



Standard Test Methods for Measurement of Torque Retention for Packages with Continuous Thread Closures Using Non-Automated (Manual) Torque Testing Equipment¹

This standard is issued under the fixed designation D2063/D2063M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 These test methods evaluate the torque retention of continuous thread closures on containers, with matching finishes, for predetermined environmental conditions over time.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

NOTE 1—The SI unit system is the recommended system.

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:²

D996 Terminology of Packaging and Distribution Environments

D3198 Test Method for Application and Removal Torque of Threaded or Lug-Style Closures

D3474 Practice for Calibration and Use of Torque Meters Used in Packaging Applications

D4169 Practice for Performance Testing of Shipping Containers and Systems

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

E41 Terminology Relating To Conditioning

E171 Specification for Atmospheres for Conditioning and Testing Flexible Barrier Materials

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 Definitions:

3.1.1 For definitions of general packaging and distribution terms, see Terminology **D996**.

3.1.2 For definitions of application torque and removal torque, see Test Method **D3198**.

3.1.3 For Definitions regarding conditioning, see Terminology **E41**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *immediate removal torque*—removal torque that is measured at a stated interval, from 1 to 5 min after closure application.

3.2.2 *torque retention*—a comparison between removal torque at the end of a test period and a predetermined immediate removal torque.

4. Summary of Test Methods

4.1 *Test Method A: Static Evaluation*—At predetermined time intervals, the removal torques of representative samples of a container/continuous thread closure system, previously stored at various environmental conditions, are measured.

4.2 *Test Method B: Dynamic Evaluation*—Practice **D4169** is used to develop a uniform system of evaluating the ability of primary packages, in the shipping units, to withstand the distribution environment. At the end of predetermined distribution cycles, the removal torques of representative samples of a container/continuous thread closure system are measured.

5. Significance and Use

5.1 This test method allows for the measurement of the torque retention properties of container/continuous thread closure systems of various designs, materials, and manufacture, and is suitable for packaging development and engineering evaluation.

¹ These test methods are under the jurisdiction of ASTM Committee **D10** on Packaging and are the direct responsibility of Subcommittee **D10.32** on Consumer, Pharmaceutical and Medical Packaging.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



5.2 This test method can be used for the evaluation of container/continuous thread closure systems under controlled conditions (where the application torque is known and the applied downward force to the closure is zero).

5.3 This test method measures torque retention properties of container/continuous thread closure systems with the use of a non-automated, spring torque-meter (with either a dial indicator or a digital readout) or a torque wrench.

6. Apparatus

6.1 *Non-automated Spring Torque Meter*, with an appropriate scale that accurately measures within the expected torque range for the particular container/continuous thread closure system to be evaluated.

6.1.1 Torque meter, if used, will have a scale where the anticipated torque readings are not less than one-third of the maximum range of the scale for the container/continuous thread closure system to be evaluated. Torque results will be available in a visual format.

6.1.2 A torque wrench, if used, will have an appropriate design and capacity capable of providing a reading within the anticipated range for the container/continuous thread closure system to be evaluated. Torque results will be available in a visual format.

7. Sampling and Test Specimens

7.1 Measure no less than ten test specimens for each torque measurement point per test variable.

7.2 Select previously unused continuous thread closures and containers as test specimens.

8. Calibration

8.1 Calibrate spring torque meters in accordance with the procedures of Practice **D3474**.

9. Conditioning and Preparation of Test Specimens

9.1 Perform test specimen conditioning in accordance with Specification **E171** and Practice **D4332**.

9.2 Fill all of the containers with the specified volume or weight of product, or other materials that yield similar weight and thermal characteristics. See **Note 2** and **Note 3**.

NOTE 2—The total quantity of test specimens sampled will depend upon the method selected and the number of environmental storage conditions.

NOTE 3—Given the purpose of the evaluation, empty containers may be used as an option to filled containers.

10. Procedure (See **Note 5)**

10.1 Test A: Static Evaluation:

10.1.1 Select the minimum application torque for the container/continuous thread system as recommended by the closure manufacturer. (For example, the U.S. Pharmacopæia, the Society for the Plastics Industry, the Glass Container Manufacturers Institute, or other sources.)

10.1.2 Firmly position the container or closure in such a manner that the axis of rotation of the closure is concentric with the center of the torque measuring device. See **Note 4**.

NOTE 4—It is recommended that one operator, and a single torque

instrument be used to apply all closures in any one test to reduce possible operator/instrument inconsistencies and variabilities.

10.1.2.1 Exercise care in positioning the container or closure to prevent distortion of either component.

NOTE 5—Under certain conditions of product-filling, storage and distribution, it may be desirable to combine appropriate segments of Test Method A and Test Method B.

10.1.3 Avoiding contact with the fixed component, grip the movable component (normally the continuous thread closure) and rotate it at a constant and uniform rate, in a tightening direction, to the predetermined application torque.

10.1.4 Release the movable component (normally the continuous thread closure) upon reaching the desired torque. See **Note 6**.

10.1.5 Apply the balance of the closures or containers to the matching components as directed in **10.1.2**, **10.1.3**, and **10.1.4**.

10.1.6 Store the assembled test specimens as appropriate in accordance with Specification **E171** or Practice **D4332**.

10.1.6.1 Maintain one group of test specimens as a control by storing this group at ambient laboratory conditions. See **Note 6**.

NOTE 6—The application torque range is usually determined on the basis of the desired removal torque range.

10.1.6.2 Maintain, as appropriate, one or more groups of test specimens at constant temperatures different than ambient laboratory conditions. If desired, cycling at various temperature and relative humidity conditions may be performed.

10.1.7 At the end of each predetermined time period, determine the removal torque for each test sample.

10.1.7.1 Determine the removal torques either at ambient laboratory conditions or at the alternative temperature and relative humidity conditions.

10.1.7.2 The following test intervals are recommended: immediate (between 1 and 5 minutes), 24 h, 48 h, 7 days, 14 days, and 28 days. See **Note 7**.

NOTE 7—Sterilization cycles, if applied, using steam, ethylene oxide, gamma radiation, or other methods are known to affect certain plastics; these effects may influence removal torques.

10.1.8 Determine the removal torque for each test specimen by firmly positioning either the container or the continuous thread closure in such a manner that the axis of rotation of the closure is concentric with the center of the measuring device.

10.1.8.1 Exercise care in positioning the container or continuous thread closure to prevent distortion of either component.

10.1.9 Avoiding contact with the fixed component, grip the movable component (normally the continuous thread closure), and rotate it uniformly, at a constant rate, in a loosening direction until the continuous thread closure rotates freely. Note the maximum torque required to loosen the closure and record this value for the test specimen. See **Note 8**.

NOTE 8—It is recommended that one operator, and a single torque instrument, be used to remove all closures in a given test to reduce possible operator/instrument inconsistencies and variabilities.

10.1.10 Record the maximum torque required to loosen the closure for each remaining specimen.

10.1.11 Remove the balance of the movable components (normally the continuous thread closures) as directed in 10.1.8 and 10.1.9.

10.2 Test Method B: Dynamic Evaluation:

10.2.1 Follow the procedures of Practice D4169 for recommendations relevant to the number of test specimens, conditioning, and distribution cycles to be used to evaluate these test specimens.

10.2.2 Follow Section 8 on Calibration for test equipment calibration.

10.2.3 Follow Section 10 on Procedure (Test Method A) for recommendations concerning continuous thread closure application.

10.2.4 Begin evaluation of a selected distribution cycle after immediate removal torque has been determined and before any additional long-term storage, if long-term storage is desired. (Testing may be determined following distribution cycling with removal torques noted.)

11. Report

11.1 Report the following information:

11.1.1 Identification of the test method used.

11.1.2 Identification of the continuous thread closure and container manufacturer(s), the material(s) of construction of the closure (including any liner, liner coating, and additional sealing components), and the container (including any coating or annealing agents).

11.1.3 Thread finish and other designation(s) of the continuous thread closure and the container.

11.1.4 Description of test specimen preparation.

11.1.5 Description of storage conditions.

11.1.6 Description of distribution cycles and handling conditions.

11.1.7 Description of the test area environment.

11.1.8 Number of test replicates.

11.1.9 Application torque range and mean value for each test condition variable.

11.1.10 Removal torque range and mean value for each test condition variable.

11.1.11 Description of the torque instruments used.

11.1.12 Evaluation of comparative results, if appropriate.

11.1.13 Statement that testing was done in accordance with this test method or a description of the difference(s) from this test method.

12. Precision and Bias ³

12.1 Precision:

12.1.1 The repeatability and reproducibility are in accordance with the definitions of these terms in Practice E691 (at 95 % probability level). These values are based on an interlaboratory study involving six laboratories each of which measured removal torques of three different closures at the recommended six time intervals. (See Note 9.)

12.1.2 *Repeatability*— The difference between successive removal torque results, after 28 days of storage, obtained by the same operator with the same equipment unit under constant operating conditions on test packages from a single lot complying with given specifications, within a laboratory, was determined to be as follows (see Note 10):

	Test Package 1	Test Package 2	Test Package 3
Average	5.97 (0.68)	8.04 (0.92)	8.09 (0.92)
Repeatability	0.74	1.06	1.91
Standard deviation, <i>Sr</i> (within a laboratory)	(0.08)	(0.12)	(0.22)
95 % Limits	2.06	5.35	2.97

NOTE 9—See Research Report RR:D10-1005 for a complete description of the interlaboratory/intralaboratory evaluation of this test method.

NOTE 10—Initial values are expressed in torque inch pounds-force; values in parentheses are expressed in Newton-metres.

12.1.3 *Reproducibility*— The difference between successive removal torque results, after 28 days of storage, obtained by different operators with different equipment units under constant operating conditions on test packages from a single lot complying with given specifications in different laboratories, was determined to be as follows (see Note 10):

	Test Package 1	Test Package 2	Test Package 3
Average	5.97 (0.68)	8.04 (0.92)	8.09 (0.92)
Reproducibility	1.992	2.932	2.605
Standard deviation, <i>SR</i> (between laboratories)	(0.23)	(0.33)	(0.29)
95 % Limits	5.55	7.14	8.17

12.2 *Bias*—Since there is no accepted reference component suitable for determining the bias for the procedure in this test method for measuring torque retention, no statement on bias is being made.

13. Keywords

13.1 continuous thread closure; removal torque; retention

³ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D10-1005.



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