



AEROSPACE RECOMMENDED PRACTICE	ARP3050™	REV. A
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	Superseded by AS6837	
Suitable Test Sizes for O-Ring Specifications		

RATIONALE

This document is being cancelled and replaced by AS6837, which has already been published. This cancellation was unanimously approved by vote at CE Spring 2021 Meeting on May 12, 2021. The Aerospace Council has also approved this cancellation.

CANCELLATION NOTICE

This Technical Report has been declared "CANCELLED" as of September, 2021 and has been superseded by AS6837. By this action, this document will remain listed in the respective index, if applicable. Cancelled Technical Reports are available from SAE.

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1. SCOPE

1.1 Purpose

There are many tests that have been developed to characterize rubber O-rings. Many of these tests are independent of the size of the O-ring being tested. However, there are some tests, specifically, stress/strain properties, that are a function of the O-ring's size. The purpose of this report is to provide guidelines for specifying O-rings that would be considered "suitable for testing" when writing O-ring material specifications.

1.2 Background

The vast majority of O-ring specifications written to date do not specify a specific O-ring size as the appropriate test specimen. Typically, phrases like "the finished part," "if of suitable size," or "the end item" are used when conformance testing is referred to. Currently, this situation is handled by the O-ring manufacturer on a case-by-case basis through discussions with the customer. The reason why this is problematic is that physical properties can change as the O-ring size being tested changes. It should be noted that some polymer families are more sensitive to this phenomenon than others.

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.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS568B Aerospace Standard for O-rings

2.2 ASTM Publications

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

ASTM D 1418 Standard Practice for Rubber and Rubber Latices - Nomenclature

3. DISCUSSION

As the size of the O-ring being tested changes, there are a number of factors that can affect the results obtained and, therefore, must be considered prior to writing a statistically stable specification. Some of these factors include:

3.1 Overall Dimensions of the O-ring

O-rings are available in a huge variety of sizes, both large and small. As a result, there are practical limitations in what sizes would be deemed suitable for testing. Very small inside diameters do not fit on standard test spools and are, therefore, deemed unsuitable for testing. Similarly, very large inside diameter O-rings cannot be tested on conventional tensile testing equipment due to crosshead travel limitations and, therefore, are considered unsuitable for testing. Finally, very large cross-section O-rings may not fit on standard size spools and would, therefore, pose unique testing challenges.

3.2 Test Apparatus Limitations

Stress/strain testing machines are typically available in two varieties: table model or floor model. The limiting factor of both models, as it relates to O-ring tensile testing, is that of crosshead "travel." This common term is defined as the total distance that the crosshead can travel within the constraints of the test frame itself. This simple fact can determine very quickly whether or not a very high elongation material can even be tested on a specific tensile testing machine. In the O-ring testing community there are typically three standard spool diameters used for testing (1/8th, 1/4th, and 1/2 in nominally). In addition, most test labs have grips that are used for testing segments of very large diameter O-rings. This testing is typically called single strand segment testing. Any O-ring size that does not fit conveniently on one of these spools or grips would be considered unsuitable for testing. It should be noted that the crosshead travel rate has a very large influence on the data generated for a given O-ring compound and size. Simply stated, different strain rates yield different results. For this reason, ASTM and ISO have specified a standard strain rate of 20 in/min. In special instances, other strain rates may be used, but these variations must be evaluated on a case-by-case basis.

3.3 Material Mixing Inhomogeneities

Rubber mixing is a physical mastication process. As a result, there are areas in any batch of rubber that exhibits material ingredient inhomogeneities. These regions may contain filler aggregates or polymer rich areas that may affect the stress/strain properties as tested. The larger the inside diameter of the O-ring being tested, the higher the statistical probability that one of these regions will cause a non-uniform stress concentration and cause a premature break. When it comes to specification writing there is basically two choices; limit the suitable test sizes or allow for the larger variations with testing larger inside diameter O-rings. These aggregate formations are indicative of batch-to-batch variations typical in rubber mixing. The statistical probability of these stress "risers" increases proportionally with the volume of rubber being tested.

3.4 Differing Material Formulations

Different elastomeric formulations exhibit differing stress/strain responses. Depending on the degree of difference, the sizes that would be deemed suitable will change accordingly. In other instances, very large cross-section O-rings made out of specialty materials may exhibit mechanical properties that would be out of the range of the load cells for the tensile testing equipment. Finally, materials that have very high elongation characteristics may be deemed unsuitable for testing due to the fact that there is not enough crosshead travel length to accommodate their high elongation characteristics. This situation becomes even more troublesome when testing is performed on single strand O-ring specimens exhibiting large elongation.

4. GUIDELINES

4.1 Guidelines for Suitable Test Sizes

Below are a series of tables that offer recommendations for suitable test sizes for O-rings for a variety of instances. Keep in mind that these are recommendations for use when generating material testing requirements for industry specifications. Special fixturing is available to test O-rings that are outside the recommendations in the following tables. However, these situations would be considered outside the scope of an industry guideline for specification writing and are, therefore, not considered in this document. The tables that follow are based on the following general guidelines. Most O-ring materials will fall into one of the following categories. For materials that do not, empirical testing would be required in order to establish suitable test sizes.

- O-ring inside diameter nominal range of 0.300 to 6.000 in
- O-ring cross-sections of 0.070, 0.103, 0.139, 0.210, 0.275 in
- Strain rate of 20 in/min
- O-ring size standard AS568B
- Compound nomenclature per ASTM D 1418
- 3 spool diameters based on cross-section
- Single strand recommendations independent of compound and cross-section

TABLE 1 - SUITABLE TEST SIZES FOR NBR, HNBR, SBR MATERIALS

O-ring Cross-section (in) 2-XXX	AS568B Size Designation
0.070	-011 through -050
0.103	-110 through -163
0.139	-204 through -256
0.210	-309 through -361
0.275	-425 through -437
Plus all -9XX sizes except -901 through -903	

TABLE 2 - SUITABLE TEST SIZES FOR EPDM, IIR, CR MATERIALS

O-ring Cross-section (in) 2-XXX	AS568B Size Designation
0.070	-011 through -049
0.103	-110 through -159
0.139	-204 through -250
0.210	-309 through -353
0.275	-425 through -430
Plus all -9XX sizes except -901 through -903	