



# Standard Test Method for Rubber Deterioration—Surface Cracking<sup>1</sup>

This standard is issued under the fixed designation D 518; 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.

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

## 1. Scope

1.1 This test method covers three test specimen procedures that estimate the comparative ability of rubber compounds to withstand the effects of normal weathering, or exposure in an atmosphere containing controlled amounts of ozone. It does not apply to testing of electrical insulation or other rubber parts where high concentrations of ozone prevail due to electrical discharge, nor to testing of material ordinarily classified as hard rubber.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *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 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber<sup>2</sup>

D 4575 Test Methods for Rubber Deterioration: Reference and Alternative Method(s) for Determining Ozone Level in Laboratory Test Chambers<sup>2</sup>

## 3. Summary of Test Methods

3.1 Three test methods are used to measure ozone cracking resistance:

	Sections
Method A—Exposure of Straight Specimens (Elongated)	5 to 8
Method B—Exposure of Bent Looped Test Specimens	9 to 12
Method C—Exposure of Tapered Specimens (Elongated)	13 to 17

3.2 Each test consists of continuously exposing rubber test specimens, held under strain, to normal weather conditions or in an atmosphere containing controlled amounts of ozone. Specimens are exposed for definite periods of time and their deterioration observed as evidenced by the appearance and growth of cracks on the surfaces.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D-11 on Rubber and is the direct responsibility of Subcommittee D11.15 on Degradation Tests.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 09.01.

3.3 Refer to Test Method D 4575 for the reference and optional alternative test methods for the measurement of the ozone partial pressure in laboratory test chambers.

## 4. Significance and Use

4.1 In the development of rubber compounds for use in applications where ozone cracking is objectionable, it is necessary to have a test in which simple comparative performance for resistance to cracking can be evaluated. This test method can be used for this performance comparison.

4.2 This test method is not suited for use in purchase specifications, not only because correlation with service life is uncertain, but because the results from duplicate specimens tested in different locations do not ordinarily give the same values. No exact relation between the results of the test and actual service performance is given or implied. The test is principally of value when used for comparisons between two or more rubber compounds.

## METHOD A—EXPOSURE OF STRAIGHT SPECIMENS

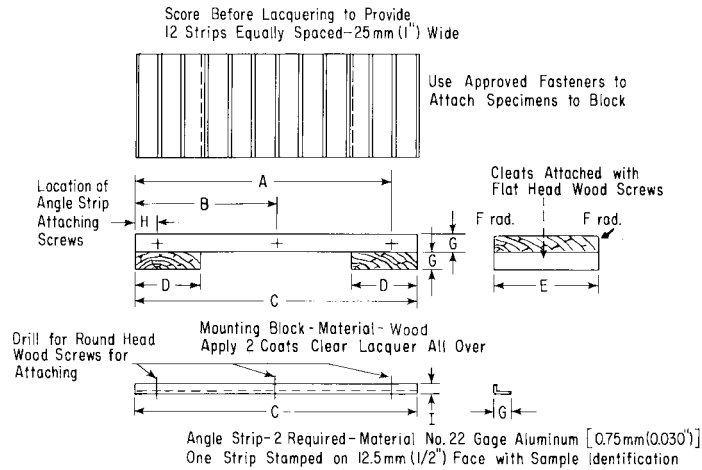
### 5. Apparatus

5.1 *Mounting Block*—A rectangular wooden block shall be used for supporting the extended specimens. The block shall be 140 mm (5.5 in.) wide and approximately 380 mm (15 in.) long and shall have a thickness of not less than 22 mm (0.875 in.). The block shall have the grain running lengthwise and shall be suitably reinforced on the back to prevent warping. Both of the 380-mm edges of the face carrying the specimens shall be rounded with a 3-mm (0.125-in.) radius. (Fig. 1 shows the details of construction.) The block shall have a smooth finish and shall be painted with two coats of clear lacquer<sup>3</sup> or spar varnish.

5.2 *Fasteners*—Aluminum tacks, or other suitable material fasteners inert to ozone shall be used for fastening the specimens to the edges of the wooden block.

5.3 *Angle Strips*—Right angled aluminum molding strips 13 by 22 mm (0.5 by .0875 in.) and of approximately No. 22 gage thickness, for shielding the specimens where tacked and bent over the edges of the block. Strips made from commercial aluminum sheet of Alloy No. 2-S are suitable.

<sup>3</sup> duPont clear lacquer, or its equivalent, has been found suitable for this purpose.



	A	B	C	D	E	F	G	H	I
mm	350	190	380	90	140	3	22	32	12
in.	15 $\frac{3}{4}$	7 $\frac{1}{2}$	15	3 $\frac{1}{2}$	5 $\frac{1}{2}$	$\frac{1}{8}$	$\frac{7}{8}$	1 $\frac{1}{4}$	$\frac{1}{2}$

FIG. 1 Apparatus for Mounting Straight Rubber Test Specimens, Procedure A

**6. Test Specimens**

6.1 The test specimens shall be rectangular strips 25 mm (1 in.) in width by 150 mm (6 in.) in length cut from standard laboratory test sheets having a thickness of 1.9 mm (0.075 in.) minimum and 2.5 mm (0.100 in.) maximum. The “milling grain” shall be in the lengthwise direction of the specimen.

6.2 Duplicate test specimens shall be tested whenever possible.

**7. Procedure**

7.1 Firmly fasten the test specimens at one end to one long side of the test block, spacing them 6 mm (0.55 in.) apart and using three aluminum tacks per specimen. Then draw the strips across the face of the block in such a manner as to cause an extension of 20 %, measured between gage marks that shall be 100 mm (4 in.) apart and centered at the middle of each strip. Fasten the other end of each specimen in the same way to the opposite long side of the block. Mount the aluminum shields by means of screws on each of the long sides so that the 22-mm (0.875-in.) leg covers the tacked ends of the specimens and the 13-mm (0.15-in.) leg covers the specimens at the bend on to the face of the block.

7.2 Expose the extended specimens to the weather and sunlight at an angle of 45° with the horizontal facing south, preferably on a roof of a building; or they may be exposed in a cabinet having an atmosphere in which the ozone content is controlled, as described in Test Method D 1149.

7.2.1 Take note of the warnings in Test Method D 1149 regarding the hazardous nature of ozone if an ozone cabinet is used.

7.3 Record the date on which the tests were begun, and examine the specimens daily thereafter or as often as necessary, for the effects of ozone. Observation of cracks shall be made with a 7-power magnifying glass. Record the time of the appearance of the first surface cracks on these specimens. If desired, the exposure may subsequently be continued for the purpose of observing the rate of growth of the cracks in length

and number or the development of any characteristic or unusual surface effects.

**8. Report**

8.1 The report shall include the following:

8.1.1 Statement of the method used,

8.1.2 Description of the specimens, identifying the rubber compounds and giving the duration, temperature, and date of vulcanization, if known,

8.1.3 Dates of starting the exposure and the first appearance of checks or cracks, and

8.1.4 Geographical location of specimens exposed to weather.

**METHOD B—EXPOSURE OF LOOPED TEST SPECIMENS**

**9. Apparatus**

9.1 *Clamping Strips*, made of medium-soft wood for clamping the specimens. Each strip shall be 13 mm (0.5 in.) in thickness, 25 mm (1 in.) in width, and 575 mm (23 in.) in length. Holes shall be drilled through the 13-mm thickness of each strip at intervals of 40 mm (1.6 in.) starting 14 mm (0.6 in.) from one end. The holes shall be made approximately 4 mm (0.160 in.) in diameter, and shall match in paired strips. The strips shall be fastened together using appropriate round-head chromium-plated or galvanized iron machine screws fitted with nuts.

9.1.1 *Clamping Devices*, made from aluminum also may be used in place of the wood clamping strips. Several types of metal angles and channels have been successfully used. One way is the use of aluminum channels 3.5 mm (0.138 in.) thick by 298 mm (11.75 in.) in length by 19 mm (0.75 in.) wide and 19 mm high joined two or more to hold the specimens. The channel sides have three holes drilled 8.0 mm (0.31 in.) in diameter 32 mm (1.25 in.) from each end and 150 mm (5.875 in.) in the center of the channel. The channels shall be fastened together using appropriate hexagon head chromium-plated or

galvanized iron screws fitted with washers and wing nuts.

9.2 *Base Panel*, made of medium-soft wood upon which the clamped specimens are mounted. It shall be 530 mm (24 in.) long, 205 mm (8 in.) wide, and at least 13 mm (0.5 in.) thick. Three crosspieces each 205 mm (8 in.) long, 25 mm (1 in.) wide, and 6 mm (0.25 in.) thick, shall be fastened to the base. The crosspieces shall be mounted 19 mm (0.75 in.) from each end of the panel and at the center. Each crosspiece shall be held in place by three 50 mm (2 in.) round head chromium plated or galvanized iron machine screws. These screws shall be fitted with washers on the underside of the base panel and shall fit into a countersink. The screws shall pass through the panel and through the crosspieces, 32 mm (1.25 in.) from each end of the crosspieces and through the center. These screws shall protrude above the surface of the panel to a height of about 35 mm (1.38 in.) and shall be used to fasten the wooden specimen strips securely to the base as described in 11.2.

9.3 All wooden panels, strips, and crosspieces, shall be painted with two coats of clear lacquer<sup>3</sup> or spar varnish.

**10. Test Specimens**

10.1 The test specimens shall be rectangular strips 25 mm (1 in.) wide by 95 mm (3.75 in.) in length, cut from standard laboratory test sheets having a thickness of 1.9 mm (0.075 in.) minimum and 2.5 mm (0.100 in.) maximum. The “milling grain” shall be in the lengthwise direction of the specimen.

10.2 Duplicate test specimens shall be tested whenever possible.

**11. Procedure**

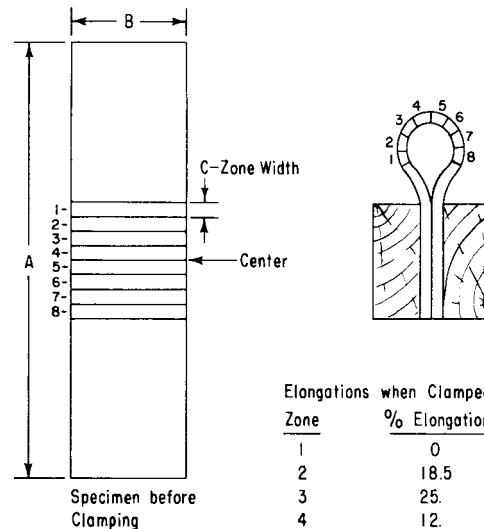
11.1 Loop the test specimens until their ends meet and then insert these ends between the paired wooden or aluminum strips until they are flush with the underside of the strips. The minimum distance between the specimens shall be 6 mm (0.25 in.). Clamp the wooden strips together by means of machine screws so that the specimens are firmly held in place. As a result of this procedure, 25 mm (1 in.) of each end of the specimen will be covered by the wooden strips, which will act as a protective shield. The remaining 43 mm (1.75 in.) of the specimen shall form a loop having a varying elongation along its length, as shown in Fig. 2.

11.2 Mount the rack of clamped specimens on the crosspieces attached to the base panel by passing the protruding machine screws of the panel between the paired wooden or aluminum strips and fastening them with nuts and washers, as shown in Fig. 3.

11.3 Expose the looped specimens to the weather and sunlight at an angle of 45° facing south, preferably on the roof of a building; or they may be exposed in a cabinet having an atmosphere in which the ozone content is controlled, as described in Test Method D 1149.

11.3.1 Take note of the warnings in Test Method D 1149 regarding the hazardous nature of ozone if an ozone cabinet is used.

11.4 Record the date on which the tests were begun, and examine the specimens daily thereafter or as often as necessary, for the effect of sunlight weather or ozone, or both. Record the time of the appearance of checking as well as the time of appearance of initial surface cracking for each speci-



Elongations when Clamped	Zone	% Elongation
	1	0
	2	18.5
	3	25.
	4	12.
	5	12.
	6	25.
	7	18.5
	8	0

	A	B	C
mm	95	25	3.2
in.	3¾	1	0.125

**FIG. 2 Cross-Sectional View of Mounted Looped Specimen Showing Elongation at Different Parts, Procedure B**

men. Observations shall be made with a 7 × magnifying glass. If desired, the exposure may subsequently be continued for the purpose of observing the rate of growth of the cracks or the development of any characteristic or unusual surface effect.

**12. Report**

12.1 Report the results in accordance with Section 8.

**METHOD C—EXPOSURE OF TAPERED SPECIMENS**

**13. Apparatus**

13.1 *Mounting Frames*—Wooden frames for mounting the test specimens shall have the following dimensions: inside width, 100 mm (4 in.); overall width, 175 mm (7 in.); inside length, 300 mm (12 in.); overall length, 380 mm (15 in.). For constructing the frames, 25 mm (1 in.) thick medium softwood shall be used, and the members shall be joined with dowels using waterproof glue for the bond. The frame shall be planed smooth and painted with two coats of clear lacquer<sup>3</sup> or spar varnish.

13.2 *Fasteners*—Aluminum tacks, size No. 6, made from Alloy No. 51-S, or stainless steel staples for fastening the specimens to the wooden frame.

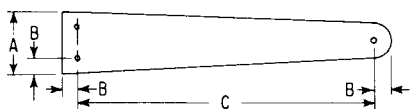
13.3 *Angle Strips*—Aluminum strips 38 mm (1.5 in.) wide and of approximately No. 22 gage, for shielding the specimens. Strips made from commercial Alloy No. 2-S are suitable.

**14. Test Specimens**

14.1 The test specimens shall be die-cut tapered strips having outside dimensions as shown in Fig. 4, cut from standard laboratory test sheets having a thickness of 1.9 mm (0.075 in.) minimum and 2.5 mm (0.100 in.) maximum. The grain shall be in the lengthwise direction of the specimen.



FIG. 3 Assembled Panel, Showing Method of Mounting Looped Specimens



	A	B	C
mmin.	25	6	125
Sections	1	0.25	5

FIG. 4 Die-Cut Tapered Specimen

14.2 Duplicate test specimens shall be tested whenever possible.

15. Procedure

15.1 Place an identification mark on the broad end of each test specimen, using materials that will not have a deleterious effect on the specimens during aging and that shall not extend beyond the area covered by the aluminum angle strips.

15.2 Superimpose upon the specimen a template conforming to the dimensions shown in Fig. 4, and mark the specimen with a sharp pointed pencil to conform with the holes in the template.

15.3 Draw parallel lines on the frame at the desired distance to give the required overall elongation in accordance with the following table:

Overall Elongation, %	Distance Between Parallel Lines, mm (in.)
10	140 (5.5)
15	146 (5.75)
20	152 (6.0)

Fasten the stretched specimen to the frame in such a manner that the fasteners or staples driven through the pencilled dots on the specimen will coincide with the awl points on the two lines. These awl points are spaced according to the holes in a template for the required elongation, as shown in Fig. 5. Because of the taper, the elongation for any one area will vary with the width of the strip. By placing bench marks at regular intervals along the center line of the tapered strip prior to stretching, it is possible to determine the percentage elongation for any given area by measuring the distance between the bench marks after the strip has been elongated, and applying the following formula:

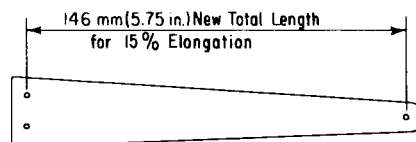


FIG. 5 Template for Spacing Holes in Frame for Mounting Elongated Specimens (Template Shown is for 15 % Elongation)

$$\text{Elongation, \%} = [(L_a - L_o)/L_o] \times 100 \tag{1}$$

where:

$L_a$  = length after stretching, and

$L_o$  = length before stretching.

15.4 After the specimens have been mounted, mount the aluminum shield on each of the long sides so that the tacks holding the specimens and the markings are covered.

15.5 Expose the extended specimens to the weather and sunlight at an angle of 45° with the horizontal facing south, preferably on a roof of a building; or they may be exposed in a cabinet having an atmosphere in which the ozone content is controlled, as described in Test Method D 1149.

15.5.1 Take note of the warnings in Test Method D 1149 regarding the hazardous nature of ozone if an ozone cabinet is used.

15.6 Record the date on which the tests were begun, and examine the specimens daily thereafter, for the effects of ozone. Observation shall be made with a 7-power magnifying glass. Record the time of the appearance of the first minute surface cracks on each specimen. If desired, the exposure may subsequently be continued for the purpose of observing the rate of growth of the cracks or the development of any characteristic or unusual surface effects.

16. Report

16.1 Report the results in accordance with Section 8.

17. Precision and Bias

17.1 Since all three methods yield essentially qualitative comparison data, candidate test compound versus a control, precision as normally expressed for quantitative measurement test methods is not directly applicable.

 **D 518**

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