

BS 8542:2011



BSI Standards Publication

Calculating domestic water consumption in non-domestic buildings – Code of practice

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 38, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 October 2011. It was prepared by Panel B/504/2/2, *Water consumption in buildings*, under the authority of Technical Committee B/504, *Water supply*. A list of organizations represented on this committee can be obtained on request to its secretary.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it was a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following regulations which may be amended from time to time. The commentary in this British Standard reflects the state of the regulations in 2011.

In this document, the following national regulations, which apply to plumbing systems in premises to which a supply of public mains water has been provided, are referred to as the “Water Fittings Regulations” [1]:

- The Water Supply (Water Fittings) Regulations 1999, in England & Wales;
- The Water Byelaws 2004 (Scotland), in Scotland;
- The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009, in Northern Ireland.

0 Introduction

0.1 General

Calculating water use in non-domestic buildings provides a means for estimating a building's impact on water consumption whether looking at the consumption of new or existing buildings. Calculating water use in non-domestic buildings also provides a means for estimating the impact of a terminal fitting on an individual basis to inform procurement choices. Figure 1 provides a guide on the calculation procedure.

There are common water uses between different building types, e.g. the use of wash basin taps in a restaurant is similar to that found in an office or a hotel, but variations also exist, e.g. water use for showering.

NOTE The domestic water use requirements for an employee may be simplified into key water uses including water used for WC flushing and other sanitary purposes, water used for drinking, and water used in food/drink preparation and washing-up.

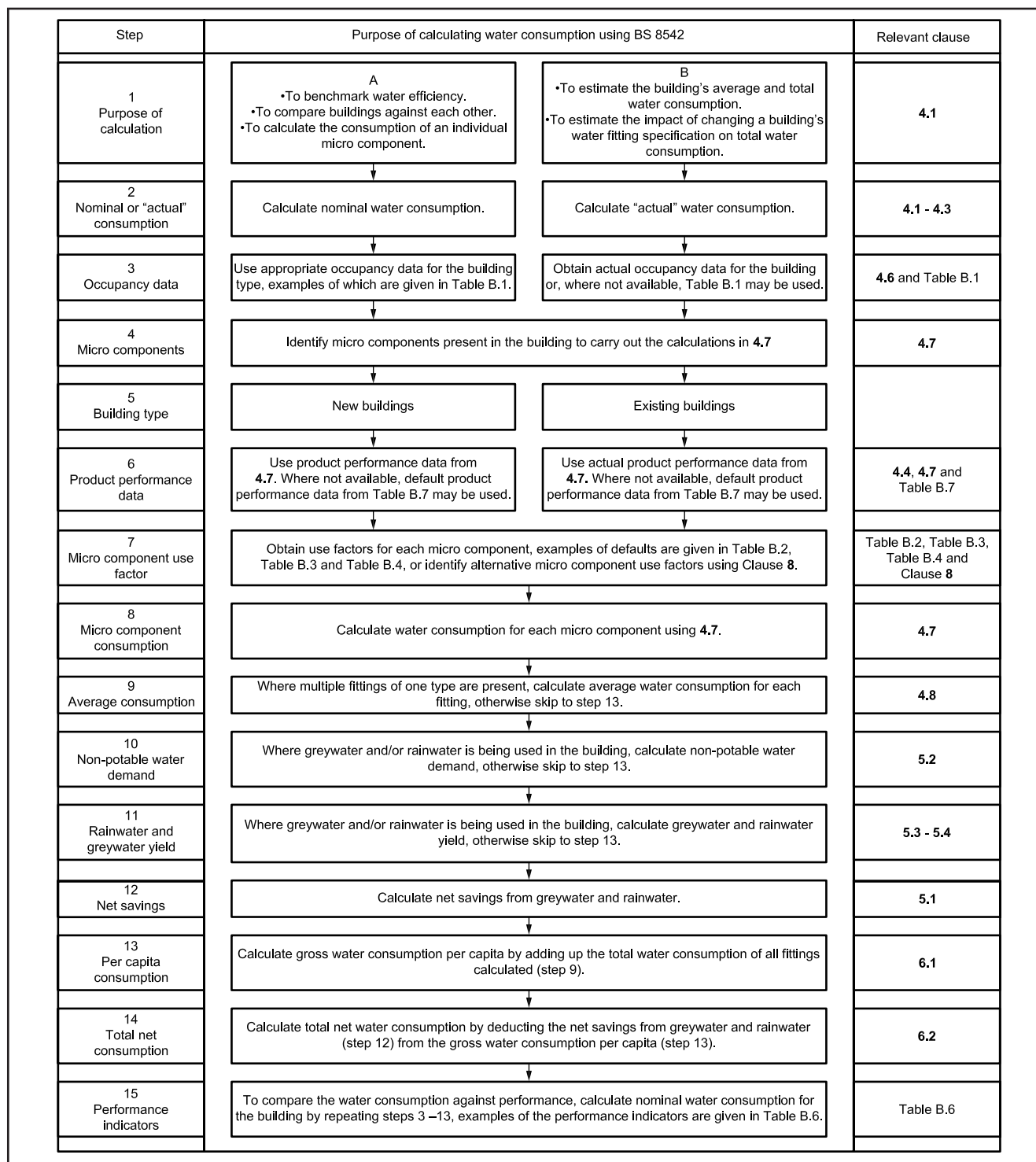
With an increasing demand for water efficiency in non-domestic buildings, a standardized framework for reporting water consumption is useful to allow designers, specifiers, building managers, water authorities and product manufacturers to estimate and report water consumption in a consistent way.

0.2 Non-domestic building types

There is a wide range of building types that constitute non-household buildings including, but not limited to:

- offices;
- restaurants;
- retail buildings;
- industrial buildings;
- hotels;
- leisure buildings;
- education buildings.

Figure 1 Calculating water consumption using BS 8542



1 Scope

This British Standard gives recommendations for calculating the volume of public mains water that is consumed per head per day, per unit per day, or per building per annum for domestic use in non-domestic buildings. It gives recommendations for estimating the total water use from the buildings' components, allowing consumption to be indicated on a whole building level against other buildings for best practice levels.

This standard is not for use as a design guide.

It provides a framework for and details the development of water use calculation methodologies in non-domestic buildings. It provides recommendations for the quality of data used to calculate water use for each component in non-domestic buildings and also standardized reporting for product performance data.

It applies to both new and existing buildings and covers:

- water that is sourced from unwholesome sources such as rainwater harvesting systems or greywater reuse systems; and
- water that is sourced from wholesome sources including both hot and cold water.

This British Standard does not cover design, installation, testing and maintenance of services supplying water for domestic use. Water use in industrial processes or for agricultural, medical or fire suppression applications and external water use such as irrigation or building services, e.g. air conditioning plant and cooling, are also not covered.

It does not provide all data for calculating water use in non-domestic buildings, but provides recommendations for the data used to calculate water use in non-domestic buildings. This includes the product performance data for each terminal fitting and water use research data determining the frequency and duration of use for each terminal fitting.

NOTE Total water use may be determined by metering the building, although it might be difficult to differentiate between domestic water uses and water use for other purposes unless these are sub-metered.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 8515:2009, *Rainwater harvesting systems – Code of practice*

BS 8525-1, *Greywater systems – Part 1: Code of practice*

BS EN 200, *Sanitary tapware – Single taps and combination taps for water supply systems of type 1 and type 2 – General technical specification*

BS EN 817, *Sanitary tapware – Mechanical mixing valves (PN 10) – General technical specifications*

BS EN 997, *WC pans and WC suites with integral trap*

BS EN 1111, *Sanitary tapware – Thermostatic mixing valves (PN 10) – General technical specification*

BS EN 1286, *Sanitary tapware – Low pressure mechanical mixing valves – General technical specification*

BS EN 1287, *Sanitary tapware – Low pressure thermostatic mixing valves – General technical specifications*

BS EN 13407, *Wall-hung urinals – Functional requirements and test methods*

BS EN 14055, *WC and urinal flushing cisterns*

BS EN 14743+A1, *Water conditioning equipment inside buildings – Softeners – Requirements for performance, safety and testing*

BS EN 50242 (BS EN 60436), *Electric dishwashers for household use – Methods for measuring the performance*

BS EN 60456, *Clothes washing machines for household use – Methods for measuring the performance*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 building terminal fittings

different components of water demand

NOTE This includes devices such as WCs, showers, baths, washing machines, dishwashers and taps.

3.2 cistern

fixed, vented container for holding water at atmospheric pressure

3.3 collection area

plan area of the roof or other collection surface, which is to be drained to the rainwater harvesting system

3.4 covers per m²

number of dining spaces per m²

3.5 domestic water use

use related to residential or similar dwellings

NOTE 1 Domestic potable water use includes water for the kitchen sink, wash basins, bath, shower and dishwasher. Domestic non-potable water use includes water for WC flushing, domestic washing machines and garden watering.

NOTE 2 In commercial, industrial or public premises, "domestic use" is limited to water used for those applications/appliances described above and excludes, for example, water used for fire fighting, central heating or irrigation systems.

3.6 effective flushing volume

average volume of water discharged from the flushing device during a flush cycle

3.7 flushing device

device fitted to a cistern to provide controlled, measured volume(s) of water to a WC suite or urinal for flushing

3.8 flush-free

WC suite or urinal designed to operate without the use of a flushing device

3.9 frequency of use factor

average number of uses per day of a terminal fitting based on nominal usage

3.10 greywater

domestic wastewater excluding faecal matter and urine

NOTE This British Standard covers systems using washroom and bathroom greywater including greywater sourced from wash basins, showers and baths.

3.11 hydraulic filter efficiency

loss of rainfall volume collected as a result of the filtering process

3.12 intensity of use factor

average water use of a terminal fitting for each user event as a result of the duration of use and/or the proportion of a terminal fitting's total capacity used per event

3.13 regeneration process

part of softener operating cycle, during which all the operations needed to restore the ion exchange capacity of a resin bed are carried out

3.14 regeneration water

quantity of water, expressed in litres (or in cubic meters), necessary for a complete regeneration process, including water used for the preparation of the brine

3.15 non-domestic building

building other than a dwelling

NOTE A dwelling is a self-contained unit designed to accommodate a single household.

3.16 non-potable/unwholesome water

water not suitable for human consumption that does not meet minimum legal requirements for wholesome water

3.17 per capita consumption

water use in units of litres per person per day

3.18 potable/wholesome water

water suitable for human consumption that meets minimum legal requirements for wholesome water from mains or private extraction

3.19 rainwater

water arising from atmospheric precipitation

3.20 softener

complete installation necessary for the ongoing production of softened water

3.21 softening

reduction of the hardness of water by exchange of alkaline earths ions (mainly calcium and magnesium) with sodium ions, by passing through a bed of cation exchange resin in the sodium form

3.22 terminal fitting

water outlet device

3.23 yield co-efficient

factor that represents the loss of rainfall volume from wetting of the collection area as a result of pitch and surface type

4 Water consumption calculation methodology

4.1 General

The total domestic water consumption in a non-domestic building should be calculated using the following four parameters:

- a) the performance of all terminal fittings as described in 4.7, e.g. the flow rate of a shower (L/min);

- b) the frequency and intensity of use of the terminal fitting, e.g. the number of showers taken per day and the duration of each shower (min);
- c) occupancy data, including the total occupancy, operating hours and male to female ratio; and
- d) the volume of unwholesome water available, including the yield and demand for greywater and rainwater supply systems (L).

Water consumption should be calculated using either of the following two approaches:

- 1) calculated actual water consumption for the building; or
- 2) nominal water consumption.

The required use of the calculation should determine whether calculated actual water consumption or nominal water consumption are used.

Calculated actual water consumption should be used when:

- estimating the building's average and total water consumption; and
- estimating the impact of changing a building's water terminal fitting specification on total water consumption.

Nominal water consumption should be used when:

- indicating water efficiency of the building;
- comparing the building to other buildings of the same type; and
- calculating the consumption of an individual terminal fitting.

4.2 Calculated actual water consumption

The calculated actual water consumption for the building should be calculated using actual occupancy and product performance data for the building, see 4.7. Frequency and intensity of use factors for the building should also be used within these calculations.

NOTE 1 Where this data and actual product performance data is not available, default performance data may be used as provided in Table B.1.

All calculations in Clause 4 should be carried out to two decimal places.

NOTE 2 The calculated actual water consumption is not comparable with in-use metered consumption as metered consumption data can include additional water usage, e.g. irrigation, building services, process water. Metered water consumption can demonstrate a more dynamic situation due to occupant behaviour, which can vary from the assumptions used for calculated actual water consumption in this British Standard.

4.3 Nominal water consumption

Where comparability between buildings is required, the nominal water consumption should be calculated using default occupancy values and frequency and intensity of use factors for similar building types, see 4.7 and, for examples, Annex A. Where available, product performance data that reflects actual terminal fittings in the building should be obtained.

NOTE The default factors in Annex B may be used to calculate nominal water consumption.

4.4 Product performance data

The performance of terminal fittings should be determined in accordance with 4.7. Product manufacturer's performance data should be obtained or default values used if manufacturer's performance data is not available.

NOTE Manufacturer's product performance data is most relevant for new terminal fittings. For existing terminal fittings, if product performance data is not available, default values based on age and type of terminal fittings may be used.

4.5 Frequency and intensity of use factors

COMMENTARY ON 4.5

The frequency of use factor represents the number of uses per person per day for terminal fittings.

The intensity of use factor is applied to terminal fittings where the consumption per use is not fixed and is dependent on user behaviour. The terminal fittings affected include taps and showers where the volume per use is dependent on the duration of use, and also the proportion of total flow rate per use.

For WCs, urinals and other fixed volume terminal fittings, the intensity of use in this British Standard is set at a value of ×1 as there is no user impact on volume per use. The impact of double flushing can be accounted for in the frequency of use factor.

The use of each terminal fitting should be determined by the intensity and frequency of use factor. Actual duration and frequency of use factors for the building should be used if available. Alternative use factors, if available, should be used in accordance with Clause 7.

NOTE Recommended intensity and frequency of use factors may be used from Table B.2, Table B.3 and Table B.4.

4.6 Occupancy data

Occupancy data should be identified and documented for the building as follows:

- a) number of staff, residents and visitors;
- b) hours of operation for the building per day;
- c) average hours of occupation for staff and residents per day;
- d) average duration of stay per visitor per day; and
- e) male to female ratio of staff, residents and visitors.

Where occupancy data is unavailable, occupancy data (occupants per m²) should be obtained from another building of the same building type, size and function, e.g. office areas, staff restaurant and workshop/laboratory areas.

NOTE 1 For calculated actual consumption where actual occupancy data for the building is unavailable, the recommended defaults in Table B.1 may be used.

Where a building contains multiple function areas, the occupancy of each function area should be added together to calculate the total number of occupants for both staff and visitors. This should be calculated for each occupant type as follows:

$$N_o = \sum \{ (m^2 \text{ of function area A} \times D_o) + (m^2 \text{ of function area B} \times D_o) + (\text{etc...}) \} \quad (1)$$

where:

- N_o is the total occupancy of the building for any given working day;
- D_o is the default occupancy for a building function type per m², examples of which are given in Table B.1.

NOTE 2 Table B.1 may be used to provide recommended default occupancy data for function areas in a building based on floor area.

The m² of the function area should be the total occupied internal floor area of the given function, e.g. the total internal floor area of all office areas.

NOTE 3 Where calculating nominal water consumption, the values provided in Table B.1 may be used. Table B.1 is not comprehensive, but provides recommended default occupancy data for the most common non-domestic building types. Occupancy data is used to calculate the total water consumption for the building per annum. Occupancy data may also be used to calculate water consumption per person per day for an individual terminal fitting. BS 6465-1+A1 provides assumptions for building occupancy, which may be used in addition to Table B.1.

4.7 Calculating water consumption of terminal fittings

4.7.1 General

The consumption of each terminal fitting should be calculated in litres per person per day using the equations in 4.7.2 to 4.7.11 and 4.8, examples of which are given in Annex A.

To calculate water consumption, the performance of terminal fittings should be determined. Where the make of the terminal fitting is known, the performance should be determined using standardized performance data from manufacturer's product information, see performance subclauses of 4.7.2 to 4.7.11.

Manufacturer's product performance data should be based upon the testing requirements set out within the relevant British Standard, see Table 1.

NOTE 1 Where the make of the terminal fitting is unknown and manufacturer's product information is not available, the default values set out in Table B.7 may be used. Where the terminal fitting type is unknown, the highest default value from Table B.7 may be used.

Table 1 Product performance data

Terminal fitting	Type	Performance measure	Reference testing standard
WCs	All	Effective flushing volume	The Water Fittings Regulations [1]
Urinals	Flush per use system	Flush volume in litres per use	BS EN 14055
	Controlled system	Flushing frequency per hour and cistern capacity	BS EN 14055
Taps	All	Flow rate in litres per minute	BS EN 200
Showers	All	Flow rate in litres per minute	BS EN 1111 BS EN 1287 BS EN 817 BS EN 1286 BS EN 200
Baths	All	Volume to overflow in litres	Market transformation programme, Baths – water efficiency performance tests [2]
Dishwashers	Domestic	Volume per cycle	BS EN 50242 (BS EN 60436)
Washing machines	Domestic	Volume per cycle	BS EN 60456
Softeners	All	Litres of regeneration water consumed per day	BS EN 14743+A1

NOTE 2 The post-2001 installation default values for WCs and urinals are based on the requirements of the Water Fittings Regulations [1]. Where these are superseded, the default values may be taken from the maximum flush volumes set out in the Water Fittings Regulations [1] as amended.

NOTE 3 Manufacturer's product performance data might not always be available, e.g. for existing buildings where historical data is not available, new water terminal fittings not yet specified. Default figures in Table B.7 allow the typical performance of terminal fittings to be indicated based on their type and age.

4.7.2 WCs

4.7.2.1 Performance

The performance of WCs should be determined by the effective flushing volume. For single flush cisterns, the effective flushing volume should be calculated using the total volume of water consumed per flush. For dual flush WCs, the following calculation should be used:

$$\text{effective flushing volume} = \sum \frac{\{(\text{volume at full flush} \times 1) + (\text{volume at part flush} \times 2)\}}{3} \quad (2)$$

NOTE For dual flush WCs, this includes the flushing volume in litres for the cistern at both full and part flushes.

Manufacturer's data should be obtained to specify the full flushing volume in litres for the cistern.

To determine the flushing volume of WCs, the test methods specified in BS EN 997 should be used.

4.7.2.2 Calculation

The following equation should be used to determine the water consumption of WCs:

$$C = EF \times UF \times IU \times MF_R \quad (3)$$

where:

- C is the consumption in litres per person per day (L);
- EF is the effective flushing volume (L);
- UF is the frequency of use factor (uses per person per day);
- IU is the intensity of use factor (duration or percentage of capacity);
- MF_R is the male to female ratio (%).

Where urinals are present, the consumption of WCs should be calculated separately for males and females and added together to calculate the total consumption.

For the calculated actual consumption, an actual male to female ratio should be used for the building if available. Where urinals are not present, the male to female ratio should be given as 1 to demonstrate an equal use of WCs per day for both male and female users.

NOTE 1 The frequency of use factor for WCs is the average number of times a WC is used per person per day. This assumes a relatively constant use of WCs throughout the year and does not take into account peaks and troughs in water usage.

NOTE 2 The male to female ratio is taken into account for WCs to reflect the presence of urinals. The frequency of use factor for WCs is dependent on whether urinals are present or not, showing a higher frequency of use where urinals are not present.

4.7.2.3 Flush-free WCs

Flush-free WCs should be assumed to have zero water consumption.

NOTE Flush-free WCs, such as composting toilets, have zero water consumption per use, but they might require minimal volumes of water for cleaning purposes.

4.7.3 Urinals

4.7.3.1 Performance

The performance of urinals should be determined by their type and specified as the volume in litres per flush per bowl.

For use-activated flush control urinals, the litres per flush per bowl should be determined from manufacturer's data derived from the test method set out in BS EN 13407.

NOTE Use-activated flush control urinals operate on a flush per use basis and include urinals that are both manually operated on a flush per use basis or operated by proximity detection.

For automatic flush control urinals, the litres per flush per bowl and the number of flushes per hour should be determined from manufacturer's data.

4.7.3.2 Calculation

4.7.3.2.1 Urinals – automatic flush control

The following equation should be used to determine the water consumption of urinals with automatic flush control:

$$C = \frac{EF \times Q_C \times HO \times FH}{N_O} \quad (4)$$

where:

C is the consumption in litres per person per day (L);

EF is the flushing volume (L);

NOTE 1 The flushing volume for urinals is the average flushing volume per urinal bowl. Where a flushing system serves multiple urinal bowls, the flushing volume is the average flushing volume per urinal bowl.

Q_C is the number of urinal bowls served by the system;

HO is the operating hours;

NOTE 2 The operating hours may be taken from the default values provided in Table B.1 to calculate the nominal water consumption for the building type.

FH is the number of flushes per hour;

N_O is the total number of occupants.

NOTE 3 Where calculating total urinal usage for a building or unit, it is not necessary to divide by the total number of occupants.

The actual operating hours should be used to calculate the actual water use for the building if available.

4.7.3.2.2 Urinals – use-activated flush control

The following equation should be used to determine the water consumption of urinals with use-activated flush control:

$$C = EF \times UF \times IU \times MN_O \times PF \quad (5)$$

where:

C is the consumption in litres per person per day (L);