Requirements and test methods for on site domestic wastewater treatment plants: the European standard (prEN 12566-3) compared to other international standards

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Abstract To ensure that domestic wastewater treatment plants run in an efficient and reliable way, certifications already exist while others will be implemented soon. To date, we have listed eight standards: four from European countries (Germany, Great Britain, The Netherlands and Norway), one project from the European Union, two from North America (USA and Quebec) and one from Australia and New Zealand together. The European procedure includes verification of structure stability, water tightness and treatment capacity at test centre (38 weeks). The American Standard sets minimal standards for materials, dimensioning, building and performances of the plants. It also highlights the information and minimum service that should be provided by the manufacturer and distributors. The review process relating to treatment performances shares major similarities with the EU project since both documents were elaborated almost simultaneously. Australia and New Zealand have adopted a series entitled On-site Domestic Wastewater Treatment Units made up of three parts. The third one integrates construction requirements and describes quite an interesting procedure to efficiently test the small plant: after approximately 13 weeks of testing (half the total duration), the aeration chamber (provided it exists) is filled with sludge from septic tanks to simulate its operation after several years. Overview of the treatment efficiency test procedures of the three main standards is given.

Keywords Domestic; on-site; requirements; standard; wastewater treatment

Introduction

On-site wastewater treatment is gaining more and more importance in the Walloon Region (Belgium). Since 1998 and following EU legislation, the Walloon authorities have decided to prescribe on-site systems for houses located in areas without sewers. Existing houses must be equipped before January 2006 for capacities higher than 20 PE and by January 2010 for those with a capacity ranging from 1 to 20 PE. New houses must be fitted at the time of building.

According to a recent decree (2003), old houses may be granted a governmental funding of 2,500 for 5 EH, provided their on-site systems are approved by a technical committee.

At EU level, the European Committee for Standardization (CEN), particularly Technical Committee 165, has developed a draft European Standard called “Small wastewater treatment systems for up to 50 inhabitants – Part 3: Packaged and/or site assembled domestic wastewater treatment plants”. This document (prEN 12566-3, 2003), which will come soon into force, specifies requirements, test methods, as well as the marking and factory production control for small wastewater treatment plants used for raw domestic wastewater.

The Belgian Federal Office for Scientific, Technical and Cultural Affairs (OSTC) has funded a research program responsible for evaluating and assessing the European standard (four Belgian scientific partners: FUL, CSTC, VITO and CEBEDEAU). One of its first tasks was to compare the European project with other international standards. This
paper presents and explains existing or soon-to-come standards that apply to on-site domestic wastewater treatment plants, with special emphasis on the European project.

**Standards for on-site domestic wastewater treatment plants**

To ensure that domestic wastewater treatment plants run in an efficient and reliable way, certifications already exist while others will be implemented soon. The following two very different approaches coexist:

1. Technical assessment by an experts committee, consisting in an objective evaluation of the product, mainly based on a technical dossier. This approach has been extended recently throughout the Walloon Region in the framework of the special allowance (Decree of the Walloon Government of 19.07.2001, *Moniteur Belge* of 28.08.2001) and is one of the missions of the Scientific and Technical Center for Building (CSTB) in France. This procedure has the advantage of being both inexpensive and quick. Yet, the quality of the assessments expressed is dependent on the quality of the information made available to experts: technical specifications, visual examination of the product, on-site visit and so on. Overall treatment performance remains questionable if the results are not validated by an independent body.

2. Compliance with the requirements of a product-based standard including the experimental measurement of treatment performances according to a detailed protocol. Although more costly and usually longer, this approach can guarantee the effectiveness of the product and its compliance with building constraints. Due to its experimental approach, it can better assess innovative products and technological developments.

We took an inventory of eight documents containing a description of the requirements relating to low-capacity individual wastewater treatment units. These are listed in Table 1.

The EN 12566 series of European standards is dedicated to small wastewater treatment systems for up to 50 PE and contains six parts:

- Part 1: Prefabricated septic tank
- Part 2: Soil infiltration systems (soon to be released)
- Part 3: Packaged and/or site assembled domestic wastewater treatment plants (project submitted to the Formal Vote)
- Part 4: Septic tanks built *in situ* from prefabricated kits – execution standard (soon to be released)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>State</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>prEN 12566-3</td>
<td>2003</td>
<td>European Union</td>
<td>Small Wastewater Treatment Systems ≤ 50 PE; Part-3-Packaged and/or site assembled Domestic Wastewater Treatment Plants.</td>
</tr>
<tr>
<td>DIN 4261</td>
<td>1984</td>
<td>Germany</td>
<td>Small sewage treatment plants; plants with sewage aeration; application, design, construction and testing.</td>
</tr>
<tr>
<td>ANSI/NSF 40</td>
<td>1999</td>
<td>United States</td>
<td>Residential Wastewater Treatment Systems</td>
</tr>
<tr>
<td>NQ 3680-910</td>
<td>2000</td>
<td>Quebec</td>
<td>Wastewater treatment – Stand-alone Wastewater Treatment Systems for Isolated Dwellings.</td>
</tr>
<tr>
<td>AS/NZS 1546:3</td>
<td>2001</td>
<td>Australia/New Zealand</td>
<td>On-site domestic wastewater treatment units: aerated wastewater treatment systems.</td>
</tr>
<tr>
<td>TA-604</td>
<td>1986</td>
<td>Norway</td>
<td>Specifications and guidelines for approval of small wastewater treatment plants (≤ 35 PE).</td>
</tr>
</tbody>
</table>
Part 5: Filtration systems (including sand filters) (soon to be released)
Part 6: On site testing (soon to be released)

Part 3 specifies, among other things, test methods at a platform centre used to evaluate wastewater treatment efficiency.

The initial releases of the project were largely inspired by the English document (document 94/103014) which already described the influent daily flow pattern, sample collections (24-h composite) and stress tests (holiday period, power break down, washing machine discharges).

In 2000, the Dutch certification body (KIWA) published its BRL-K10002 standard describing the procedure to control the quality of treated water. Testing, carried out over a period of 26 weeks, was largely inspired by the then current version of the prEN 12566-3. It also contains a ranking of the treatment plants according to the quality of effluents.

The American ANSI/NSF Standard 40 sets minimal standards for materials, dimensioning, building and performances of residential plant. It also highlights the information and minimum service that should be provided by the manufacturer and distributors. The review process relating to treatment performances shares major similarities with the prEN 12566-3 since both documents were elaborated almost simultaneously. It is worth noticing that the certification organization keeps an updated list of labelled plants (NSF listing; wastewater treatment units and related products, components and materials, NSF International) and that a standard regarding the disinfection treatment of residential water is under preparation (draft ANSI/NSF 46).

The standard in force in Quebec is a retranscription of the French NSF document (the NSF certification programme is officially confirmed by the Standards Council of Canada) with some minor changes. The most interesting difference lies in the imposition of a minimum concentration at the outlet of the septic tank if the plant is equipped with a septic tank before measuring treatment performances.

Finally, Australia and New Zealand have adopted the AS-NZS 1546 series entitled On-site Domestic Wastewater Treatment Units made up of three parts:
- Part 1: Septic Tanks (1998),
- Part 2: Waterless Composting Toilets (2001),

The latter integrates construction requirements and describes quite an interesting procedure to efficiently test the small plant: after approximately 13 weeks of testing (half the total duration), the aeration chamber (provided it exists) is filled with sludge from septic tanks to simulate its operation after several years. Disinfection needs, if any, are also accounted for.

Finally, the DIN 4261 standard, the oldest one, defines the dimensioning criteria for different processes; one paragraph deals with performance review.

**Comparison between different standards**
Given the similarities between the various standards, we will focus more specifically on the European project as well as on the North American and Australian/New Zealand documents. We shall also highlight the differences between testing procedures.

**Performance review**
The European procedure includes verification of structure stability, water tightness and treatment capacity at test centre (38 weeks). The water tightness imposes that the water loss, after 30 minutes, should be \( \leq 0.1 \text{ l/m}^2 \) of the internal wet surface for tanks made up of concrete. For tanks constructed of plastics or other material, no leakage shall occur. Calculation and test methods for structural behaviour are performed to ensure that the plants resist to loads and stresses resulting from handling, installation and use, including desludging and maintenance.
The American standard also includes a simple *in situ* visual evaluation of the structural integrity and a water tightness test: after 24 hours, the water loss should not exceed 0.5% change in the initial water level. The noise associated with system operation measured at 6 metres must remain under 60 dBA. Treatment performances are evaluated over a 6-month period.

Australian/New Zealand standard specifies performance requirements: the maximum permissible noise level measured at 1 m shall be 40 dBA. Effluent compliance criteria are checked over a period of 26 weeks.

The DIN standard specifies that stability, imperviousness to water and corrosion resistance shall be demonstrated. Treatment efficiencies shall be assessed on a 12-month period.

According to British, Norwegian and Dutch standards, only effluent performances are controlled, during 40 (or 52) weeks, at least 6 months and 12 months, respectively.

**Requirements**

Generally speaking, all above-mentioned references specify that materials should be stable, durable and in compliance with national and European legislations.

Access to the different bodies is requested to provide maintenance, washing, desludging and sampling. Sometimes dimensions are specified (prEN).

An alarm system to prevent disfunctioning may be required. It can be equipped with a different range of functionalities: acoustic or visual signals (DIN), noise level between 70 to 75 dBA or visible from 15 metres (ANSI/NSF).

Specifications are also provided within AS/NZS whereas pr-EN only requires an alarm to prevent any disfunctioning without specification. The various standards usually specify that the electric system shall comply with current regulations in this field.

**Information to be provided by the manufacturer**

This is where the strongest divergence is recorded in terms of the approaches adopted by European and American standards. While prEN-12566-3 simply requires the manufacturer to supply clear instructions in terms of installation (providing some details) and maintenance in the local language, both ANSI/NSF and NQ standards detail each piece of information to be supplied:

- a user manual containing a description of the installation, a list of inadvisable products, the frequency of desludging, the details and telephone number in case of default,
- an installation guide containing technical specifications, plans and pictures, the startup procedure also. It should be noted, however, that distributors and installers shall be authorized and recognized by the manufacturer,
- a maintenance guide with the maintenance, detection of disfunctioning, as well as sampling procedures,
- an emergency guide in case of default.

Beyond this detailed information, the American supplier shall ensure:

- a 2-year service contract, included in the initial price of the wastewater treatment station including five technical inspections and a verification of the quality of the effluent,
- the possibility to subscribe to an extension of maintenance contract,
- sufficient stock of spare parts,
- an emergency repair service available within 48 hours.
The AS/NZS standard comes with two informational appendices providing additional details on the specific information that needs to be mentioned in the installation guide and user manual.

**Evaluation of treatment performance**

**Yields or concentrations?**

National legislations in The Netherlands, USA and Quebec classify domestic wastewater treatment plants according to their efficiency, which is generally expressed in terms of effluent concentrations. For indicative purposes, Table 2 contains a summary of the various categories defined in BRL K10002.

Thus the results of performance measurements boil down to classifying tested plants within one of the classes, the denomination of which will appear clearly on the marking.

In Australia and New Zealand, effluent that is to be of secondary quality shall meet the following characteristics:

- BOD₅: 90% of the samples ≤ 20 mg/L and no sample > 30 mg/L.
- SS: 90% of the samples ≤ 30 mg/L and no sample > 45 mg/L.

In Europe, the definition of effluent regulations depends on national or regional jurisdictions, while prEN 12566-3 makes no reference to quality objectives (effluent concentrations or minimum yield to be reached). It only measures the treatment yields of COD, BOD₅ and SS parameters (temperature and power consumption also, other parameters as N and P if required) and checks the compliance with the yields announced by the supplier (tolerance of ± 7%). Such yields will appear in the EC marking.

**Description of tests**

Our objective is not to describe test procedures in detail (the reader can find all information requested in the original publications of the standards) but rather to identify their respective similarities and originalities. Table 3 provides an overview of the three major standards.

Both the European and American standards prescribe relatively complex procedures likely to simulate the on-site operation of the wastewater treatment plant. Different types of stress are being reproduced simulating under- and overloading, even power breakdowns. It is worth mentioning that the simulation of washing machine outlets was abandoned in the European standard.

The Quebec standard forms a useful complement to the American standard: before initiating samplings and analyses, sewage water coming out of the septic tank (pre-treatment) should have a minimum load (BOD₅ ≥ 140 mg/L or COD ≥ 250 mg/L, and SS ≥ 50 mg/L).

The Australian/New Zealand standard is somewhat more specific: it imposes the pre-processing chamber to be filled in with 800 L of sludge from a septic tank so as to simulate

**Table 2 Dutch classifications according to effluent quality**

<table>
<thead>
<tr>
<th></th>
<th>Class I</th>
<th>Class II</th>
<th>Class IIIa</th>
<th>Class IIIb</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD₅ (mg/L)</td>
<td>&lt; 250</td>
<td>&lt; 30</td>
<td>&lt; 20</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>&lt; 750</td>
<td>&lt; 150</td>
<td>&lt; 100</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>NH₄-N (mg/L)</td>
<td>&lt; 2</td>
<td>&lt; 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tot-N (mg/L)</td>
<td>&lt; 30</td>
<td></td>
<td>&lt; 30</td>
<td></td>
</tr>
<tr>
<td>Tot-P (mg/L)</td>
<td>&lt; 2</td>
<td></td>
<td>&lt; 2</td>
<td></td>
</tr>
<tr>
<td>SS (mg/L)</td>
<td>&lt; 70</td>
<td>&lt; 30</td>
<td>&lt; 30</td>
<td>&lt; 30</td>
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</tbody>
</table>
Table 3 Overview of the treatment efficiency test procedures for 3 major standards

<table>
<thead>
<tr>
<th>prEN 12566-3</th>
<th>ANSI/NSF 40-1999</th>
<th>AS/NZS 1546.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Number of plants to be tested and location of the test plant</strong>&lt;br&gt;A representative model from a range, normally the smallest size/Test platform</td>
<td>A system with the smallest hydraulic capacity within the series/Test platform (not said explicitly)</td>
<td>One system/Test platform</td>
</tr>
<tr>
<td><strong>2. Field of application and test duration</strong>&lt;br&gt;* Up to 50 PE * Capacities between 1,514 L/day and 5,678 L/day * 26 weeks</td>
<td>* Capacities up to 14,000 L/week * 26 weeks</td>
<td></td>
</tr>
<tr>
<td><strong>3. Influent</strong>&lt;br&gt;Raw domestic wastewater (coarse screening and removal of grit acceptable) with quality:&lt;br&gt;* BOD5 = 150–500 mg/L or COD = 300–1,000 mg/L&lt;br&gt;* SS = 200–700 mg/L&lt;br&gt;* KN = 25 to 100 mg/L or NH4-N = 22–80 mg/L&lt;br&gt;* Tot P = 5–20 mg/L</td>
<td>The 30-day average shall be between:&lt;br&gt;* BOD5 = 100–300 mg/L&lt;br&gt;* SS = 100–350 mg/L</td>
<td>Raw influent after coarse screening with the following characteristics:&lt;br&gt;* BOD5 = 150–300 mg/L&lt;br&gt;* SS = 150–300 mg/L&lt;br&gt;* Tot N = 20–100 mg/L&lt;br&gt;* Tot P = 6–25 mg/L</td>
</tr>
<tr>
<td><strong>4. Daily flow pattern</strong>&lt;br&gt;Percentage of daily flow&lt;br&gt;3 hours 30%&lt;br&gt;3 hours 15%&lt;br&gt;6 hours 0%&lt;br&gt;2 hours 40%&lt;br&gt;3 hours 15%&lt;br&gt;7 hours 0%</td>
<td>Percentage of daily hydraulic capacity&lt;br&gt;6 am to 9 am 35%&lt;br&gt;6 am to 11 am 25%&lt;br&gt;11 am to 2 pm 25%&lt;br&gt;5 pm to 8 pm 40%</td>
<td>6 am to 11 am X L/h&lt;br&gt;6 pm to 9 pm X L/h&lt;br&gt;with X = 150 for 8 persons&lt;br&gt;170 for 9 persons&lt;br&gt;190 for 10 persons&lt;br&gt;Based on 150L/PE</td>
</tr>
<tr>
<td>prEN 12566-3</td>
<td>ANSI/NSF 40-1999</td>
<td>AS/NZS 1546.3</td>
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<tr>
<td>4. Nominal flow – Power breakdown during 24 h, 5 samplings. 6 weeks</td>
<td>4. Design loading, sampling. 2.5 weeks. Influent and effluent samples shall be flow-proportional, 24-hour composites obtained during periods of system dosing. 5 samples a week during design loading sequences. During stress loading, samples shall be collected on the day the stress is initiated. Samples are collected for 6 consecutive days, 24 h after the completion of stresses</td>
<td>4. Testing week, sampling 1 week</td>
</tr>
<tr>
<td>5. Low occupation stress, no flow, no sampling. 2 weeks</td>
<td>5. Sludge loading</td>
<td></td>
</tr>
<tr>
<td>6. Nominal flow, 3 samplings. 6 weeks</td>
<td>6. Normal flow, no sampling till 25th week</td>
<td></td>
</tr>
<tr>
<td>7. Overloading, 125 or 150% nominal flow during 2 days, 2 samplings. 2 weeks</td>
<td>7. Testing week, sampling 1 week</td>
<td></td>
</tr>
<tr>
<td>8. Nominal flow – Power breakdown during 24 h, 5 samplings. 6 weeks.</td>
<td>During testing week, the following procedure is performed: Day 1: increasing hourly flow by 20% Days 2, 3, 4 and 5: $t = 00$ min: adjust flow to 30L/person/hour $t = 30, 60, 90$ min: sample $t = 120$ min: sample and adjust flow to 600 L/h $t = 150$ min: sample and adjust flow to day 1 Day 5: after sampling, return to normal flow</td>
<td></td>
</tr>
<tr>
<td>9. Underloading, 50% nominal flow, 2 samplings. 2 weeks</td>
<td>10. Nominal flow, 3 samplings. 6 weeks. Peak flow discharge (200L in 3 min) shall be executed once a week during nominal sequences. Inlet and outlet samples shall be flow-based, composite over 24 h</td>
<td></td>
</tr>
<tr>
<td>10. Nominal flow, 3 samplings. 6 weeks.</td>
<td>6. UEl Maintenance</td>
<td>Operation according to manufacturer’s specifications, yet no maintenance during the test</td>
</tr>
<tr>
<td><strong>6. UEl Maintenance</strong></td>
<td>Maintenance on week 12 and week 24</td>
<td></td>
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</tbody>
</table>
operation over several years. It is also more simple: periods of functioning at nominal load shall alternate with ± 120% load, with one significant stress (600 L/h) and no under loading.

Both the Norwegian and German documents advocate on-site testing, i.e. three plants must be tested at different loads for TA-604 (Norway) and only one with not less than two thirds of nominal capacity for DIN 4261 (Germany).

Conclusions
The EC label shall be granted to domestic wastewater treatment plants (up to 50 PE) fulfilling the requirements described in the future EN 12566-3 standard, including control of treatment yields announced by the manufacturer. Consequently the standard is not aimed at recognising the intrinsic qualities of the product as such. More particularly, it will not guarantee both the user and public authorities that the national regulation regarding sewage standards is actually met.

The control of treatment yields according to prEN 12566-3 is both complex and relatively time-consuming. Other standards allow shorter test periods. AS/NZS imposes a simple test and simulates a longer operation period by injection of sludge from septic tanks in the pre-processing chamber of the treatment plant. In our opinion, this approach is worth considering.

The American standard highlights the need for user protection by imposing manufacturers to provide extensive information on the product to both users and installers. The American standard even imposes a compulsory service contract as well as an emergency repair service. This is also the right way to ensure proper environmental protection as the efficiency of the plant depends on both the installer and the end-user in terms of monitoring, maintenance, desludging, etc.

The imminent adoption of EN 12566-3 standard is a major breakthrough. This will surely have far-reaching consequences on the market. One can expect to see ill-manufactured products with mediocre treatment performance disappear, maybe along with smaller manufacturers for whom labelling costs will be prohibitive. Better serving the interests of the plant users, like ANSI/NSF regulations do, would also be auspicious.

Acknowledgements
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