 50% reduction in the work to break respectively.
b. σ_{sc}^{1000} and σ_{wc}^{1000} that gives a 25% reduction in the tensile strength and a 50% reduction in the work to break respectively.

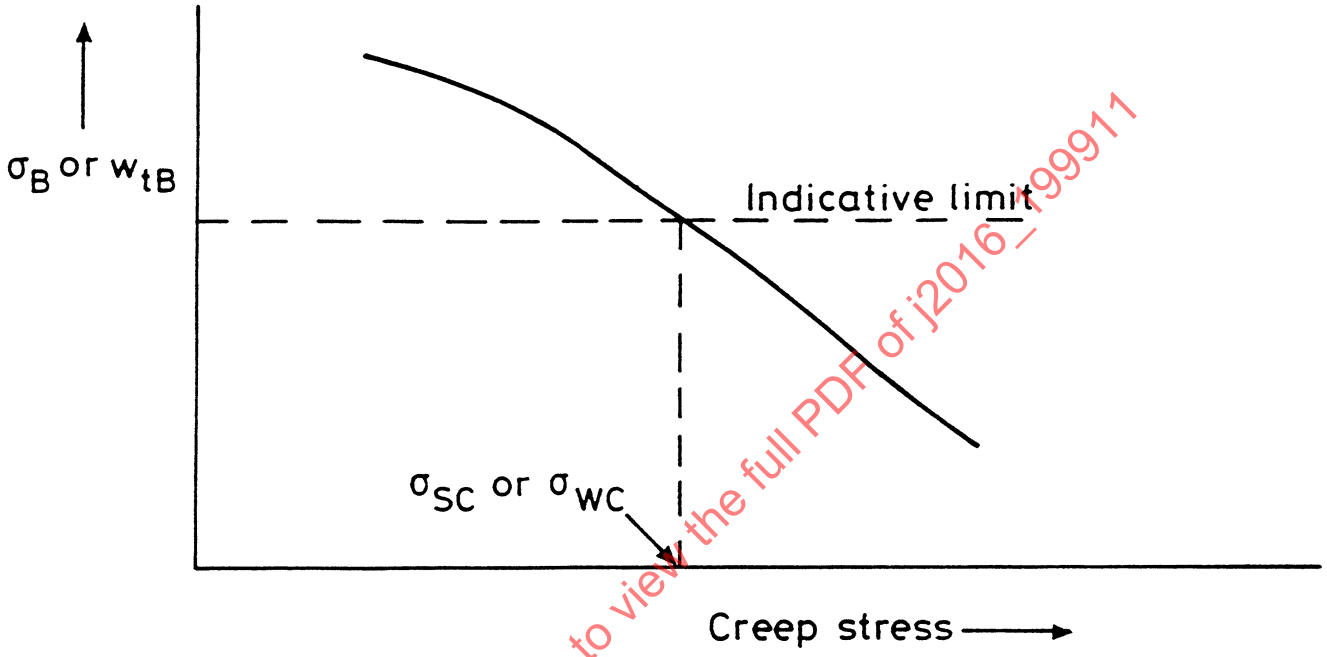

FIGURE 2—PLOT OF INDICATIVE PROPERTY VALUES, MEASURED AFTER THE TENSILE STRESS LOADING, AGAINST APPLIED STRESS SHOWING HOW THE QUANTITIES σ_{sc} AND σ_{wc} ARE DETERMINED

10.6 Record the ratios, $\sigma_{sc}^{100}/\sigma_{uo}$ and $\sigma_{sc}^{1000}/\sigma_{uo}$ as well as $\sigma_{wc}^{100}/\sigma_{uo}$ and $\sigma_{wc}^{1000}/\sigma_{uo}$.

NOTE—The final testing should be conducted on prototype parts which includes the evaluation of parts exposed to chemicals and unexposed parts. Since the reactivity of a chemical depends on the total strain imposed on the polymer as well as any other influences that may degrade the polymer, care should be given to closely represent all fabrication and end use conditions.

11. Notes

11.1 Marginal Indicia—The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE PLASTICS COMMITTEE