MaP
Maximum Performance

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How and why did MaP begin?

From the 1980s to EPAct 92

For the 1980s, the generally accepted maximum flush volume for toilet fixtures in the U.S. was 3.5 gallons, or 13 Litres. Ongoing water supply issues, coupled with the introduction into North America of the early 1.6 gal/6.0 Litre toilets (ULFTs) in the late 1980s, led ultimately to the adoption by 16 states and six local jurisdictions in the U.S. of new water efficiency standards for these fixtures. All but one of the jurisdictions mandated a maximum flush volume of 1.6 gal/6.0 Litres. Acting upon the requests of various organizations (including manufacturers and water efficiency advocates), the U.S. Federal government preempted these differing state and local standards with the Energy Policy Act of 1992. With a few exceptions, this legislation required that by 1994, the flush volume of all toilet fixtures sold in the U.S. be no greater than 1.6 gal/6.0 Litres.

Early consequences of EPAct 92 and 1.6 gal/6.0 Litre toilet fixtures

Although some manufacturers were producing ULFTs prior to the passage of EPAct 92, product development by many of those manufacturers was confined to fitting 3.5 gal/13 Litre models with modified tank trim. That trim merely reduced the flush volume of the old model by moving only a portion (usually around one-half) of the water from the tank into the bowl. This permitted manufacturers to merely re-badge their old 3.5 gal/13 Litre fixtures as ULFTs. Some may argue that this was an expedient way for manufacturers to avoid new product development while others argue that manufacturers were not given enough time to develop new product that cut the available water in half and did so without sacrifices (except to the consumer, of course!).

Whatever your point of view, the fact is that many of the new ULFTs were marginal performers, at best. Some manufacturers re-designed their entire fixture line, while many did not. As a result, customers double-flushed and complained about it, home builders complained about "call-backs" on brand new homes, and many people questioned whether these "new" fixtures were actually "efficient"! Water utilities encouraging their customers to replace old fixtures with ULFTs (by offering rebates or free product) began hearing the complaints loud and clear.

Los Angeles Supplementary Purchase Specification (LADWP SPS)

In the 1990s, some consumers tampered with their "new", poor-performing 1.6-gallon toilets to increase their water consumption, usually by replacing the flush valve flapper with one designed for older 3.5 gallon toilets. Presumably, this would improve flush performance, but at the expense of higher water use. In 2000, as a consequence of these "adjustments" to what were rated as 1.6 gallon fixtures (but no longer were such), the Los Angeles Department of Water & Power, together with the Metropolitan Water District of Southern California and the International Association of Plumbing and Mechanical Officials (IAPMO) developed the LADWP SPS, which covered such important topics as adjustability of tank-type toilet flush volume, flapper physical durability, and other items. By 2005, the SPS had evolved to address toilet fill valves as well. Many of the provisions in the SPS later became integral to the ASME/CSA standard for vitreous china (ceramic) toilet fixtures. **Download the most current version (2005) of the SPS.**

SPU, EBMUD and the NAHBRC step in!

In 2001-2002, Seattle Public Utilities (SPU), East Bay Municipal Utility District (EBMUD), and the National Association of Home Builders Research Center (NAHBRC) jointly proposed to conduct toilet testing at the NAHBRC facility in Upper Marlboro, Maryland. The NAHBRC had previously developed a toilet "clog index" that was designed to assist NAHB member builders in choosing toilet fixtures that would be reliable performers (and reduce customer "call-backs"). The "clog index" was determined through a testing protocol that flushed a varying quantity of sponges and paper wads.

As the study progressed through 2002, it became clear to some that sponges were not a realistic representation of the 'real demand' upon a toilet fixture. Furthermore, the work by the research center did not include identification of the minimum acceptable fixture performance level for a residential toilet. That is, while about 50 different fixture models were included in the study, there was no indication as to which fixtures would meet minimum requirements and perform satisfactorily in a home. As a result, the findings of the report did not prove to be helpful to consumers and others. The final version of the NAHBRC report is available for download.

Certification of toilets to national standards

Although virtually all toilet models sold in Canada and the U.S. meet both the flush volume and performance requirements of the Canadian Standards Association (CSA) and the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME), there remains some question as to whether models that meet the minimum certification requirements also meet the flushing performance expectations of the consumer. What's more, since certification testing offers only a pass/fail grading, it does not afford consumers an opportunity to distinguish between the superior and marginal toilet models available in the marketplace.

Origins of Maximum Performance (MaP) testing

Until 2003, there was no convenient way for the consumer, builders, specifiers, or other design professionals to readily distinguish between the superior, good and marginal performers. The NAHBRC study of flush performance did not yield helpful results in that process. In addition, this lack of information on toilet performance levels created a negative perception regarding all ULFTs.

By 2003, most (but not all) toilet fixtures destined for residential and light commercial applications exceeded customer performance expectations, thanks to investments in product development by the toilet fixture manufacturers. But, research concluded in 2003 that there were still some certified and commercially available models that did not meet customer expectations. There were two key concerns:

1. Fixtures that fail to meet the 6-litre maximum flush requirements of the CSA or the 1.6-gallon requirements of the ANSI/ASME result in toilets that flush with either too much or too little water; and
2. Fixtures that do not flush effectively by removing all waste usually result in customer complaints and, occasionally, in double flushing.

In 2002, a group of water-efficiency advocates gathered to assess the need for further work on development of a toilet testing protocol that would....

(a) Establish a minimum acceptable flush performance threshold for toilet fixtures
(b) Enable consumers and design professionals to compare toilet models on the basis of flush performance
(c) Provide water utilities with information necessary for their customers to make informed purchase decisions and for making purchase decisions on behalf of their toilet giveaway and rebate programs

Although other toilet performance studies (such as the NAHBRC study) had been completed by 2003, none was performed using realistic test media, nor did those other studies establish a quantifiable performance benchmark (or minimum performance threshold) based on scientific data.

A total of 22 interested organizations in Canada and the U.S. contributed the funds needed to meet these objectives. Development of MaP began in 2002.

What is MaP?

The Maximum Performance (MaP) testing process identifies how well toilet models perform bulk waste removal using a realistic test media, and grades (ranks) each toilet model based on this performance metric. A soybean paste having similar physical properties (density, moisture content) to human waste was used in combination with toilet paper as the test media. In addition to using a realistic test media, all toilet samples are adjusted, where possible, to their rated flush volume (typically 6 litres / 1.6 gallons) prior to testing to ensure a level playing field.

The original testing protocol required the soybean paste to be extruded through a 7/8-inch (22-mm) die and cut into 50-gram (50g) specimens (each specimen approximately 100 mm or 4 inches in length). Toilet models were subjected to progressively larger loadings (in 50-gram increments) until the unit failed to completely clear the bowl in two of three attempts, or to fully restore a minimum 50mm (2-in.) trap seal, essentially a "test to failure".

The first report on the MaP test protocol and test results for 44 different toilets was released in December 2003.

Since its initial release, some changes have been made to simplify the process. Whereas the initial protocol used uncased paste, an alternative approach uses encased soybean paste media as described in the MaP test protocol. However, organizations applying to have a fixture tested are now given the option of choosing either the new encased test media OR the original uncased test media.

The original 2003 MaP report contained information on replacement flapper interchangeability. That is no longer covered in the current MaP reports.

The original minimum performance benchmark adopted by MaP was 250 grams of waste (plus toilet paper). That is, a toilet fixture should completely evacuate at least 250g of waste from the fixture in a single flush action. This value is based on the results of a British medical study (Variability of Colonic Function in Healthy Subjects) that identified 250g as the average maximum fecal size of the male participants in the study. Thus, any toilet that meets or exceeds the 250g-performance threshold should meet customer expectations for flushing.

How were the 250 gram and 350 gram flush performance thresholds selected?

These minimum performance thresholds of 250 grams (approx. 9 ounces) and 350 grams (about 12 ounces) were chosen as a result of medical and other studies performed on humans, each of which measured the amount of solid waste deposited at each 'sitting'. The 250-gram threshold represents the 95th percentile of all males (or, to put it another way, 95% of all males will deposit 250 grams or less or solid waste at a 'sitting'). The 350-gram threshold represents the 99th percentile. As a result, initial MaP recommendations set a 250-gram performance minimum for toilets to be 'qualified' as acceptable. Later, that number was increased to 350 grams and the U.S. EPA followed with their WaterSense Program also selecting 350 grams for their tank-type toilet specification.

You may download the four (4) medical studies that were consulted by MaP in developing the two performance threshold levels:.

1. Wyman-Variability of Colonic Function in Healthy Subjects, 1977 (less 1 mb)

2. Wignarajah-Simulated Human Feces for Testing Human Waste Processing Technologies in Space Systems, 2006

3. Part One - Health Hazards of Excreta: Theory and Control, undated (1.4mb)

4. Fecal Weight, Colon Cancer Risk, and Dietary Intake of Nonstarch Polsaccharides (Dietary Fiber), 1992.

MaP aftermath

Since 2003, over 6,000 different fixture models (of all different types) have been MaP tested by the various MaP-approved laboratories located around the world. The current database of fixtures numbers **6,000+ different models** of all types: single-flush, dual-flush, ULFTs, HETs, tank-type, and commercial flushometer valve/bowl combinations. Overall, the MaP test protocol has been well-received by consumers, water providers, architects and engineers, specifiers, builders, retailers, and manufacturers alike. Many water agencies and municipalities in the U.S. and Canada consider the results of MaP testing when evaluating which toilet models to promote, subsidize, or rebate.

It is important to note that the U.S. Environmental Protection Agency (EPA) adopted 350g of uncased MaP media (soy bean paste) as the minimum performance threshold for high-efficiency toilets (HETs) promoted within its WaterSense program. Furthermore, most water utilities currently adopting toilet replacement rebate and installation programs (with HETs) are also establishing their minimum performance threshold at 350g (some set the criteria as high as 500g minimum).

The EPA's WaterSense program does not post performance scores for toilet models certified as compliant with its WaterSense specification for tank-type toilets; models are instead simply certified as meeting the WaterSense requirements on a **pass-fail** basis. Those requirements include the 350g threshold and many other criteria. Independent of WaterSense website, however, this MaP website will continue to report MaP testing results as part of this online database.

Summary

Fortunately, after dealing with the user complaints of the 1990s, the plumbing industry responded positively to the flush performance issues of the past. The fixtures available in the marketplace today are **significantly better performers** than those MaP tested as recently as 2003 and are **far superior to most of those produced in the early 1990s**. Much of this improved performance can be attributed to the MaP test and its acceptance by the marketplace and by plumbing manufacturers. Plumbing manufacturers are to be commended for developing and delivering outstanding toilet fixtures to the marketplace today.