Tank-Type High-Efficiency Toilet Specification

1.0 Scope and Objective

This specification establishes the criteria for a tank-type high-efficiency toilet (HET) under the U.S. Environmental Protection Agency WaterSense[SM] program. It is applicable to:

- Single flush, tank-type gravity toilets;
- Dual flush, tank-type gravity toilets;
- Dual flush, tank-type flushometer tank (pressure-assist) toilets;
- Tank-type, flushometer tank (pressure-assist) toilets;
- Tank-type electrohydraulic toilets; and
- Any other technologies that meet these performance specifications.

The specification is designed to ensure both sustainable, efficient water use and a high level of user satisfaction with flushing performance.

2.0 Summary of Criteria

Toilets must meet criteria in three areas:

- Effective flush volume shall not exceed 1.28 gallons[1] (4.8 liters), as specified in Section 3.0;
- Solid waste removal must be 350 grams[2] or greater, as specified in Section 4.0; and
- The toilet must conform to the adjustability and other supplementary requirements specified in Section 5.0.

3.0 Water Efficiency Criteria

3.1 Single Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is the average flush volume when tested in accordance with ASME A112.19.2[3].

3.2 Dual Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is defined as the composite, average flush volume of two reduced flushes and one full flush. Flush volumes will be tested in accordance with ASME A112.19.2 and ASME A112.19.14.

[1] The effective flush volume has been established as 1.28 gallons, which is a 20 percent reduction from the 1.6 gallons per flush standard that became mandatory pursuant to the 1992 EPAct.
[2] A qualified HET must provide superior flushing performance while saving significant volumes of water. Based on data contained in the medical study *Variability of colonic function in healthy subjects*, 1978, J.B. Wyman, K.W. Heaton, A.P. Manning, and A.C.B. Wicks of the University Department of Medicine, Bristol Royal Infirmary, the greatest single 'loading' of the 20 study participants was approximately 450g, and the 99.5 percent confidence level of the men in the study equates to a loading of approximately 350g.
[3] References to this and other ASME standards apply to the most current version of that standard.

4.0 Flush Performance Criteria

4.1 Toilet model performance is identified as either a Pass or Fail depending upon whether it can successfully and completely clear all test media from the fixture in a single flush in at least four of five attempts. Only toilet models that Pass qualify for the EPA WaterSense label. Flush performance testing shall be conducted in accordance with the test protocol provided in Appendix A.

4.2 Test media consists of seven test specimens, 50 ± 4 grams each, consisting of soybean paste forming a 'sausage' approximately 4 ± 0.5 inch (100 ± 13 mm) in length and 1 ± 0.25 inch (25 ± 6 mm) in diameter and four loosely crumbled balls of toilet paper as defined in Appendix A.

4.3 The flush performance criteria apply to single flush toilets, and to the full flush option of dual flush toilets. No solid waste removal requirement applies to the reduced flush option on dual flush toilets.

5.0 Supplementary Requirements for Flush Volume Adjustability

5.1 All single flush toilets must conform to ASME A112.19.2 and all dual flush toilets must conform to ASME A112.19.14.

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

5.2.1 Must conform to ASME A112.19.5.

5.2.2 Fill Valve

The fill valve shall be the pilot valve type only, or, alternatively, the fill valve shall meet the performance requirements of the fill valve test protocol in Appendix B. All fill valves must conform to ANSI/ASSE 1002.

5.2.3 Tank Capacity

5.2.3.1 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 5.2.3.2 shall be deemed noncompliant.

5.2.3.2 The maximum volume of water that may be discharged by the toilet, when field adjustment of the tank trim is set at its maximum water use setting, shall not exceed the following amounts:

- For single flush fixtures: 1.68 gallons (6.4 liters) per flush[4]
- For dual flush fixtures: 1.40 gallons (5.3 liters) per flush[5] in reduced flush mode and 2.00 gallons (7.6 liters) per flush[6] in full flush mode.

[4] Value based on a maximum effective flush volume of 1.28 gallons (4.8 liters) per flush, with no more than 0.40 gallon (1.6 liter) increase with tank trim adjusted to maximum water use settings.
[5] Value based on the reduced flush requirement in ASME A112.19.14-2001.

- The maximum volume of water discharged, using both original equipment tank trim and using after market closure seals, shall be tested according to the protocol in Appendix C.

6.0 Effective Date

This specification is effective on January 24, 2007.

7.0 Future Specification Revisions

EPA reserves the right to revise this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. Revisions to the specification would be made following discussions with industry partners and other interested stakeholders.

8.0 Definitions

Definitions within ASME A112.19.2 and ASME A112.19.14 are included by reference.

- **Electrohydraulic toilet**: A toilet fixture of siphonic or washdown design that uses a motor, pump, and controller to assist flushing action.
- **Pressure-assist toilet**: A flushometer tank toilet as defined in ASME A112.19.2.
- **Rated flush volume**: The stated flush volume of the toilet, as certified.

[6] Value based on the requirement in the Los Angeles Department of Water and Power Supplementary Purchase Specification, adopted in 2000 and as amended in 2005.

Appendix A: HET Fixture Performance Testing Protocol[7]

1.0 Scope of Testing

1.1 Toilet model performance is identified as either a **Pass** or a **Fail** depending upon whether the test fixture can successfully and completely clear all media (350 grams) from the fixture in a single flush in at least four of five attempts.

1.2 Tests where toilet sample clogs, plugs, or fails to restore a minimum of a 2 inch (50 mm) trap seal following each flushing test will be deemed a failed test.

1.3 Test media is comprised of the following:

1.3.1 Seven test specimens at 50 ± 4 grams per test specimen ("test specimen") consisting of soybean paste forming a "sausage" approximately 4 ± 0.5 inch (100 ± 13 mm) in length and 1 ± 0.25 inch (25 ± 6mm) in diameter. The total mass of test media used for each test shall be 350 ± 10 grams.

1.3.2 Four loosely crumpled balls of toilet paper ("paper").

2.0 Testing Protocol

2.1 Fixture Model Selection

The product sample tested to these requirements shall be selected according to the procedure provided in Section A4 of ASME A112.19.2, Nonmandatory Appendix A, Demonstrating Compliance to ASME A112.19.2.

2.2 Set-Up

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

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

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

2.2.4 Inlet water temperature shall be 65 to 80°F (18 to 27 °C).

2.2.5 Flush sample a minimum of three times prior to commencement of testing.

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

2.3 Flush Volume Measurement

2.3.1 Measure and record flush volume of sample (sample set-up as outlined in Section 2.2). Repeat the test two additional times and record the results and the average of the three test replicates. A receiving vessel may be used, either calibrated in increments not exceeding 0.025 gallon (0.1 L) or

[7] Testing protocol based on Maximum Performance (MaP) Testing Protocol, Version 3, January 2006, by Bill Gauley, Veritec Consulting, Inc., and John Koeller, Koeller and Company.

placed on a load cell with a readout in increments not exceeding 0.025 gallon (0.1 L). Other methods capable of measuring volumes to within in 0.025 gallon (0.1 L) shall be acceptable.

2.3.2 Samples with average flush volumes in excess of 0.10 gallon (0.4 L) greater than their rated flush volume shall be deemed to fail testing requirements due to excessive flush volume[8].

2.3.3 Samples with average flush volumes less than 0.10 gallon (0.4 L) greater than their rated flush volume shall be adjusted, if possible, to their rated flush volume prior to performance testing.

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

2.4 Waste Extraction Test

2.4.1 Test specimens shall be formed such that they are roughly cylindrical in shape and uniform in diameter.

2.4.2 A test specimen drop guide shall be placed across the top of the bowl, with the centerline of a 2 inch (50 mm) diameter opening 6 inches (15 cm) 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 0.5 inch (12 mm) thick, and be of sufficient length to span top of toilet bowl.

2.4.3 Seven (7) test specimens (350g) shall be freely dropped in a vertical orientation through opening in drop guide into bowl.

2.4.4 Immediately remove drop guide and freely and randomly drop four balls of crumpled toilet paper over center of bowl sump.

2.4.5 Wait 10 ± 1 seconds.

2.4.6 Flush sample.

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

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

2.4.9 Repeat testing until toilet sample either (i) achieves four **Pass** grades or (ii) achieves two **Fail** grades.

2.4.10 Models must **Pass** at least four of five attempts to qualify for the EPA WaterSense Program.

3.0 Test Media Specifications

3.1 Soybean Paste Nominal Specifications:
35.5 percent water, 33.8 percent soybean, 18.5 percent rice, and 12.2 percent salt, and having a density of 1.15 ± 0.10 g/mL (i.e., density greater than that of water).

3.2 Test Specimens:

[8] For example, fixtures rated at 1.28 gallons per flush (the HET maximum) but flushing at greater than 1.38 gallons (5.2 L) when adjusted to water line shall be deemed to have "failed" the requirements of this specification.

Each test specimen shall have a mass of 50 ± 4 grams.

3.3 Toilet Paper Specifications:
Each ball of paper is comprised of six sheets of single-ply toilet paper conforming to ASME A112.19.14, section 3.2.5.1.2.

Appendix B: HET Fill Valve Integrity Test Protocol[9]

1.0 Scope of Testing

This requirement shall apply to all fill valves that are not otherwise classified as pilot valves. Samples must conform to both Sections 2.0 and 3.0 of this appendix.

2.0 Consistent Water Level

2.1 Purpose of Test: 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.

2.2 Test Procedure

- 2.2.1 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 at an inlet water pressure of 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.
- 2.2.2 Flush the tank to verify and mark water level after completed refill.
- 2.2.3 Increase the inlet water pressure to 60 ± 2 PSIG.
- 2.2.4 Flush the tank.
- 2.2.5 Measure any difference in water level after completed refill.
- 2.2.6 Repeat steps 2.2.3 to 2.2.5 utilizing 80 ± 2 PSIG inlet water pressure.

2.3 Performance Requirement: The fill valve shall shut off at the same water level ± 0.5 inch (± 12 mm) 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.

3.0 Shutoff Integrity with Increased Water Pressure

3.1 Purpose of Test: 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.

3.2 Test Procedure

- 3.2.1 Install the fill valve in a toilet tank and adjust the water level per the manufacturer's recommendation at an inlet water pressure of 20 ± 2 PSIG or at the manufacturer's recommended minimum pressure as noted in the product literature and product packaging.
- 3.2.2 Flush the tank to verify and mark water level after completed refill.

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

3.2.3 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.

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

Appendix C: Tank Trim Adjustability Testing Protocol[10]

1.0 Scope of Testing

All tank-type gravity toilet fixtures must conform to the requirements of Section 2.0 of this appendix, 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 seals must conform to the requirements in Section 3.0 of this appendix, which address the flush volume resulting from the replacement of original equipment seals with seals available in the after market.

2.0 Tank-Type Gravity Toilets With Original Equipment

2.1 Purpose of Test

The objective of this tank trim adjustability test is to determine the upper limit to the volume of water that may be discharged by 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:

For single flush fixtures – 1.68 gallons (6.4 liters) per flush

For dual flush fixtures:

Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush

Full flush mode – 2.00 gallons (7.6 liters) per flush

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

2.2 Test Procedure

Test shall be conducted per section 8.4 of ASME A112.19.2 with the following modifications:

2.2.1 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 to the maximum water use setting, while taking care not to damage or alter the parts.

2.2.2 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.

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

2.2.4 The toilet shall be flushed maintaining the activator in the flushing position for a period of one (1) second, the water being drained into a container.

2.2.5 After the flush cycle is complete, the total flush volume shall be observed and recorded.

[10] Testing protocol based on Los Angeles Department of Water and Power Supplementary Purchase Specification, 16 November 2005 version, modified to reflect the deletion of certain trim durability and marking requirements incorporated into ASME A112 19.5.

2.2.6 This procedure shall be repeated until five (5) sets of data are obtained.
2.2.7 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 literature and product packaging, and test procedure steps 2.2.4 to 2.2.6 shall be repeated.
2.2.8 For dual-flush toilet fixtures, this test shall be conducted at both full flush and reduced flush modes.

2.3 Report: The five (5) individual flush volumes and the average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

2.4 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 following:

For single-flush fixtures – 1.68 gallons (6.4 liters) per flush
For dual-flush fixtures:
Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush
Full flush mode – 2.00 gallons (7.6 liters) per flush

The volume of water may be determined visually using a graduated container or by weight calculated as a unit to volume unit.

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

3.1 Purpose of Test

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 replacement flush valve seal/flapper is installed on the toilet. 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:

For single flush fixtures – 1.68 gallons (6.4 liters) per flush
For dual flush fixtures:
Reduced flush ("short flush") mode – 1.40 (5.3 liters) gallons per flush
Full flush mode – 2.00 gallons (7.6 liters) per flush

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

3.2 Test Procedure

Test shall be conducted per section 8.4 of ASME A112.19.2 with the following modification:

3.2.1 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.

3.2.2 Remove the original equipment flush valve seal and replace it with a standard (buoyant) non-adjustable after-market seal/flapper for that toilet 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. For non-standard flush valves, including 3-inch flush valves, one or more replacement seals available at hardware, plumbing supply, and building supply stores or from the manufacturer or other recognized source shall be used[11].

3.2.3 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.

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

3.2.5 The toilet shall be flushed maintaining the activator in the flushing position for a period of one (1) second maximum, the water being drained into a container.

3.2.6 After the flush cycle is complete, the total flush volume shall be observed and recorded.

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

3.2.8 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 3.2.5 to 3.2.7. shall be repeated.

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

3.3 Report: The five (5) individual flush volumes and the average of the five (5) runs shall be reported for each of the two static water supply pressures specified.

3.4 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 following:

For single-flush fixtures – 1.68 gallons (6.4 liters) per flush

For dual-flush fixtures:

Reduced flush ("short flush") mode – 1.40 gallons (5.3 liters) per flush

Full flush mode – 2.00 gallons (7.6 liters) per flush

The volume of water may be determined visually using a graduated container or by weight calculated as a unit to volume unit.

[11] Where neither the Fluidmaster Bullseye Super flapper nor the Coast Foundry Ultra Blue flapper fit the flush valve, where a 3-inch flush valve is employed, or in the case of a toilet fixture with a non-standard flush valve seal, the testing laboratory shall have discretion as to which after-market flapper or seal shall be used in the test.

Appendix D: Informative Annex for WaterSense Labeling

The following requirements must be met for products to be marked with the WaterSense label.

1.0 WaterSense Partnership

The manufacturer of the product must have a signed partnership agreement in place with EPA.

2.0 Conformity Assessment

Conformance to this specification must be certified by a body either accredited by ANSI in accordance with the WaterSense certification scheme, or otherwise approved for that purpose by EPA.

3.0 Prior Testing

Products previously tested under the predecessor UNAR specification[12] must still be certified under this specification.

[12] Uniform North American Requirements (UNAR) for toilet fixtures, a supplementary specification developed in 2005 for water utilities.