BNWAT05: Water closets – water efficiency performance tests

Version 2.1

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis form part of the Evidence Base created by Defra's Market Transformation Programme.

1 Summary

This Briefing Note reviews potential methods for quantifying the water consumption associated with the use of water closet (WC) pans and suites, including the concept of the 'effective flush'. This review has been undertaken in the context of the Market Transformation Programme (MTP) which is seeking to develop a water efficiency rating scheme for water-using appliances and fixtures.

Definition of WCs within the study: close-coupled suites, one-piece and independent WC pans with integral trap, used for personal hygiene and manufactured from vitreous china or stainless steel.

2 Background to current standards

The current European Standard relating to WCs is BS EN 997:2003 (WC pans and WC suites with integral trap). This standard outlines the requirements for WCs from the perspective of construction and performance, emphasising functional criteria.

Two classes of WC are identified within the standard. Class 1 covers suites for sale in mainland Europe, and a number of the tests are different from the UK requirements. Class 2 covers WCs sold in the UK. Specific flush volumes are listed for the two classes of WC and are summarised as follows:

Class 1
A nominal flush volume of four, five, six, seven or nine litres.

Class 2
A maximum flush volume of six litres for pressure flushing valve WCs.
A maximum flush volume of six litres and a reduced flush no greater than two-thirds of this volume for dual-flush WCs.

The WC performance specification in the Water Supply (Water Fittings) Regulations 1999 includes a comprehensive set of tests designed to measure the performance of a complete WC suite. One of these tests is the flush volume test which is used to determine the maximum flush volumes of both single and dual-flush WC suites. The

specification allows for single-flush WC suites with a maximum flush of six litres and dual-flush WC suites with a maximum full flush of six litres and a maximum reduced flush volume of two thirds of the full flush volume. A relaxation of the regulations also allows for the retro-fitting of dual and interruptible flushing devices installed before 1 July 1999.

3 Options for the quantification of WC water consumption

The current European Standard does not identify a method for comparing water efficiency between the different WC pans and suites on the market, nor does it include a test for the effectiveness of the reduced flush from a dual-flush WC. The technical issues associated with the quantification of water consumption by WCs are not considered significant enough for inclusion in this standard.

The requirement for a single test has led to the concept of an 'effective flush' – used to describe an average flush volume that is comparable across all types of WC. The maximum effective flush permitted under the Water Supply (Water Fittings) Regulations 1999 is six litres, offered by a six-litre single flush WC.

The key assumption behind the 'effective flush' is the ratio of full to reduced flushes and, for the purposes of the MTP, the choice of ratio for 'effective flush' needs to be based upon up-to-date UK research. There have been a number of trials to determine this ratio and these are summarised in Table 1.

Table 1 International studies of the effective flush

Trial	Nominal flush volume	Theoretical flush volume (at 1:4 ratio)	Measured flush volume (litres)	Actual flush volume	Size of sample
Seattle	6/3	3.6	4.73	>1 full: 1 part	40
Oregon	6/3	3.6	4.92	>1 full: 1 part	50
Canada	6/3	3.6	4.20	1 full :1.5 part	
Bradford	6/3	3.6	4.6	>1 full: 1 part	6
Bradford	4/2	2.4	4.6	Full flush only	4
Hereford	4/2	2.4	3.83	> 3 full: 1 part	1
Hereford	4	4	3.74		1

Source: *The Economics of Water Efficient Products in the Household*. Report for the Environment Agency by Elemental Solutions, June 2003.

These trials have shown the current ratio of full to part flush to be in the range 1:0 (i.e. full flush only used for 4/2 nominal flush) to 1:1.5 (one full flush to 1.5 part flushes). This varies from the ratio used as a benchmark in the trials (one full flush to

four` part flushes) and from the ratio currently used for the Enhanced Capital Allowance Scheme (one full flush to three part flushes).

A WC must have an 'effective flush' of 4.5 litres or less to be eligible for inclusion in the Water Technology List. For this scheme, the average of three reduced flushes and one full flush defines an 'effective flush'. Awareness and correct use of dual-flush WCs will be required in order to achieve the potential savings presented by dual-flush systems.

A study by Portsmouth Water in 2001 showed that an average of 5.4 litres per flush was seen from a 6/4 dual-flush toilet. Also, a study undertaken by the Building Research Establishment for Essex and Suffolk Water in 2003 showed that in a trial of 6/3 litre dual flush toilets, although a flush ratio of one full to four part flushes was seen, the overall number of flushes increased . Taking into account the volume of water used for this apparent double flushing, the actual volumes support a ratio of one full to one part flush[1].

It is proposed that:

- The test method should include the calculation of effective flush at 1 full: 3 part (see Clause 6 of BS EN 997:2003 discussed below).
- To model current water consumption, a ratio of 1:1 should be used to reflect practical usage.
- To model future water consumption a transition point should be selected to move from a ratio of 1:1 to 1:3.

The final point above is dependent upon the activities outlined in the Policy Brief and Briefing Note BNDWWC[2] for improving the understanding of dual-flush WC operation by the consumer.

The current standard includes some methods for measuring the flush volume as a component of a specific test (such as a test of the water trap seal). These methods would be valid for the purposes of quantification of flush volume to determine water efficiency as a defined means of measuring the 'effective flush' of a WC under consideration. The following proposed test method is based on BS EN 997:2003, Clause 6.5 for Class 2 WC suites.

4 Proposed test method

The method is used to determine the effective flush volume of complete WC suites (both single and dual-flush), retrofit dual-flush mechanisms and retrofit interruptible flush mechanisms.

Complete WC suites are required to meet the full requirements of Clause 6 of BS EN 997:2003 before the additional test is used to determine the effective flush volume.

[1] EA (2007) Assessing the cost of compliance with the Code for Sustainable Homes. www.environment-agency.gov.uk
[2] http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=340

Retrofit flushing mechanisms should meet the requirements of Clause 6.16 of BS EN 997:2003 when installed on a nine-litre flush WC before the additional test is used to determine the effective flush volume.

Scope

This clause describes the test method for assessing the effective flush volume of complete WC suites (dual and single-flush), retrofit dual-flush mechanisms and retrofit interruptible flush mechanisms.

Principle

The complete WC suite is initially set up and installed in accordance with the manufacturer's instructions. The maximum flush volume at full flush and reduced flush is measured and the effective flush volume is calculated.

For a retrofit flushing mechanism, the device is fitted to a nine-litre flush WC to carry out the test and determine the effective flush volume. The effective flush volume of the nine-litre flush WC with original flushing mechanism is determined using the procedure for full flush before fitting the retrofit device and determining the effective flush volume of the device.

Apparatus

As BS EN 997: 2003

Procedure

1. Set the dual-flush control or setting if provided, to the full-flush volume in accordance with the manufacturer's instructions.
2. Connect the water supply to the flushing cistern and fill to the marked water line.
3. Operate the flushing mechanism three times, completing three flushing cycles.
4. Fill the cistern to the water line.
5. Shut off the water supply, unless essential for the normal operation of the flushing device.

   Note: Where a water supply is essential for the normal operation of the device, the supply should be maintained at a hydraulic pressure of (0.15 ± 0.01) MPa or the minimum required to operate the device, whichever is the greater.

6. Operate the flushing device and collect the water in the measuring vessel recording the volume of water collected.
7. Repeat the procedure a further four times.
8. During this procedure, record the water trap seal depth on two occasions at random by measuring the height from the invert of the trappage back plate to the surface of the water.
9. Reset the dual-flush control or setting, if provided, to the reduced-flush volume and repeat the whole procedure (steps 2 – 9 above).
10. Calculate the effective flush using the following formula:

    Effective flush = (1 x the average full flush + 3 x the average reduced flush)/4

Note: For a retrofit flushing mechanism, the average full flush should be no more and no less than 10% of the average full flush volume of the nine-litre flush WC determined before fitting the retrofit device.

Note: The reported expanded uncertainty for the tests shall be better than 5% based on a standard uncertainty multiplied by a coverage factor k = 2.

Report

The report should include the following:

a) A full identification of the WC or device tested.
b) The volume of water collected at full-flush volume in litres to an accuracy of ± 0.01.
c) The volume of water collected at reduced-flush volume in litres to an accuracy of ± 0.01.
d) A calculation of the effective flush.

5 Outstanding issues

A transition point needs to be established at which 'effective flush' used in stock modelling will move from that currently measured of one full: one part flush to one full: three part flushes.

Leaking valves could mean that water consumption is continuous and consequently above that measured in the test proposed. The propensity of valves to leak and the extent of this problem needs to be established and appropriate criteria and/or installation guidance developed.

6 Recommendations

- Dual-flush action WCs should have readily discernible identification for each volume of flush because poor flush performance is often caused by user confusion. The operation of the dual-flush action needs to be unmistakable if usage of the system is to improve. It may then be necessary to review and update test methodologies to take account of the transformation.
- Manufacturers should also be encouraged to develop delayed action inlet valves as a means to reduce flush volumes.
- The ratio used to define 'effective flush' in the test method and for future stock modelling should be the average of three reduced flushes and one full flush as defined by the Enhanced Capital Allowance (ECA) scheme.
- Research on the ratio of reduced to full flushes should be reviewed as the market share of dual-flush technology increases.

Related MTP information

Briefing Note BN DW WC: WC design and efficiency.

Changes from version 2.0

Updated references throughout the document.

Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email **info@mtprog.com** quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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