



AEROSPACE INFORMATION REPORT

AIR4738™**REV. B**

Issued 1992-10
Revised 2020-04
Reaffirmed 2025-11

Superseding AIR4738A

(R) Hardness Testing of Elastomeric O-Rings

RATIONALE

Five-Year Review. Significant additional information added to bring this AIR up to current information.

AIR4738B has been reaffirmed to comply with the SAE Five-Year Review policy.

FOREWORD

Hardness measurements are widely used in the elastomer industry as a basic specification requirement, especially for procurement purposes. Hardness tests are referenced in specifications for the following purposes:

- To specify elastic modulus (stiffness), though a simple one-to-one correlation between hardness and elastic modulus does not exist. Different formulations of even the same elastomer type with the same hardness can exhibit substantially different modulus values.
- As a quality assurance measure.
- To determine property changes due to time, heat, or fluid immersion.

Standard test methods have been developed which utilize a flat, parallel faced specimen of a minimum thickness, but for quality assurance and property changes, it is often desirable to test production O-rings. Three standard methods for testing the hardness of O-rings have been developed and are described in ASTM D1414, ASTM D1415, and ASTM D2240. Test apparatus has also been developed specifically to test O-rings. Hardness measurements on O-rings do not necessarily give the same results as those obtained on standard flat test pieces and the reproducibility of results is inferior.

1. SCOPE

This SAE Aerospace Information Report (AIR) provides a general description of methods for hardness testing of O-rings including factors which affect precision and comparison of results with those obtained in standard tests.

1.1 Purpose

To provide information on methods for hardness testing of O-rings.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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Documents

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2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D1414 Standard Test Methods for Rubber O-Rings

ASTM D1415 Standard Test Method for Rubber Property - International Hardness

ASTM D2240 Standard Test Method for Rubber Property - Durometer Hardness

Bafna, S., "A Comparison of Type A and Type M Hardness Measurements on Commercial Fluorocarbon Grades Conforming to AMS7276," ASTM Journal of Testing and Evaluation (JOTE), 49 (2) 2021 [in press]; published online on January 3, 2019.

2.2 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS1613 Packing, Preformed, Ethylene Propylene Rubber

2.3 Other Publications

Bafna, S., "Factors Influencing Hardness and Compression Set Measurements on O-Rings," Polymer-Plastics Technology and Engineering, 52, 2013, pp. 1069-1073.

R. P. Brown, "Physical Testing of Rubbers," Elsevier Applied Science.

Tuckner, P., "A Parametric Evaluation of Hardness, Compression Set and Compression Stress Relaxation," presented at the 182nd Technical Meeting of the Rubber Division of American Chemical Society, Cincinnati 9-11 October 2012 [Paper No. 91].

3. DISCUSSION

3.1 Test Methods

Due to the difficulty of preparing a parallel faced flat specimen from an O-ring, tests are conducted on the curved surface of the ring. To minimize testing error, it is essential that the apparatus provide:

- a. A means of providing a constant load on the indenter.
- b. Control of the rate at which the indenter contacts the surface of the O-ring.
- c. A jig to prevent the ring from moving laterally.
- d. A method of aligning the indenter above the thickest cross-section of the O-ring.

Test apparatus is available which meets the above criteria and a suitable jig is described in ASTM D1414.

3.2 Comparison of ASTM D2240 Type A, Type M, and IRHD Type M on O-Rings

When using an ASTM D2240 Type M microhardness test instrument on O-rings, the results obtained are not necessarily the same as those obtained on the same compound using a standard test instrument on hardness buttons per Type A; this has been demonstrated in Bafna (2013). Variations in the results between the two methods are influenced by a number of factors such as O-ring cross section, elastomer type, and formulation. It is important to recognize this difference because most rubber specifications use the hardness Type A scale (ASTM D2240) measured on disks or plied platens to specify the required hardness range.