7.12 Quality assurance of point of use devices

7.12.1 Background

A series of test protocols has been produced as an aid for anyone with responsibility for the installation or operation of small drinking water systems. The purpose of the protocols is to provide a consistent basis for evaluating and reporting on the claims made for the performance of water treatment units. It is recommended that testing be carried out in laboratories accredited to ISO 9000 or equivalent for testing or calibration that is relevant to the protocols. Each protocol represents a standard of good practice. Compliance with a protocol does not confer immunity from relevant legal requirements.

The protocols were drafted by the Committee on Point of Use Device Test Protocols. This Committee was appointed by the Department of the Environment in 1991 to provide advice to local authorities on water treatment for private water supplies. Production and editing of the protocols was carried out by WRc under the terms of a DOE research contract.

The protocols incorporate existing standards produced by British Water and were developed on the basis of existing copyrighted standards (ANSI/NSF Standards 42, 44, 53, 55, 58 and 62) produced by NSF International. British Water and NSF International played an active role in developing the protocols and their contributions and permission to make use of copyright material are gratefully acknowledged.

7.12.2 NSF standards

NSF International is an independent, not-for-profit organisation that works with manufacturers, users and regulators to develop and maintain standards, then tests and evaluates products to their requirements. NSF's Drinking Water Treatment Unit (DWTU) programme has the following standards for point of use and point of entry treatment technologies:

- ANSI/NSF 42: Drinking water treatment units - Aesthetic effects
- ANSI/NSF 44: Cation exchange water softeners
- ANSI/NSF 53: Drinking water treatment units - Health effects
- ANSI/NSF 55: Ultraviolet microbiological water treatment systems
- ANSI/NSF 58: Reverse osmosis drinking water treatment systems
- ANSI/NSF 62: Drinking water distillation systems

7.12.2 NSF standards (continued)

All have basic requirements that products must satisfy in order to be certified to the standard:

- verification of contaminant reduction claims made by the manufacturer or assembler for which certification is requested;
- structural integrity testing of the product;
- toxicological assessment and acceptance of all materials used in the fabrication of the product;
- extraction testing and health effects assessments of all materials in contact with the water to assure the product is not adding any substance of toxicological significance; and
- review and acceptance of all labelling and sales literature used with the product.

All certified products bear the NSF Mark and appear in the listing book and on the internet at www.nsf.org.

7.12.3 The test protocols

The following Sections provide a summary of the principal requirements and testing specified in the protocols. All of the protocols include general requirements relating to the suitability of materials in contact with drinking water. The following summaries cover the performance requirements specified in the protocols. The actual protocols should be consulted regarding the detailed requirements and test methodology. The protocols are available in *Adobe Acrobat* format and can be downloaded from http://www.dwi.detr.gov.uk/regs/protocol/index.htm.
Annexes 6.A – 6.E reproduce these test protocols.

It is recommended that only products that conform to the requirements of the test protocols, or relevant standards of international standing (e.g. NSF standards), should be used for treatment of drinking water.

Annex 7.A

7.A Ultraviolet (UV) disinfection units

7.A.1 Performance requirements

Performance indication. Systems shall be equipped with a UV sensor and alarm to monitor UV transmission or intensity through the water during operation.

Disinfection performance. Disinfection performance for a UV system shall provide a minimum UV dose equivalent to 38,000 $\mu W.sec/cm^2$ at the fail-safe point.

UV alarm performance. The alarm shall operate for at least 100 on-off cycles.

7.A.2 Testing

Challenge water is specified as chlorine-free water spiked with *Bacillus subtilis* spores (5×10^4 to 1×10^5 spores/ml). Sufficient parahydroxybenzoic acid (PHBA) is added to reduce UV light transmission to the fail-safe set point in the device.

A calibration is performed to determine the actual UV sensitivity of the *Bacillus subtilis* challenge used in the performance test method. This is done by using a radiometer to determine the output of a UV lamp (not the unit under study). Then samples of challenge water in petri dishes are irradiated for various time periods to provide a graph of organism survival versus total UV dose which is interpolated to determine the inactivation for a UV dose of 38,000 $\mu W.sec/cm^2$.

Testing of flow-through systems is carried out in duplicate using an operating cycle of 50 percent on, 50 percent off with a 15 to 40 minute cycle, 8 hours per day over a 10 day period. Samples of influent and effluent water are collected at specified sampling points. A test method is also given for batch treatment systems. To pass the protocol, the geometric mean of all *B. subtilis* spore counts on influent samples minus the geometric mean of counts on all effluent samples have to demonstrate a reduction of *B. subtilis* equal to or greater than the reduction caused by a dose of 38,000 $\mu W.sec/cm^2$.

A UV alarm system performance test is performed to determine that the UV alarm sensor provided with the system will activate 100 consecutive times in response to decreased UV intensity. The dose of PHBA sufficient to activate the alarm system is determined. This dose is then injected into the feed to the unit in order to activate the alarm. This is repeated 100 consecutive times.

Annex 7.B

7.B Activated carbon filter units

7.B.1 Performance requirements

Rated capacity. The manufacturer or supplier shall state the activated carbon filter rated capacity. This will be confirmed by conducting contaminant reduction tests. This rated capacity will allow for an over-run of at least 20% (e.g. to achieve a rating of 10,000 litres a unit would have to treat 12,000 litres).

Chemical contaminant reduction. The unit may be classified for chemical contaminant reduction in one of the categories below for each chemical contaminant tested.

Category	Reduction (%)
A	≥90
B	70 to 89
C	50 to 69
No category	<50

Silver leaching. The silver content in treated water samples shall not exceed 80 µg/l.

Microbiological growth potential. The geometric mean of the treated water Total Viable Counts (flowing samples) shall be no greater than five times the geometric mean of the influent TVC. The TVCs in stagnation samples shall be no greater than ten times the geometric mean of the TVCs of the influent samples. There shall be no demonstrable increase in *Pseudomonas aeruginosa* numbers. Samples taken immediately after start-up shall have total and faecal coliform counts not exceeding 0 per 100 ml.

Taste and odour. The flowing sample taken at 120% capacity shall comply with the standards for taste and odour.

7.B.2 Testing

The test conditions, test apparatus and test water quality are specified in detail. Duplicate units are tested and water samples are taken to correspond to treated water volumes of 25, 50, 75, 100 and 120% of the manufacturer's claimed capacity. Plumbed-in units are run with an operating cycle of 10% on, 90% off, with a 15 to 40 minute cycle (e.g. 3 min on, 27 min off), for not more than 16 hours per day, 7 days per week. Two stagnation periods are imposed: one period of 80 ± 8 hours after 50% capacity and one of 7 to 10 days after 100% of claimed capacity. Surrogate compounds may be used to test removal of PAHs, phenols, surfactants and THMs but for other species individual compounds have to be tested.

A microbiological growth potential test is conducted to determine whether a filter supports microbiological growth. Silver leaching and taste and odour testing are carried out at the same time. The suitability of the test rig has to be determined prior to the test. The basic test procedure is the same as for chemical reduction testing. For each sampling time (e.g. corresponding to 20% of capacity), samples of influent and effluent are taken and analysed .The odour and taste of the 7-day stagnation sample taken at 100% capacity and the flowing sample taken at 120% capacity are determined. Where an activated carbon filter has silver impregnated carbon and/or other silver treated components in contact with the filtered water the treated water is tested to determine the amount of silver being leached.

Annex 7.C

7.C Ceramic and cartridge filters

7.C.1 Performance requirements

Mechanical filtration units. Claims for particulate reduction may be made for the classes below provided that at least 85% removal of the specified size rating is achieved.

Class	Rating (µm nominal)
I	0.5 to less than 1
II	1 to less than 5
III	5 to less than 15
IV	15 to less than 30
V	30 to less than 50
VI	50 and up

Bacteriological filtration. Claims for reduction of pathogenic bacteria may be made where filtration efficiency of greater than 99.9% is measured against a particle size of 0.5 to 1.0 µgm. Claims for cyst reduction may be made where filtration efficiency of greater than 99.9% is measured against a maximum particle size of 1 to 1.5 µgm.

Filter media. All media, which may be subject to blocking, shall be tested to withstand the maximum pressure drop stipulated by the manufacturer.

Bacteriostatic units. The geometric mean of the treated water Total Viable Counts (TVCs) (flowing samples) shall be no greater than five times the geometric mean of the influent TVC. The TVCs in stagnation samples shall be no greater than ten times the geometric mean of the TVCs of the influent samples; and there shall be no demonstrable increase in *Pseudomonas aeruginosa* numbers.

Silver leaching. The silver content in treated water samples shall not exceed 80 µg/l.

Microbiological contamination. Samples taken immediately after start-up shall have total and faecal coliform counts not exceeding 0 per 100 ml.

Pressure drop. The pressure drop across the clean filter cartridge and housing shall not exceed that specified by the manufacturer at the rated service flow.

7.C.2 Testing

The test conditions, test apparatus and test water quality are specified in detail. Duplicate units are tested. Particulate test water is prepared using standard test dusts. Challenge water is fed to the filters and two successive feed and effluent particle counts are determined for each of the two filters under test.

To test the integrity of the filter media, challenge water is pumped through the test filter until the manufacturer's stated maximum pressure drop is achieved. Influent and effluent samples are checked for turbidity and evidence of media in the effluent.

The pressure drop across the unit is determined by measuring the influent and effluent pressures of the unit under flow.

A test is conducted on filters claimed to be bacteriostatic. Silver leaching testing is carried out at the same time. The suitability of the test rig has to be determined prior to the test. Test water is run through the unit using a cycle of 50% on, 50% off with a minimum cycle time of two hours. Samples of influent and effluent are taken after 25, 50, 75, 100 and 120% of the manufacturer's claimed capacity. In addition, the filter units are allowed to stagnate for a period of 80 ± 8 hours at 50% capacity and for a period of 7 to 10 days at 100% capacity.

Annex 7.D

7.D In situ regenerated ion-exchange nitrate removal units

7.D.1 Performance requirements

Accuracy of the brine system. The brine refill and draw system shall be accurate to within ±5% of the manufacturer's stated figures.

Rated nitrate capacity. The claimed capacity shall be based on the average volume of treated water per pressure vessel produced in three runs between successive regenerations. The treated water nitrite concentration shall be no more than 0.1 mg/l.

Regeneration water volume. The total volume of regeneration water for each pressure vessel shall not exceed 18 bed volumes (BV).

Rinse effectiveness. On completion of a normal regeneration cycle the conductivity of the treated water shall not be more than 20% higher than the conductivity of the mains or test water.

Overrun. When overrun by a factor of twice the rated capacity volume the treated water nitrate level shall not exceed 110% of the influent test water and the nitrite concentration shall not exceed 0.1 mg/l.

Microbiological contamination. Samples taken immediately after start-up shall have total and faecal coliform counts not exceeding 0 per 100 ml.

Microbiological colonisation. Samples of treated water taken one day before and one day after regeneration shall have total viable counts (22 °C, 72 hour) no greater than 100 times the corresponding influent water counts.

7.D.2 Testing

The test conditions, test apparatus and test water quality are specified in detail. Test water has a nitrate concentration of 150±10 mg/l as NO_3, a sulphate concentration of 250±10 mg/l as SO_4, and a nitrite concentration <0.01 mg/l as NO_2. The suitability of the test apparatus for bacteriological testing has to be demonstrated prior to the test run. The unit is conditioned over five exhaustion/regeneration cycles prior to testing. At this stage the coliform counts are measured to check for microbiological contamination. The volume of the brine system is measured five times to determine its accuracy.

The rated nitrate capacity is determined by running the unit and determining nitrate concentrations at intervals. The regeneration water volume is measured during these runs. The overrun test is conducted in a similar manner, running the unit to twice the rated nitrate capacity.

Rinse effectiveness is determined by comparing the conductivity of the test water and treated water immediately following regeneration.

To test whether the resin bed becomes colonised by micro-organisms to an unacceptable extent, samples of influent and treated water are taken and Total Viable Count (22 ˚C, 72 hours) is determined.

Annex 7.E

7.E Reverse osmosis units

7.E.1 Performance requirements

Total Dissolved Solids reduction. Reverse osmosis systems shall reduce the TDS by at least 75%.

Chemical reduction. The system shall reduce the level of contaminant from an influent challenge level of twice the regulated value. The unit may be classified according to the removal achieved, as for activated carbon units (Section 7.3.1).

Product water contamination. Treated water shall be monitored for metals used in the product and the arithmetic mean of all samples and 95% of the individual product water samples shall comply with the regulated concentrations of these metals.

Microbiological growth potential. The geometric mean of the treated water Total Viable Counts shall be no greater than five times the geometric mean of the influent TVC. There shall be no demonstrable increase in *Pseudomonas aeruginosa* numbers.

Microbiological contamination. Samples taken immediately after start-up shall have total and faecal coliform counts not exceeding 0 per 100 ml.

7.E.2 Testing

The test conditions, test apparatus and test water quality are specified in detail. For testing TDS reduction by reverse osmosis membranes a 750 mg/l sodium chloride solution is used (conductivity 1500 µS/cm). For testing nanofiltration membranes a magnesium sulphate solution with a conductivity of 1000 µS/cm is used. The unit is operated continuously and conductivity is measured every five minutes for one hour.

To test chemical reduction, the unit is operated for 7 days against challenge water spiked with contaminants and run continuously. A minimum of 20 samples is taken from the outlet tap and the samples shall be taken at intervals of not less than three hours. The concentrations of metals are measured in the permeate during the chemical contaminant reduction tests to check for contamination from metals in contact with treated water.

The suitability of the test apparatus for bacteriological testing has to be demonstrated prior to the test run. The reverse osmosis unit is checked for microbiological contamination by starting the unit up and immediately sampling for total coliforms, faecal coliforms and total viable count (22 °C, 72 h). The test for microbiological contamination is made on at least 20 samples taken at intervals of not less than three hours.