

**RUBBER - DEGRADATION BY OZONE****PROCEDURE A: STATIC-STRAIGHT****PROCEDURE B: STATIC-MANDREL****PROCEDURE C: STATIC-SIMULATED INSTALLATION****PROCEDURE D: DYNAMIC FLEX-SEVERE SERVICE-BENT LOOP****Application**

These procedures are used to assess the resistance of rubber materials to accelerated ozone attack. These procedures are for estimating the comparative ability of elastomeric materials to withstand the effects of cracking in a controlled ozone environment when held under constant strain or when subjected to dynamic strain. Tests can be performed on flat sheet (slab stock), standard specimens prepared from parts, or actual parts.

Apparatus and Materials Required**Ozone Test Cabinet**

The cabinet interior shall be constructed of a material that will not be affected by ozone and shall be designed to allow suspending mounted test specimens without shielding or masking any specimen from the ozone/air flow. The ozone-air mixture must be introduced into the chamber and circulated in a manner that provides uniformity of temperature and ozone concentration throughout the chamber. The ozone concentration and chamber temperature shall be continuously controlled and recorded.

Equipment is available that automatically controls the ozone concentration, temperature, and provides a record of these conditions. As additional assurance of uniform ozone exposure over and above that which is provided by air handling provisions of the chamber, a moving specimen carrier for circulating the specimens along a predetermined path in a plane normal to the gas flow is permissible. Intake air should be filtered to remove particles. Dynamic flex apparatus in conformance to ASTM D1149 with adjustable shaft movement of 12 - 50 mm incorporated in the chamber design are recommended.

Unless defined in the applicable Engineering Materials Specification, Engineering Specification, or Engineering print, the following standard conditions are to be met:

Ozone concentration: 50 mPa partial pressure (50 +/- 5 pphm)

Temperature: 38 +/- 1 °C

Duration of exposure: 70 + 2 h

Air-Ozone replacement rate (throughput): 1.2 - 2.0 changes/minute

Air-Ozone velocity over specimens: 60 +/- 5 cm/s

Sources for equipment capable of meeting the requirements of this method are as follows:

SATRA Technology Centre
Wyndham Way, Telford Way
Kettering, Northamptonshire NN16 8SD
United Kingdom
www.satra.com

Mast Development Co.
2200 Dickerson Rd.
Reno, Nevada 89503
USA
www.mastdev.com

Date	Action	Revisions
2018 04 18	Revised	See Summary of Revisions L. Pollard, NA
2001 08 23	Revised	Editorial – no technical change A. Cockman
1991 10 03		



OREC
221 Beaver St.
Akron, Ohio 44304
USA
www.orecozone.net

Clamps

For holding test specimens at the specified elongation and constructed from material inert to ozone - e.g. steel, aluminum, or polymethylmethacrylate.

Mandrels

For wrapping specimens to achieve specified surface elongation of rubber hose, tubing, weather-strip, etc., constructed from extruded aluminum tubing, varnished wood "dowel rod", steel rod or any material capable of retaining a known diameter and is inert to ozone.

Compression Plates

According to ASTM D 395 for compressing components, or portions of components, to simulate service conditions.

Ozone-Resistant Coatings

For protection of heavily-stressed areas adjacent to clamps or wire. It is recommended that all exposed rubber surfaces not required for evaluation be protected in order to minimize ozone stress-crack "relaxation" of the specimen in tension. Care should be taken to ensure that the area of the specimen to be evaluated is not contaminated with the protective coating. For the static procedures A, B, and C, a paraffin wax or water based coating verified to be a protective barrier against ozone may be used.

Magnifier

Hand-held/table-mounted 2X or 7X magnifier, or as specified in the engineering specification, and good light source.

Fixtures (various)

Fixtures of non-reactive materials to simulate service conditions for mounting specimens to a mobile test piece carrier in the chamber, mandrel mounting, clamps and brackets for dynamic ozone testing, and actual component assemblies for installations of elastomeric parts according to simulated in service conditions.

Specimen Holder

Per ASTM D 1149, a device, constructed of a material with minimal reaction to ozone, such as stainless steel or aluminum, with dimensions suitable to stretch the test specimen 20 +/- 2% and allowing for a minimum space between specimens of 3.2 mm. The specimen grip area shall be grooved or crosshatched to prevent slippage. Available from CCS Instruments, Inc. (<http://www.ccsi-inc.com>) (or equivalent). Refer to Figure 1.

Flexible Scale

Typical plastic "pocket scale" graduated in 1 mm divisions for measuring distance increase between bench marks on both straight and mandrel-mounted specimens.

Marking Devices

For applying "bench marks" to establish elongation of specimens. Marking techniques may include use of aluminum powder with wedge applicators, and light-colored opaque inks and vinyl "flags" for dark materials or various dark ink pens for light materials.

**Fastening Wire**

Non-reactive wire for securing mandrel-mounted specimens. See Figure 2.

Chemicals, materials, parts, and equipment referenced in this document must be used and handled properly. Each party is responsible for determining proper use and handling in its facilities.

Conditioning and Test Conditions

All test values indicated herein are based on material conditioned in a controlled atmosphere of 23 +/- 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.

Procedure**Conditioning**

Minimal handling of the specimens during and after installation into test fixturing is recommended in order to not disturb protective anti-ozonants that migrate to the polymer surface. Coat non-test areas with ozone-resistant coating as appropriate (see Ozone Resistant Coatings section of Apparatus). Unless otherwise specified, the pre-stressed materials are to be conditioned according to ASTM D 1349 at 23 +/- 2 °C and 50 +/- 5 % RH for 24 h minimum in a draft free plastic bag and stored in a light free environment, e.g. drawer or empty oven. Note: Omit conditioning for dynamic testing (Procedure D) unless otherwise specified.

Procedure A (Static-Straight)

Prepare test specimens from slab materials or actual parts into either uniform width and thickness or tensile-shaped (ASTM D 412 and ISO 37) specimens. For straight specimens, cut into lengthwise strips by sharp die or surgical blade and metal guide to a uniform width of 2.0 - 12.0 mm and a length of not less than 35 mm. Unless otherwise specified, strain to an elongation of 20 +/- 2%, established by the measurement of "bench marks" placed upon the specimen and measured according to ASTM D 412 and ISO 37. Elongate specimens as described in ASTM D 1149 using wood mounting blocks, clamps, frames, or other suitable means of achieving accurate elongations (see Figure 1). Report die type or sample dimensions and observe for cracking with specified magnification prior to specimen relaxation after exposure.

Note 1: Testing of straight specimens imparts greater stress at the clamping region than that of tensile-shaped specimens making the use of protective coatings in the clamp region advisable.

Procedure B (Static-Mandrel)

Continuous extrusions (or molded, if of sufficient length) of hose, tube, weatherstrip and composite constructions that would otherwise be difficult or impractical to elongate by Procedure A may be evaluated by wrapping about a mandrel. Select a mandrel of suitable diameter to elongate the surface 20 +/- 2% unless otherwise specified. Determine elongation by observing the increased distance between initial "bench marks" (10 mm minimum, 50 mm maximum) applied to a relaxed sample to the nearest 1 mm and secure the assembly by wire or any inert fastening (see Figure 2).

Note 1: Because accurate measurement of the increase in distance between benchmarks when on the mandrel becomes increasingly difficult as thickness becomes less, the use of Procedure A is encouraged when evaluating unreinforced slab or sheet materials that are easily elongated.