Maximum Performance (MaP) Testing
Toilet Fixture Performance Testing Protocol[1]
Version 6 – June 2016

1.0 Purpose and Scope of MaP Testing

1.1 Purpose

1.1.1 The purpose of this specification is to measure the maximum bulk waste removal flush performance of all types of toilet (water closet) models.

1.1.2 In addition, tank-type gravity-fed models are to be evaluated to meet criteria for flush volume adjustability and fill valve performance.

1.2 Scope

The three (3) elements of this specification cover the following toilet fixture designs:

1.2.1 Bulk waste removal – All toilet models measured according to the Maximum Performance (MaP) Testing Protocol in Sections 2.0 and 3.0.

1.2.2 Flush volume adjustability and maximum water consumption – Tank-type gravity-fed toilet fixtures measured according to the testing protocols in Sections 5.0 and 6.0.

1.2.3 Fill valve integrity - Tank-type gravity-fed toilet fixtures measured according to the protocol in Section 7.0.

1.3 Reference Standards and Specifications

The following documents form a part of this specification to the extent specified herein (the latest approved version shall apply):

ASME A112.19.2/CSA B45.1 – Ceramic Plumbing Fixtures

ASME A112.19.14 - Six-Liter Water Closets Equipped with a Dual Flushing Device

ASME A112.19.5/CSA B45.15 - Flush valves and spuds for water closets, urinals, and tanks

ASSE 1002/ASME A112.1002/CSA B125.12 – Anti-siphon Fill Valves (Ballcocks) for Gravity Water Closet Flush Tanks

U.S. EPA WaterSense® Program – WaterSense® Specification v.1.2 for Tank-Type Toilets

2.0 MaP Testing Protocol

2.1 Performance Requirements

2.1.1 Toilet model maximum performance (MaP) level is identified as the maximum media loading (in discrete increments expressed in grams) at which a toilet model successfully clears all test media from fixture in at least four of five attempts when cased media is used and in at least two of three attempts when raw (uncased) media is used.

2.1.2 Tests where test sample clogs, plugs, or fails to restore a minimum of a 2-in. (50mm) trap seal after each test will be deemed a failed test.

[1] For further information on or clarification of this test protocol, contact the following individuals:
Bill Gauley, P.Eng., Gauley Associates, Ltd. bill@gauley.ca
John Koeller, P.E., Koeller and Company jkoeller@map-testing.com

2.2 Test Media

2.2.1 MaP test media is comprised of either of the following:

2.2.1.1 Cased Media: One or more 50 ± 4g test specimens ("test specimen") consisting of soybean paste contained in latex casing, tied at each end forming a 'sausage', and meeting the requirements of Section 4.2, and four loosely crumpled balls of toilet paper ("paper"), or

2.2.1.2 Uncased (Raw) Media: One or more 50 ± 4g test specimen ("test specimen") consisting of extruded soybean paste meeting the requirements of Section 4.1 and four loosely crumpled balls of toilet paper ("paper").

2.2.2 Each test specimen shall be 100 ± 13mm in length and 25 ± 6mm in diameter[2].

2.2.3 Unless otherwise specified, all MaP testing shall be completed using cased media; however, the client may choose, at their discretion, to have fixture samples tested with uncased test media.

2.3 Fixture Model Sample Selection

2.3.1 A single randomly selected sample of each toilet model ("sample") is required for testing.

2.3.2 Any toilet model not *certified* to the applicable plumbing standards as specified in Section 5.0 shall be identified as a "Prototype Model".

2.4 Set-Up

2.4.1 Samples shall be assembled according to manufacturer's written instructions as contained within the product packaging, and placed on test apparatus (rig), ensuring tank and bowl are level.

2.4.2 Tank water level shall be adjusted to the level specified by manufacturer in the manufacturer's instructions (e.g., set to waterline).

2.4.3 Static water supply pressure shall be set to 50 ±3 PSIG.

2.4.4 Inlet water temperature shall be 15 ±10°C (59 ±18°F).

2.4.5 Samples shall be flushed a minimum of three times prior to commencement of testing.

2.4.6 Re-adjust tank water level to proper level if required.

2.5 Flush Volume Measurement

2.5.1 Measure and record flush volume of sample in accordance with *ASME A112.19.2-2013/CSA B45.1-13*, paragraphs 7.4.2 and 7.4.3.

2.5.2 Samples with measured flush volumes in excess of 0.10 gallons (0.4 litres) greater than their rated flush volume when adjusted to the indicated waterline shall be deemed to fail MaP testing requirements due to excessive flush volume.

2.5.3 Samples with measured flush volumes less than 0.10 gallons (0.4 litres) greater than their rated flush volume when adjusted to the indicated waterline shall be adjusted, if possible, to their rated flush volume prior to performance testing. The rated flush volume shall be recorded on the MaP test report.

2.5.4 Samples with measured flush volumes less than their rated flush volume shall be tested at their measured volume and this volume shall be recorded on the MaP test report.

2.6 Waste Extraction Test

2.6.1 Cased test specimens shall be formed such that they are roughly cylindrical in shape and uniform in diameter. Uncased test specimens shall be extruded such that they are cylindrical.

[2] Approximately 4 ± 0.5 inches in length and 1 ± 0.25 inches in diameter

2.6.2 A test specimen drop guide shall be placed across the top of the bowl, with a 50mm (2-in.) diameter opening positioned 150 mm (6-in.) in front of the center of the seat post holes, equidistance from each hole. Drop guide may be made of plastic or other rigid material, to be no more than 12mm (0.5-in.) thick, and be of sufficient length to span the top of the toilet bowl.

2.6.3 Soybean paste test specimens shall be freely dropped in a vertical orientation into bowl through opening in drop guide. Test specimen should be held in such a way that approximately half of the specimen protrudes through the opening in the drop guide prior to release into the bowl. Additional test specimens shall be added, as required, to achieve desired mass loading. Record total mass loading (number of test specimens x 50g each).

2.6.4 Freely drop four balls of crumpled toilet paper through drop guide opening.

2.6.5 Wait 10 ± 1 seconds.

2.6.6 Flush sample. Collect discharged media in strainer or other suitable container positioned below toilet fixture.

2.6.7 Record test as Pass or Fail (test is a Fail if any waste remains in the bowl or trap, or if minimum 50mm (2-in.) trap seal has not been restored).

2.6.7.1 If cased media is used (reference section 2.2.1.1), remove (rinse) discharged toilet paper from test specimens, and re-form and prepare test specimens for further testing.

2.6.7.2 If uncased (raw) media (reference section 2.2.1.2) is used, discard discharged media into waste receptacle or other suitable container.

2.6.7.3 Flush sample to clean bowl and trapway and fully restore trap seal.

2.6.8 Increase (or decrease) mass loading, as required, and repeat waste extraction test until such time as the maximum loading has been reached as described in paragraph 2.4.11. Testing shall be completed at the following intervals:

350g, 400g, 500g, 600g, 800g, and 1000g.

2.6.8.1 No testing shall be conducted at a mass loading greater than 1,000g.

2.6.9 Record highest mass loading at which toilet test sample successfully removed all test media from fixture and restored minimum 2-in. (51mm) trap seal in at least four of five attempts when cased media is used or two of three attempts when raw (uncased) media is used. This loading represents the maximum performance level for the test sample (i.e., the "MaP score").

2.7 Trap Diameter Ball Pass

2.7.1 The toilet trap diameter shall be measured by passing solid balls with known diameters in 1/8-inch (3.175-mm) increments through the trap.

2.7.2 The toilet trap diameter ball pass shall be listed as equivalent to the diameter of the largest ball that can pass completely through the tap.

3.0 MaP 'PREMIUM' Rating

3.1 Tank-type toilet models may be eligible to carry the MaP PREMIUM rating if:

3.1.1 they are certified to the U.S. EPA "WaterSense Specification for Tank-Type Toilets", and

3.1.2 they achieve a maximum performance (MaP) score of at least 600g, and

3.1.3 dual-flush toilet model functions with a rated flush volume not exceeding 4.8 litres (1.28 gallons) on the full flush, and

3.1.4 they operate with a rated/effective flush volume[3] of no more than 4.0 litres (1.1 gallons)[4]

[3] The 'effective flush volume' for 'PREMIUM' rated dual-flush toilets shall be the average of one full flush and one reduced flush.

3.2 NOTE: The determination of a 'PREMIUM' rating shall be made solely by MaP-testing.com based upon the results of Sections 2.0, 5.0, 6.0, and 7.0 herein as reported by the testing laboratory.

[4] MaP PREMIUM rounds flush volumes to a single decimal place. While we recognize that 1.1 gallons is slightly greater than 4.0 litres, it is our professional opinion that this difference is not materially significant.

4.0 MaP Test Media Specifications[5]

4.1 Soybean paste nominal specifications – uncased test media:

4.1.1 35.5% water, 33.8% soybean, 18.5% rice, and 12.2% salt, and having a density of 1.15 ± 0.10 g/mL (i.e., density greater than water).

4.2 Cased Test Media:

4.2.1 Latex casing shall be made from non-lubricated latex condoms (e.g., LifeStyles® brand, purchased from Ansell Healthcare Products LLC, Dothan, AL 36303 USA).

4.2.2 Cord used to tie casing shall be 1.0mm diameter polymer cord that will not crack or harden with time (e.g., Stretch Magic Bead & Jewelry Cord, Pepperell Braiding Company, P.O. Box 1487, Peperell, MA 01463, 800-343-8114)

4.2.3 Each test specimen shall have a mass of 50 ± 4g and meet the specifications of Section 4.1.

4.2.4 Test specimens should be stored in air-tight containers and refrigerated when not in use. A damp sponge should be placed in bottom of container to prevent test specimen drying.

4.2.5 Temperature of test specimens during testing shall be shall be 15 ±10°C (59 ±18°F).

4.2.6 Test specimens that have been stored in a refrigerator shall be acclimatized by flushing each specimen a minimum of three times prior to conducting MaP testing.

4.2.7 Individual test specimens shall be discarded after they have been subjected to 50 flushes.

4.2.8 Test specimens with rips, tears, punctures, etc. shall not be used.

4.2.9 Test specimens that are damaged in any way shall not be used.

4.2.10 Test specimens may contain small volumes of air, however, specimens that float shall not be used.

4.3 Toilet paper specifications:

4.3.1 Each ball of paper is comprised of six sheets of single ply toilet paper conforming to ASME *A112.19.14–2013*, section 3.2.4.1. In the absence of toilet paper compliant with the dimensional requirements of 4.5 in. x 4.5 in. (114 mm x 114 mm), a paper of equivalent surface area shall be used, 20.25 square inches (130 square centimeters).

[5] NOTE: Bulk test media (soybean paste) or cased test specimens (ready-to-use) may be purchased from: Gauley Associates, Ltd., Acton, Ontario, Canada; phone 416-677-6193, email bill@gauley.ca

5.0 General Requirements

IMPORTANT NOTE: *Compliance with the U.S. EPA WaterSense Program "WaterSense Specification for Tank-Type Toilets" v.1.2, shall fully satisfy the requirements of this Section 5.0.*

5.1 All toilets must conform to the latest ANSI-approved version of *ASME A112.19.2/CSA B45.1,* and all dual-flush toilets must also conform to the latest ANSI-approved version of *ASME A112.19.14*.

5.2 The criteria in this Section 5.2 apply only to tank-type gravity toilets.

5.2.1 Must conform to the latest approved version of *ASME A112.19.5/CSA B45.15*.

5.2.2 The fill valve shall be pilot valve-type only, or, alternatively, the fill valve shall meet the performance requirements of the fill valve test protocol in Section 7.0. All fill valves must conform to the latest ANSI-approved version of *ASSE 1002/ASME A112.1002/CSA B125.12.*

5.2.3 Any barrier, bucket, dam, displacement device, or similar fixture used in a toilet tank to affect flush volume shall be tamper-resistant and permanently affixed to the tank. Any device that can be tampered with or removed such that the toilet can be made to flush with greater than the maximum flush volumes specified in Section 6.1 shall be deemed noncompliant.

6.0 Flush Volume Adjustability and Maximum Water Consumption Test[6]

IMPORTANT NOTE: *Compliance with the U.S. EPA WaterSense® Program "WaterSense® Specification for Tank-Type Toilets" v.1.2, shall fully satisfy the requirements of this Section 6.0.*

All tank-type gravity toilet fixtures with flush valve seals must conform to the requirements of Section 6.1, which address the adjustability of original equipment tank trim and the resulting flush volume of the toilet fixture.

All tank-type gravity toilet fixtures with flush valve seals must conform to the requirements of Section 6.3, which address the flush volume resulting from the replacement of original equipment seals with seals available in the after-market.

6.1 Tank-Type Gravity Toilets With Original Equipment

The objective of this tank trim adjustability test is to determine the upper limit to the volume of water that may be discharged as a result of the field adjustment of tank trim components. The maximum volume of water that may be discharged by the toilet, when field adjustment of original equipment tank trim is set at its maximum water-use setting, shall not exceed the following amounts:

Type of fixture	Original rated flush volume	Maximum flush volume
Single flush	1.6 gallons – 6.0 litres	2.0 gallons – 7.6 litres
Single flush	1.28 gallons – 4.8 litres	1.68 gallons – 6.4 litres
Dual-flush	Full flush - 1.6 gallons-6.0 litres Reduced flush-1.1 gallons-4.2 litres	2.0 gallons – 7.6 litres 1.4 gallons – 5.3 litres

The following test procedure shall be used to verify that the toilet sample meets these requirements.

6.1.1 Test Procedure

Test shall be conducted per section 7.4 of *ASME A112.19.2-2013/CSA B45.1-13* with the following modifications:

6.1.1.1 The toilet shall be installed on a leveled test stand and all adjustable tank trim components (any field adjustment features in the tank that might increase the toilet flush volume, including, but not limited to flush valve float adjustments) shall be adjusted to the maximum water use setting, while taking care not to damage or alter the parts.

6.1.1.2 The water level in the tank shall be set to 0.25 ± 0.06 inch (6 ± 2 mm) below the top of the overflow tube. Where the tank utilizes an internal containment vessel and does not possess an overflow tube, the vessel shall be filled to a level 0.25 ± 0.06 inch (6 ± 2 mm) below the top rim of the vessel or to the manufacturer's designated water line, whichever is higher.

6.1.1.3 The static pressure of the water supply shall be adjusted to 80 ± 2 PSIG.

6.1.1.4 The toilet shall be flushed maintaining the activator in the flushing position for a period not to exceed one (1) second. The total volume of the flush shall be measured to within an accuracy of ±0.25 litre (0.07 gallon) using a water meter, a graduated container, a weight scale, or another method that can achieve the required level of accuracy.

6.1.1.5 Record the total flush volume after cessation of flow of the excess trap refill water (including all trailing flow that occurs at the end of the main discharge).

6.1.1.6 This procedure shall be repeated until five (5) sets of data are obtained.

6.1.1.7 The static pressure of the water supply shall be adjusted to 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product

[6] The flush volume adjustability and maximum water consumption test has been adapted from the similar tests specified within (1) the WaterSense® Tank-Type High Efficiency Toilet Specification and (2) the Los Angeles Department of Water and Power Supplementary Purchase Specification (SPS), 16 November 2005 version, modified to reflect the deletion of certain trim durability and marking requirements incorporated into *ASME A112 19.5*.

literature and product packaging, and test procedure steps 6.1.1.3 to 6.1.1.5 shall be repeated.

6.1.1.8 For dual-flush toilet fixtures, this test shall be conducted at both full flush and reduced flush modes.

6.2 Report

The average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

6.2.1 Performance Requirement: The average total flush volume for five (5) test runs for each of the two static water supply pressures shall not exceed the amounts specified in the table in Section 6.1.

6.3 Tank-Type Gravity Toilets With After-Market Closure Seals

The objective of this tank trim adjustability and after-market seal test is to determine the upper limit to the volume of water that may be discharged when an off-the-shelf (after-market) replacement flush valve seal/flapper is installed in the toilet tank. The maximum volume of water that may be discharged by the toilet, when the original equipment flush valve seal (flapper or other sealing device) is replaced with a standard (buoyant) seal available in home improvement centers and hardware stores, and the field adjustment of tank trim is set at its maximum water-use setting, shall not exceed the following amounts:

Type of fixture	Original rated flush volume	Maximum flush volume
Single flush	1.6 gallons – 6.0 litres	2.0 gallons – 7.6 litres
Single flush	1.28 gallons – 4.8 litres	1.68 gallons – 6.4 litres
Dual-flush	Full flush - 1.6 gallons-6.0 litres Reduced flush-1.1 gallons-4.2 litres	2.0 gallons – 7.6 litres 1.4 gallons – 5.3 litres

6.3.1 Test Procedure

Test shall be conducted per section 7.4 of *ASME A112.19.2-2013/CSA B45.1-13* with the following modification:

6.3.1.1 The toilet shall be installed on a leveled test stand and all adjustable tank trim components (any field adjustment features in the tank that might increase the toilet flush volume) shall be adjusted for maximum water use, while taking care not to damage or alter the parts.

6.3.1.2 Remove the original equipment flush valve seal and replace it with a standard (buoyant) non-adjustable after-market seal/flapper where possible. In the case of a standard configuration 2-inch flush valve, a Fluidmaster Bullseye Super Flapper (part no. 501) or a Coast Foundry Ultra Blue flapper shall be used. In the case of a standard configuration 3-inch flush valve, a Fluidmaster model 5403 3-inch Universal Toilet Flapper OR a Lavelle Korky Model 3060 shall be used, adjusted to its **maximum flush volume**. For non-standard flush valves, including those between 2 inches and 3 inches in diameter and those exceeding 3-inches in diameter, one or more replacement seals available at hardware, plumbing supply, and building supply stores OR from the original manufacturer or other recognized source shall be used where possible[7].

6.3.1.3 The water level in the tank shall be set to 0.25 ± 0.06 inch (6 ± 2 mm) below the top of the overflow tube. Where the tank utilizes an internal containment vessel and does not possess an overflow tube, the vessel shall be filled to a level 0.25 ± 0.06 inch (6 ± 2 mm) below the top rim of the vessel or to the manufacturer's designated water line, whichever is higher.

6.3.1.4 The static pressure of the water supply shall be adjusted to 80 ± 2 PSIG.

[7] Where none of the specified after-market flappers properly fit the flush valve, the testing laboratory shall have discretion as to which after-market flapper or seal shall be used in the Section 6.3 test.

6.3.1.5 The toilet shall be flushed maintaining the activator in the flushing position for a period not to exceed one (1) second. The total volume of the flush shall be measured to within an accuracy of ±0.25 litre (0.07 gallon) using a water meter, a graduated container, a weight scale, or another method that can achieve an equal level of accuracy.

6.3.1.6 Record the total flush volume after cessation of flow of the excess trap refill water (including all trailing flow that occurs at the end of the main discharge).

6.3.1.7 This procedure shall be repeated until five (5) sets of data are obtained.

6.3.1.8 The static pressure of the water supply shall be adjusted to 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging, and test procedure steps 6.3.1.5 to 6.3.1.7 shall be repeated.

6.3.9 For dual-flush toilet fixtures, this test shall be conducted at both full flush and reduced flush modes.

6.3.2 Report

The average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

6.3.3 Performance Requirement

The average total flush volume for five (5) test runs for each of the two static water supply pressures shall not exceed the amounts specified in the table in Section 6.3.

7.0 Fill Valve Integrity Test Protocol[8]

IMPORTANT NOTE: *Compliance with the U.S. EPA WaterSense® Program "WaterSense® Specification for Tank-Type Toilets" v.1.2, shall fully satisfy the requirements of this Section 7.0.*

This requirement shall apply only to fill valves that are not otherwise classified as pilot valves. Samples must conform to both Sections 7.1 and 7.2 of this section.

7.1 Consistent Water Level

To determine whether or not the fill valve shuts off at a consistent water level in a toilet tank independent of any change in inlet water supply pressure.

7.1.1 Test Procedure

7.1.1.1 Install the fill valve in the toilet tank provided, install the tank on a leveled test stand, and adjust the water level per the manufacturer's recommendation to an inlet water pressure of 20 ± 2 PSIG or to the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.

7.1.1.2 Flush the tank to verify and mark water level after completed refill.

7.1.1.3 Increase the inlet water pressure to 60 ± 2 PSIG.

7.1.1.4 Flush the tank and mark water level after completed refill.

7.1.1.5 Measure any difference in water level between that marked in 7.1.1.2 and that marked in 7.1.1.4 after completed refill.

7.1.1.6 Increase inlet water pressure to 80 ± 2 PSIG.

7.1.1.7 Flush the tank and mark water level after completed refill.

7.1.1.8 Measure any difference in water level between that marked in 7.1.1.2 and that marked in 7.1.1.7 after completed refill.

7.1.2 Performance Requirement

The fill valve shall shut off at the same water level ± 12 mm (± 0.5 inch) for all three inlet water pressures. In addition, water shall not enter the overflow tube or flow out of the tank at any of the three tested inlet pressures.

7.2 Shutoff Integrity with Increased Water Pressure

To determine whether or not the fill valve shuts off at a consistent water level in a toilet tank independent of changes in inlet water supply pressure.

7.2.1 Test Procedure

7.2.1.1 Install the fill valve in the toilet tank provided, install the tank on a leveled test stand, and adjust the water level per the manufacturer's recommendation to an inlet water pressure of 20 ± 2 PSIG or to the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.

7.2.1.2 Flush the tank to verify and mark water level after completed refill.

7.2.1.3 Increase the inlet pressure to the fill valve from 20 (or recommended minimum pressure) to 60 PSIG, then to 80 PSIG at a rate of less than 10 PSIG per second.

7.2.2 Performance Requirement

The water level shall remain at the initial mark ± 12 mm (± 0.5 inch). In addition, water shall not enter the overflow tube or flow out of the tank.

[8] Testing protocol based on Appendix B to Los Angeles Department of Water and Power Supplementary Purchase Specification, November 16, 2005 version.

