NSF International Standard /
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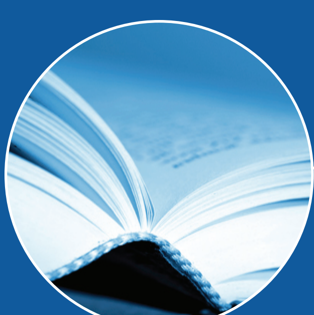
NSF/ANSI 245 - 2013

Wastewater Treatment Systems - Nitrogen Reduction



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NSF International Standard/
American National Standard
for Wastewater Technology —

Nitrogen reduction

Standard Developer

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Contents

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Foreword[2]

The purpose of this Standard is to establish minimum materials, design and construction, and performance requirements for residential wastewater treatment systems providing for nitrogen reduction. This Standard also specifies the minimum literature that manufacturers shall supply to authorized representatives and owners, as well as the minimum service-related obligations that manufacturers shall extend to owners.

The Joint Committee on Wastewater Technology granted NSF International the authority to proceed with the evaluation and development of a stand-alone Nutrient Reduction Standard. A task group of Joint Committee members was formed to do the evaluation and bring recommendations to the Joint Committee. After evaluating the scope of the Standard, the task group decided to narrow the focus to nitrogen reduction and revisit the issue of reduction of other nutrients at a later time.

This Standard (NSF/ANSI 245-2013) includes the following change:

> **Issue 7** – The purpose of this ballot was to update the language in section 8.4.1 for consistency among wastewater standards relating to pH grab samples. The change in section 9 addressed a comment on the ballot 40i20 regarding when adjustments to alkalinity are made, they are required to be reported.
>
> **Annex B Nitrogen reduction measurement (informational) -** The purpose of this annex is to help Regulators and Users of this Standard understand the percent reduction for nitrogen reduction in comparison to a set nitrogen effluent limit.

This Standard was developed by the NSF Joint Committee on Wastewater Technology using the consensus process described by the American National Standards Institute.

Suggestions for improvements of this Standard are welcome. This standard is maintained on a Continuous Maintenance schedule and can be opened for comment at any time. Comments should be sent to Chair, Joint Committee on Wastewater Technology at standards@nsf.org, or c/o NSF International, Standards Department, P.O. Box 130140, Ann Arbor, Michigan 48113-0140, USA.

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NSF/ANSI Standard
for Wastewater Treatment Systems —

Nitrogen Reduction

1 General

1.1 Purpose

The purpose of this Standard is to establish minimum materials, design and construction, and performance requirements for residential wastewater treatment systems providing for nitrogen reduction. This Standard also specifies the minimum literature that manufacturers shall supply to authorized representatives and owners, as well as the minimum service-related obligations that manufacturers shall extend to owners.

1.2 Scope

This Standard contains minimum requirements for residential wastewater treatment systems having rated treatment capacities of 1514 L/d (400 gal/d) to 5678 L/d (1500 gal/d) that are designed to provide reduction of nitrogen in residential wastewater. Management methods for the treated effluent discharged from these systems are not addressed by this Standard. A system, in the same configuration, must either be demonstrated to have met the Class I requirements of NSF/ANSI 40 or must meet the Class I requirements of NSF/ANSI 40 during concurrent testing for nutrient removal.

The water chemistry of a site for installation and use of these systems is critical to achieve expected water quality results. Before these systems are installed at a location, the water used within the residence must be analyzed to verify that there is sufficient alkalinity to achieve the system's performance. Refer to Annex A for further explanation.

Natural systems involving features such as vegetation, wetlands, free access or buried sand filters, and soil systems may be evaluated using this protocol as long as effluent samples are representative of all treated effluent discharged from the system, as sampled from a central point of collection of all treated effluent.

1.3 Alternate materials, design, and construction

While specific materials, designs, and constructions may be stipulated in this Standard, systems that incorporate alternate materials, designs, or constructions may be acceptable when it is verified that such systems meet the applicable requirements herein.

1.4 Performance classification

For the purpose of this Standard, systems are classified according to the chemical, biological, and physical characteristics of their effluents as determined by the performance testing and evaluations described herein.

All systems within a manufacturer's model series may be classified according to the performance testing and evaluation of the system with the smallest hydraulic capacity within the series. Performance testing and evaluation of larger systems within the series (having hydraulic treatment capacities within the scope of this Standard) may not be necessary provided that the dimensions, hydraulics, mixing, filtering and biological treatment capabilities, and other applicable design characteristics are proportionately equivalent to the evaluated system.

2 Normative references

The following documents contain provisions that, through reference in this text, constitute provisions of this Standard. At the time of publication, the indicated editions were valid. All standards are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the standards indicated below.

American Public Health Association (APHA), American Water Works Association (AWWA) & Water Environment Federation (WEF): *Standard Methods for the Examination of Water and Wastewater,* 21st Edition, 2005 (hereinafter referred to as *Standard Methods*)[3]

ANSI/AWS D.1.1/D1.1M:2010, *Structural Welding Code – Steel*[4]

ANSI/AWS D1.3/D1.3M:2008, *Structural Welding Code – Sheet Steel,* 5th Edition, with Errata[4]

NFPA 70®: *National Electrical Code®* (NEC®), 2011[5]

NSF/ANSI 40, *Residential Wastewater Treatment Systems*

US EPA, *Code of Federal Regulations (CFR), Title 40: Protection of Environment, July 1, 2010*[6]

3 Definitions

3.1 authorized representative: An organization, group, individual, or other entity that is authorized by the manufacturer to distribute, sell, install, or service residential wastewater treatment systems.

3.2 average: The sum of individual measurements taken during a given period divided by the total number of measurements taken during the same period.

3.3 biochemical oxygen demand (BOD_5): The concentration of oxygen (expressed as mg/L) utilized by microorganisms in the oxidation of organic matter during a 5-d period at a temperature of 20 °C (68 °F).

3.4 carbonaceous 5-d biochemical oxygen demand ($CBOD_5$): The concentration of oxygen (expressed as mg/L) utilized by microorganisms in the nonnitrogenous oxidation of organic matter during a 5-d period at a temperature of 20 °C (68 °F).

3.5 components: All of the physical, mechanical, and electrical parts that comprise residential wastewater treatment systems.

3.6 manufacturer: The entity that develops, designs, and produces residential wastewater treatment systems.

3.7 residential wastewater (wastewater): Human body waste and liquid waste generated by the occupants of an individual residence.

3.8 residential wastewater treatment system: An organized and coordinated system of components that functions to treat wastewater generated by individual residences.

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[3] Standard Methods for the Examination of Water and Wastewater <www.standardmethods.org>.

[4] American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126 <www.aws.org>.

[5] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-7471 <www.nfpa.org>.

[6] Superintendent of Documents, U.S. Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401 <www.gpo.gov>.

3.9 total nitrogen: The sum of the total Kjeldahl nitrogen (TKN), nitrite (NO_2) and nitrate (NO_3) in a sample, expressed as mg/L as N.

3.10 total suspended solids (TSS): The quantity of solids (expressed as mg/L) that can be readily removed from a well-mixed sample with standard laboratory filtering procedures.

3.11 upset: An exceptional incident in which there is unintentional and temporary noncompliance with designated effluent limitations because of factors beyond the reasonable control of the manufacturer.

3.12 wash load: The discharge from a residential clothes washer or clothes washer simulator. A wash load consists of 1 wash and 2 rinse cycles completed within 45 min. Powdered laundry detergent and powdered non-chlorine bleach are included in each wash load. The detergent and bleach are added at the rates specified on the detergent and bleach packaging for a single large wash load. Each cycle consists of 45.4 ± 3.8 L (12 ± 1 gal) of water. Wash and rinse temperature shall be between 20 and 30 °C (68 and 86 °F).

3.13 30-day (30-d) average: The average of daily measurements over a calendar month, calculated as the sum of all daily measurements taken during a calendar month divided by the number of daily measurements taken during that month.

4 Materials

Materials shall be durable and capable of withstanding stresses and wear during shipping, assembly, installation, and operation. System materials shall not be adversely affected when subjected to the use environment.

NOTE – Because there are numerous design criteria suitable for the manufacture of residential wastewater treatment systems, manufacturers should acquire appropriate engineering expertise in evaluating the design of the system.

4.1 Interior surfaces

The interior surfaces of the system shall be free of spalls, honeycombs, and pits with the exception that rough surfaces, intended to support microbiological growth, shall be permitted. Following performance testing and evaluation, interior surfaces shall show no visible signs of structural change, including, but not limited to, flaking, pitting, or the formation of structurally significant cracks.

4.2 Exterior surfaces

Following performance testing and evaluation, exterior surfaces shall show no visible signs of structural change, including, but not limited to, flaking, pitting, or the formation of structurally significant cracks.

NOTE – Small surface cracks exhibited by concrete tanks are normally expected in some circumstances and shall not be considered structural deterioration.

4.3 Welding

Welded seams and deposited weld material shall meet the requirements of 4.1 and 4.2. Welds and welding methods shall conform to ANSI/AWS D1.1[4] for steel 1/8 in (3.2 mm) and thicker or ANSI/AWS D1.3[4] for steel that is less that 1/8 in (3.2 mm). The welds shall be visually inspected and shall be acceptable if the criteria of Table 6.1 of ANSI/AWS D1.1[4] are satisfied.

The location, type, and size of welds shall be shown on the drawings required in 7. Welds that do not conform to the manufacturer's drawings, based on visual examination of the weld, shall be repaired prior to testing and the repairs noted in the final report. The system shall be free from cracks at the interface between the base metal and the weld, or within the weld metal.

4.4 Dissimilar metals

Dissimilar metal materials, not considered compatible at the electromotive level, shall not be in direct contact. An electrically nonconductive insulating fitting shall be provided at the junction between such dissimilar metal parts or components.

5 Design and construction

5.1 Exposed surfaces

All exposed surfaces shall be free from nonfunctional rough or sharp edges that may cause injury to persons using, installing, maintaining, or servicing the system.

5.2 Structural integrity

The system, when filled or empty, shall maintain its structural integrity when subjected to earth and hydrostatic pressures. An *in situ* visual evaluation shall be performed during and after the performance testing and evaluation.

5.3 Infiltration and exfiltration resistance

The system, including all joints, seams, and components, shall preclude infiltration of ground water into the system and exfiltration of wastewater out of the system. Inlet and outlet ports shall have a short section of sewer pipe installed per the manufacturer's installation recommendations. The test pipe sections shall be capped and shall be leak free at the caps. The system shall be filled to the ceiling of the tank with tap water and held for 24 h. At the end of this 24-h period, there shall be no more than a 0.5% change from the initial water volume of the system.

> NOTE – At the manufacturer's discretion, the system may be filled to the high water alarm level with tap water and held for up to 24 h prior to the start of the infiltration and exfiltration resistance test.

5.4 Noise

When installed according to the manufacturer's instructions, the system shall not produce excessive noise. Noise associated with system operation, measured at 1.2 m (4 ft) above the ground surface, 6 m (20 ft) in four directions, at 90, 180, 270, and 360° from the system and its appurtenances, shall not exceed 60 dbA.

5.5 Mechanical components

Mechanical components shall not require periodic maintenance or adjustment by the owner.

> NOTE – Replacement of fuses and similar devices or visual inspection of warning devices do not qualify as periodic maintenance or adjustment.

5.6 Electrical components

Electrical components shall be protected by safety devices, such as circuit breakers and fuses. NFPA 70®[5] shall be followed for all electrical components, electrical connections, system installation, and system operation.

5.7 Access ports

5.7.1 The system shall be demonstrated to have ground-level access ports that are sized and located to facilitate the installation, removal, sampling, examination, maintenance, and servicing of components and compartments that require routine maintenance and inspection.

The ground-level access ports shall be of sufficient size and located so as to allow for the following:

– visual inspection and removal of all mechanical or electrical components;

– periodic cleaning or replacement of components and removal of residuals as required by the manufacturer in the operations and maintenance manual;

> NOTE – "Periodic" refers to all procedures specified in the manufacturer's operation and maintenance manual that must be performed within intervals of two years.

– visual inspection and sampling as required by the manufacturer in the operations and maintenance manual, including a means for collecting a representative effluent sample, determining the need for residuals removal and determining the need for replenishing treatment chemicals (if required); and

– removal (manually or by pumping) of collected residuals as required by the manufacturer in the operations and maintenance manual. If the operation and maintenance manual describes a means to determine the need to remove residuals from a chamber without ground-level access, then only the ability to install ground-level access shall be required. Systems without ground-level access to a chamber shall be equipped with a means to locate the opening to the chambers. This information shall be provided on or in a ground-level access opening.

5.7.2 Access ports shall be protected against inadvertent unauthorized intrusions. Acceptable protective measures include, but are not limited to, a:

– padlock;
– cover that can be removed only with specialized tools; or
– cover having a minimum net weight of 29.5 kg (65 lb).

5.8 Failure sensing and signaling equipment

The system shall possess a mechanism or process capable of detecting failures of electrical and mechanical components, or the need for replenishment of treatment chemicals, critical to the treatment processes, and of delivering a visible and audible signal to notify the owner or user of the failure. The system shall possess a mechanism or process capable of detecting a high water condition and delivering a visible and audible signal to notify the owner or user that the water level is above normal operating specifications.

The visual and auditory signals shall continue to be functional in the event of an electrical, mechanical, or hydraulic malfunction of the system providing power is available to the system and shall resume once power is restarted following the power outage. This does not mandate a battery back-up for the alarm system.

Compliance with the requirements of section 5.8.1 and 5.8.2 shall be determined by a group of three observers. Observers shall be employees of the test agency.

5.8.1 Visual Alarm Test

The audible portion of the alarm shall be disabled during the visual alarm test. The visual portion of the signal shall be conspicuous from a distance of 15 m (50 ft). There shall be a minimum of 5 random on/off trials of the visual alarm. The observers shall turn their backs to the alarm panels such that they cannot see the visual portion of the alarm prior to each trial during the visual alarm test. The visual alarm shall be on for a minimum of one trial and off for a minimum of one trial during the test but the on/off condition shall otherwise be selected randomly. Observers shall face the alarm panel when requested during the test. Compliance with these requirements is demonstrated only when all observers provide the correct answer for each trial.

5.8.2 Audible Alarm Test

The visual alarm shall be disabled during the audible alarm test. Observers shall have their backs to the alarm during the audible testing. The audible portion of the signal shall be discernible from a distance of 15 m (50 ft) with a minimum ambient noise level of 60 dbA. When the ambient noise level is less than 60 dbA, it shall be augmented with a steady tone between 100 and 1000 hertz. The ambient noise level shall be measured at the location where the observers will be located. The audible alarm shall be activated a minimum of 3 times. The observers shall record the number of times the audible alarm was heard. Compliance with these requirements is demonstrated only when all observers record the correct number of times the alarm was activated. The audible portion of the alarm shall not exceed 90 dbA at a distance of 3 m (10 ft) when measured outdoors with both the alarm panel and sound level meter located at a minimum of 7.6 m (25 ft) from any permanent structure.

5.9 Flow design

Systems shall have a designated flow path that is reflective of the entire treatment process. During periods of normal system operation, as well as periods of system and component malfunction, the design and construction of the system shall preclude alternative flow paths and prevent the discharge of wastewater from an opening external to the designated flow path.

NOTE – The discharge of wastewater from access ports shall be permissible during system malfunction.

5.10 Data plate and service label

5.10.1 Systems shall have two permanent and legible data plates. One data plate shall be affixed to the front of the electrical control box. The second data plate shall be placed on the tank, aeration equipment assembly, or riser at a location accessed during maintenance cycles and inspections. The data plates shall include:

- manufacturer's name and address;
- model number;
- serial number (required on one data plate only);
- rated daily hydraulic capacity of the system; and
- the system classification as determined with the performance testing and evaluation requirements described herein.

5.10.2 A clearly visible label or plate that provides instructions for obtaining service shall be permanently located near the failure signal.

6 Product literature

6.1 Owner's manual

Each system shall be accompanied by a manufacturer-prepared owner's manual. The authorized representative shall provide the manual to the owner at the time of system installation. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

- the system's model designation;

- a statement confirming that the system meets the requirements in NSF/ANSI 245;

- a functional description of system operation, preferably including diagrams illustrating basic system design and flow path;

- a clear statement of examples of the types of waste that can be effectively treated by the system;

- a list of household substances that, if discharged to the system, may adversely affect the system, the process, or the environment;

- comprehensive operating instructions that clearly delineate proper function of the system, operating and maintenance responsibilities of the owner and authorized service personnel, and service-related obligations of the manufacturer;

- requirements for chemical additions (if required) to assure proper system function;

- manufacturer's Web address, if available;

- requirements for the periodic removal of residuals from the system;

- a course of action to be taken if the system is to be used intermittently or if extended periods of non-use are anticipated;

- detailed methods and criteria to be used to identify system malfunction or problems;

- a statement instructing the owner to reference the system data plate in the event that a problem arises or service is required;

- the name and telephone number of an appropriate service representative to be contacted in the event that a problem with the system occurs; and

- a description of the initial and extended service policies.

If not appearing on the system, electrical schematics for the system shall be included in the owner's manual.

6.2 Additional product literature

Manufacturers shall provide authorized representatives with additional product literature intended to accommodate all persons who may be involved in the installation, upkeep, or repair of systems. Each system shall be accompanied by manufacturer-prepared literature including specific instructions for system installation; operation and maintenance; and troubleshooting and repair. This information may be provided in the form of discrete manuals or may be combined into a comprehensive manual(s) as the manufacturer deems appropriate.

6.2.1 Installation manual

Manufacturers shall specify who is authorized to install their system, and provide comprehensive and detailed installation instructions to these authorized representatives. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

- guidance to the installer on the proper methods to be used to assure that the water chemistry at the site is adequate to allow the system to perform, prior to installation of a system;

- a numbered list of system components and an accompanying illustration, photograph, or print in which the components are respectively identified;

– design, construction, and material specifications for the system's components;

– wiring schematics for the system's electrical components;

– off-loading and unpacking instructions including safety considerations, identification of fragile components, and measures to be taken to avoid damage to the system;

– a process overview of the function of each component and the expected function of the entire system when all components are properly assembled and connected;

– a clear definition of system installation requirements including plumbing and electrical power requirements, ventilation, air intake protection, bedding, hydrostatic displacement protection, water tightness, slope, and miscellaneous fittings and appurtenances;

– a sequential installation procedure from the residence out;

– repair or replacement instructions in the event that a system possesses flaws that would inhibit proper functioning, and a list of sources where replacement components can be obtained; and

– a detailed start-up procedure.

6.2.2 Operation and maintenance manual

Manufacturers shall provide a manual with comprehensive and detailed operation and maintenance instructions to authorized representatives. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

– a maintenance schedule for all components;

– specifications for treatment chemicals (including any chemical additions for alkalinity and/or carbon:nitrogen ratio adjustment), if needed for proper operation of the system, along with instructions for determining the need to replenish the chemicals;

– instruction for field adjustment of the treatment process for site-specific conditions if needed for proper operation of the system;

– requirements and recommended procedures for the periodic removal of residuals from the system;

– a detailed procedure for visual evaluation of system component functions;

– a description of olfactory and visual techniques for the evaluation of system effluent and mixed liquor;

– recommended methods for collecting effluent samples; and

– the expected effluent produced by the operational system as established through analytical methods described or referred to in NSF/ANSI 245.

6.2.3 Trouble shooting and repair manual

Manufacturers shall provide comprehensive and detailed troubleshooting and repair instructions to authorized representatives.

The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

– a guide for visually evaluating the system and narrowing the scope of the problem based on effluent characteristics, system operation, and history;

– a sequential method for isolating specific component failure; and

– a step-by-step guide for repairing or replacing all system components.

7 Other documentation

The manufacturer shall prepare and maintain documentation for each system including, at a minimum:

– a basic description of the system;

– complete drawings of the system;

– design basis data, including operating parameters (aeration requirements, recycle rates, etc.) essential for proper operation of the system under differing field conditions; and

– a comprehensive and detailed discussion of process fundamentals.

8 Performance testing and evaluation

This section describes the methods used to evaluate the performance of residential wastewater treatment systems designed to remove nitrogen from residential wastewater. Performance testing and evaluation shall not be restricted to specific seasons.

8.1 Preparations for testing and evaluation

The system shall be assembled, installed, and filled in accordance with the manufacturer's instructions.

The manufacturer shall inspect the system for proper installation. If no defects are detected and the system is judged to be structurally sound, it shall be placed into operation in accordance with the manufacturer's start-up procedures. If the manufacturer does not provide a start-up procedure, ⅔ of the system's capacity shall be filled with water and the remaining ⅓ shall be filled with residential wastewater.

The system shall undergo design loading (see 8.2.2.1) until testing and evaluations are initiated. Sample collection and analysis shall be initiated within three weeks of filling the system and shall continue without interruption until the end of the evaluation period, except as specified in 8.4.2.

If conditions at the test site preclude installation of the system at its normally prescribed depth, the manufacturer shall be permitted to cover the system with soil to achieve normal installation depth.

When possible, electrical or mechanical defects shall be repaired to prevent delays. All repairs made during the performance testing and evaluation shall be documented in the final report.

The system shall be operated in accordance with the manufacturer's instructions. However, routine service and maintenance of the system shall not be allowed during the testing and evaluation period.

NOTE – The manufacturer may recommend or offer more frequent service and maintenance of the system, but for purpose of performance testing and evaluation, the service and maintenance shall not be performed beyond what is specified in this Standard.

8.2 Testing conditions, hydraulic loading and schedules

8.2.1 Influent wastewater characteristics

Except as required by NSF/ANSI 40 for systems seeking concurrent NSF/ANSI 40 and Nitrogen Reduction certification, the average wastewater characteristics delivered to the system over the course of the testing shall fall within:

- BOD_5: 100 to 300 mg/L
- TSS: 100 to 350 mg/L
- TKN: 35 to 70 mg/L as N
- alkalinity: > 175 mg/L as $CaCO_3$ (alkalinity may be adjusted if inadequate)
- temperature: 10 to 30 ºC (50 to 86 ºF)
- pH: 6.5 to 9 SU

Unless requested by the manufacturer, the raw influent shall be supplemented with sodium bicarbonate if the wastewater is found to be deficient in alkalinity. In addition, the influent shall be supplemented with urea to meet the required influent TKN concentration. The influent may also be supplemented with methanol to maintain a carbon:nitrogen ratio of no less than 5:1.

NOTE – For this testing, minimum alkalinity may be calculated as described in Annex A.

If the influent temperature drops below 10 ºC (50 ºF), impacting the nitrification process, sample collection may be suspended until the influent temperature returns to 10 ºC (50 ºF).

8.2.2 Hydraulic loading

The performance of the system shall be evaluated for a minimum of 26 wks. During the testing and evaluation period, the system shall be subjected to 16 wks of design loading, followed by 7.5 wks (52 d) of stress loading, and an additional period of design loading to obtain a minimum of 55 influent and effluent data sets collected during non-stress dosing period.

8.2.2.1 Design loading

The system shall be dosed 7 d/wk with a wastewater volume equivalent to the daily hydraulic capacity of the system. The following schedule shall be adhered to for dosing:

Time Frame	Approximate % rated daily hydraulic capacity
6 a. m. – 9 a. m.	35
11 a. m. – 2 p. m.	25
5 p. m. – 8 p. m.	40

NOTE – An individual dose shall be no more than 10 gal (37.9 L), unless the dosage system is based on a continuous flow, and the doses shall be uniformly applied over the dosing period.

8.2.2.2 Stress loading

Stress loading sequences shall begin in week 17 of the testing and will be completed in the order listed in the following sections. Each stress sequence shall be separated by 7 d of design loading, as described in 8.2.2.1.

8.2.2.2.1 Wash-day stress

The wash-day stress shall consist of 3 wash-days in a 5-d period. Each wash-day shall be separated by a 24-h period. During a wash-day, the system shall be loaded at times and capacities similar to those delivered during design loading (see 8.2.2.1). However, during the first two dosing periods per day, the design loading shall include 3 wash loads (3 wash cycles and 6 rinse cycles).

8.2.2.2.2 Working-parent stress

For five consecutive days, the system shall be subjected to a working-parent stress. During this stress, the system shall be dosed with 40% of its daily hydraulic capacity between 6:00 a. m. and 9:00 a. m. Between 5:00 p. m. and 8:00 p. m., the system shall be dosed with the remaining 60% of its daily hydraulic capacity, which shall include 1 wash load (1 wash cycle and 2 rinse cycles).

8.2.2.2.3 Power/equipment failure stress

Power/equipment failure stress simulation shall consist of a flow pattern where approximately 40% of the total daily flow is received between 5 p. m. and 8 p. m. on the day when the power/equipment failure stress is initiated. Power to the system shall then be turned off at 9 p. m. and the flow pattern shall be discontinued for 48 h. After the 48-h period, power shall be restored and the system shall receive approximately 60% of the total daily flow over a 3-h period which shall include 1 wash load (1 wash cycle and 2 rinse cycles).

8.2.2.2.4 Vacation stress

Vacation stress simulation shall consist of a flow pattern where approximately 35% of the total daily flow is received between 6 a. m. and 9 a. m. and approximately 25% of the total daily flow is received between 11 a. m. and 2 p. m. on the day that the vacation stress is initiated. The flow pattern shall be discontinued for 8 consecutive days with power continuing to be supplied to the system. Between 5 p. m. and 8 p. m. of the ninth day, the system shall receive 60% of the total daily flow, which shall include 3 wash loads (3 wash cycles and 6 rinse cycles).

8.2.3 Dosing volumes

The 30-d average volume of the wastewater delivered to the system shall be within 100% ± 10% of the system's rated hydraulic capacity.

> NOTE – All dosing days, except those with dosing requirements less than the daily hydraulic capacity, shall be included in the 30-d average calculation.

8.3 Sample collection

8.3.1 Sampling frequency

Influent and effluent samples shall be collected three times per week during design loading periods and twice during each stress recovery period (the week following completion of each of the stress simulations described in 8.2.2.2). This schedule shall be continued in the event that testing is extended beyond the 26-wk minimum.

8.3.2 Collection methods

All sample collection shall be in accordance with *Standard Methods*, unless otherwise specified. Influent wastewater samples shall be flow-proportional, 24-h composites obtained during periods of system dosing. Effluent samples shall be flow-proportional, 24-h composites obtained during periods of system discharge. Effluent samples shall be representative of all treated effluent discharged from the system, as sampled from a central point of collection of all treated effluent. Grab samples shall be collected for pH, temperature, and dissolved oxygen (DO). The location of the grab sample shall be appropriate to provide a sample that is representative of the influent or effluent, and shall be determined in conjunction with the manufacturer. Grab samples shall be collected during the morning dosing period for gravity flow systems and during a time of discharge for systems that are pump discharged.

8.3.3 Analyses

The samples collected as described in 8.3.1 and 8.3.2 shall be analyzed as follows:

		Sample location		
Parameter	Sample type	Raw influent	Treated effluent	Testing location
BOD_5	24 h composite	X		Laboratory
$CBOD_5$	24 h composite		X	Laboratory
total suspended solids	24 h composite	X	X	Laboratory
pH	Grab	X	X	Test site
temperature (°C)	Grab	X	X	Test site
dissolved oxygen	Grab		X	Test site
alkalinity (as $CaCO_3$)	24 h composite	X	X	Laboratory
TKN (as N)	24 h composite	X	X	Laboratory
ammonia-N (as N)	24 h composite	X	X	Laboratory
nitrite/nitrate-N (as N)	24 h composite	X	X	Laboratory

8.3.4 Analytical methods

The appropriate methods in *Standard Methods* shall be used to complete the analyses indicated in 8.3.3.

8.4 Criteria

8.4.1 Testing conditions

If conditions during the testing and evaluation period result in system upset, improper sampling, improper dosing, or influent characteristics outside the ranges specified in 8.2.1, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, specific data points may be excluded from the averages. Rationale for all data exclusions shall be documented in the final report.

8.4.2 Catastrophic site problems

In the event that a catastrophic site problem not described in the Standard including, but not limited to, influent characteristics, malfunctions of test site apparatus and acts of God, jeopardizes the validity of the performance testing, manufacturers shall be given the choice to:

– perform maintenance on the system, reinitiate system start-up procedures, and restart the performance testing; or

– with no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within 3 wks after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from the effluent averages.

NOTE – “Pre-existing conditions” shall be defined as the point when the results of 1 wk’s worth of sampling are within 15% of the averages of the samples from the previous 3 wks of sampling.

8.4.3 Effluent quality

For purposes of determining system performance, only samples collected during design loading periods, described in 8.2.2, shall be used in the calculations. The data collected during the stress sequences shall not be included in the calculations, but shall be included in the final report.

8.4.3.1 $CBOD_5$

The average $CBOD_5$ of all effluent samples shall not exceed 25 mg/L.

8.4.3.2 TSS

The average TSS of all effluent samples shall not exceed 30 mg/L.

8.4.3.3 Total nitrogen

The average total nitrogen concentration of all effluent samples shall be less than 50% of the average total nitrogen concentration of all influent samples.

8.4.3.4 pH

The pH of individual effluent samples shall be between 6.0 and 9.0 SU.

8.5 Final report

A final report shall be prepared that presents the following:

– all data collected in accordance with the testing and evaluations within this Standard;

– a table indicating the actual percent reduction over the course of the test (included in the Executive Summary, as well as in the body, of the report);

– observations made during the testing;

– an estimation of the pounds of nitrogen loaded during the test and the pounds removed;

– any adjustments made to the alkalinity of the influent wastewater;

– a copy of the current edition of the Owner’s Manual; and

– process description and detailed dimensioned drawings of the system evaluated.

A supplemental report shall be prepared for any system(s) approved under the performance classification section (1.4) of this Standard, including process description(s) and dimensioned drawings.

Annex A[7]
(informative)

Information about nitrogen process

A.1 Biological nitrification

Nitrification is a process carried out by bacterial populations (*Nitrosomonas* and *Nitrobacter)* that oxidize ammonium to nitrate with intermediate formation of nitrite. These organisms are considered autotrophic, because they obtain energy from the oxidation of inorganic nitrogen compounds. The two steps in the nitrification process and their equations are as follows:

1) Ammonium is oxidized to nitrite (NO_2^-) by *Nitrosomonas* bacteria.

$$2\ NH_4^+ + 3\ O_2 = 2\ NO_2^- + 4\ H^+ + 2\ H_2O$$

2) The nitrite is converted to nitrate (NO_3^-) by *Nitrobacter* bacteria.

$$2\ NO_2^- + O_2 = 2\ NO_3^-$$

Since complete nitrification is a sequential reaction, systems must be designed to provide an environment suitable for the growth of both groups of nitrifying bacteria. These two reactions essentially supply the energy needed by nitrifying bacteria for growth. Several major factors influence the kinetics of nitrification, including organic loading, hydraulic loading, temperature, pH, and dissolved oxygen (DO) concentration.

A.1.1 Organic loading

Organic loadings affect the efficiency of the nitrification process. Although the heterotrophic biomass is not essential for nitrifier attachment, the heterotrophs (organisms that use organic carbon for the formation of cell tissue) form biogrowth to which the nitrifiers adhere. The heterotrophic bacteria grow much faster than nitrifiers do at high BOD_5 concentrations. As a result, the nitrifiers can be overgrown by heterotrophic bacteria, which can cause the nitrification process to cease. In order for nitrification to take place, the organic loadings must be low enough to provide balance between the heterotrophic and nitrifying bacteria.

A.1.2 Hydraulic loading

Both hydraulic and organic loadings are important parameters that must be considered. Recirculation benefits nitrifying reactors by reducing the influent BOD_5 concentration, which makes the nitrifiers more competitive. Control of the food-to-microorganism ratio is important to maximize the nitrification process.

A.1.3 pH and alkalinity

The nitrification process produces acid, which lowers the pH and can reduce the growth rate of the nitrifying bacteria. The optimum pH for *Nitrosomonas* and *Nitrobacter* is between 7.5 and 8.5. At a pH of 6.0 or less, nitrification normally will stop. Approximately 7.1 lbs of alkalinity (as calcium carbonate [$CaCO_3$]) are destroyed per 1 lb of ammonia oxidized to nitrate.

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A.1.4 Dissolved oxygen (DO)

The concentration of DO affects the rate of nitrifier growth and nitrification in biological waste treatment systems. The DO concentration at which nitrification is limited can be 0.5 to 2.5 mg/L in either suspended or attached-growth systems under steady-state conditions, depending on the degree of mass-transport or diffusional resistance and the solids retention time. The maximum nitrifying growth rate is reached at a DO concentration of 2 to 2.5 mg/L. However, the maximum growth rate is not needed for effective nitrification if there is adequate contact time in the system. As a result, there is a broad range of DO values at which DO becomes rate limiting. The intrinsic growth rate of *Nitrosomonas* is not limited at DO concentrations above 1.0 mg/L, but DO concentrations greater than 2.0 mg/L may be required in practice. Nitrification consumes large amounts of oxygen, with 4.6 lbs of O_2 being used for every 1 lb of ammonia oxidized.

A.2 Biological denitrification

Denitrification is an anoxic process where nitrate serves as oxygen equivalent (electron acceptor) for bacteria, and the nitrate is reduced to nitrogen gas. Denitrifying bacteria are facultative organisms that can use either DO or nitrate (NO_3) as an oxygen source for metabolism and oxidation of organic matter. If both dissolved oxygen and nitrate are present, the bacteria will tend to use the dissolved oxygen first. Therefore, it is important to keep dissolved oxygen levels as low as possible.

Another important aspect of the denitrification process is the presence of organic matter to drive the denitrification reaction. Organic matter can be in the form of raw wastewater, methanol, ethanol, or other organic sources. When these sources are not present, the bacteria may depend on internal (endogenous) carbon reserves as organic matter. The endogenous respiration phase can sustain a system for a time, but may not be a consistent enough source of carbon to drive the reaction to completion or to operate at the rates needed to remove the elevated nitrate levels present in nitrified effluent.

The denitrifying reaction using methanol as a carbon source can be represented as follows:

$$6NO_3^- + 5CH_3OH = 5CO_2 + 3N_2 + 7H_2O + 6OH^-$$

Several conditions affect the efficiency of the denitrification process, including the anoxic conditions, the temperature, presence of organic matter, and pH.

A.2.1 DO

The level of DO has a direct impact on the denitrifying organisms. As DO increases, the denitrification rate decreases. DO concentrations below 0.3 to 0.5 mg/L in the anoxic zone are typically needed to achieve efficient denitrification.

A.2.2 Organic matter

The denitrification process requires a source of organic matter. Denitrification rate varies greatly depending upon the source of available carbon. The highest rates are achieved with addition of an easily assimilated carbon source such as methanol. Somewhat lower denitrification rates are obtained with raw wastewater or primary effluent as the carbon source. The lowest denitrification rates are observed with endogenous decay as the source of carbon.

A.2.3 pH and alkalinity

The optimum pH range for most denitrifying systems is 7.0 to 8.5. The process will normally occur in a wider range, pH 6 to 9, but denitrifying rates may be impacted near the extremes of the range. Acclimation of the population can lower the impact of pH on growth rates. An advantage of the denitrification process is the production of alkalinity that helps buffer the decrease in alkalinity during the nitrification process. Approximately 3.6 lbs of alkalinity is produced for each 1 lb of nitrate nitrogen removed.

Additional information on various nitrogen control strategies can be found in the *Manual for Nitrogen Control*, USEPA, 1993, 625/R-93/010[8].

A.3 Calculation example

Assuming that the minimum TKN (35 mg/L as N) is all in the ammonium-N form, the wastewater will contain 35 mg/L of ammonium-N. The EPA Nitrogen Control manual (EPA/625/R-93/010), p. 92, states that the theoretical alkalinity destruction ratio is 7.1 mg of alkalinity destroyed per mg of ammonium-N oxidized. An ammonium concentration of 35 mg/L would result in the destruction of 248 mg of alkalinity.

The denitrification process adds alkalinity, as described on page 103 of the Nitrogen Control manual, with the theoretical alkalinity production of 3.57 mg per mg of nitrate nitrogen. If it is assumed that all of the ammonium-N is converted to nitrate nitrogen (which is a generous assumption), the production of alkalinity for denitrification of 35 mg/L of nitrate will be 125 mg/L.

For this example, the amount of alkalinity needed in the influent would be around 123 mg/L (248 mg/L –125 mg/L) just to cover the process. In actuality, excess alkalinity is needed because if the alkalinity goes close to zero, wide pH swings could occur that will kill the bacteria. Allowing 50 mg/L of excess alkalinity, 173 mg/L (123 mg/L + 50 mg/L) of alkalinity will be required if the average influent TKN is 35 mg/L, the lowest allowable influent TKN.

[8]< http://yosemite.epa.gov/owrccatalog.nsf>.

Annex B[9]

(Informative)

Information about nitrogen reduction measurement

The NSF/ANSI Standard 245 total nitrogen effluent quality criterion is based on percent reduction of the nitrogen in the influent test water (the nitrogen contained in the water delivered to the treatment system during testing). Percent nitrogen reduction is considered a valid indicator of expected performance for systems installed and used under typical field conditions. Absolute concentration values for the influent and effluent are also provided in the test report to show the actual measured values obtained during the test and used to calculate percent reduction. Users of the data should recognize that these absolute nitrogen concentration values may be more sensitive than percent reduction to the specific conditions that occur at the test facility during testing (for example, influent nitrogen concentration, alkalinity to nitrogen ratio, daily wastewater flows, etc.), in comparison to conditions experienced by systems installed in the field and used in an actual residential setting. Users of the data should therefore consider the possible limitations of drawing direct comparisons between the reported absolute effluent concentration values during testing and effluent quality standards based on absolute nitrogen concentration criteria (for example, 10 mg/L) established in regulations.

Users of NSF Standard 245 testing results should furthermore understand that the total amount of nitrogen that can be removed and resulting effluent nitrogen concentration under field conditions may also be limited if available alkalinity is insufficient. Limitations of the biochemical processes involved are reviewed in more detail in Annex A.

Further information on nitrogen concentration and reduction is publicly available.

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Standards[10]

The following standards established and adopted by NSF as minimum voluntary consensus standards are used internationally:

2 Food equipment
3 Commercial warewashing equipment
4 Commercial cooking, rethermalization, and powered hot food holding and transport equipment
5 Water heaters, hot water supply boilers, and heat recovery equipment
6 Dispensing freezers
7 Commercial refrigerators and freezers
8 Commercial powered food preparation equipment
12 Automatic ice making equipment
13 Refuse processors and processing systems
14 Plastics piping system components and related materials
18 Manual food and beverage dispensing equipment
20 Commercial bulk milk dispensing equipment
21 Thermoplastic refuse containers
24 Plumbing system components for recreational vehicles
25 Vending machines for food and beverages
29 Detergent and chemical feeders for commercial spray-type dishwashing machines
35 High pressure decorative laminates (HPDL) for surfacing food service equipment
36 Dinnerware
37 Air curtains for entranceways in food and food service establishments
40 Residential wastewater treatment systems
41 Non-liquid saturated treatment systems
42 Drinking water treatment units – Aesthetic effects
44 Residential cation exchange water softeners
46 Evaluation of components and devices used in wastewater treatment systems
49 Biosafety cabinetry: Design, construction, performance, and field certification
50 Equipment for swimming pools, spas, hot tubs, and other recreational water facilities
51 Food equipment materials
52 Supplemental flooring
53 Drinking water treatment units – Health effects
55 Ultraviolet microbiological water treatment systems
58 Reverse osmosis drinking water treatment systems
59 Mobile food carts
60 Drinking water treatment chemicals – Health effects
61 Drinking water system components – Health effects
62 Drinking water distillation systems
140 Sustainable carpet assessment
169 Special purpose food equipment and devices
170 Glossary of food equipment terminology
173 Dietary supplements
177 Shower filtration systems – Aesthetic effects
184 Residential dishwashers
222 Ozone generators
223 Conformity assessment requirements for certification bodies that certify products pursuant to NSF/ANSI 60: Drinking water treatment chemicals – health effects
240 Drainfield trench product sizing for gravity dispersal onsite wastewater treatment and dispersal systems
245 Wastewater treatment systems - nitrogen reduction
305 Personal care products containing organic ingredients
321 Goldenseal root (Hydrasitis canadensis)
330 Glossary of drinking water treatment unit terminology
332 Sustainability assessment for resilient floor coverings
336 Sustainability assessment for commercial furnishings fabric
341 Health/fitness facilities
342 Sustainability assessment for wallcovering products
347 Sustainability assessment for single ply roofing membranes
350 Onsite residential and commercial water reuse treatment systems
350-1 Onsite residential and commercial graywater treatment systems for subsurface discharge
355 Greener chemicals and processes information
358-1 Polyethylene pipe and fittings for water-based ground-source “geothermal” heat pump systems
358-2 Polypropylene pipe and fittings for water-based ground-source “geothermal” heat pump systems
359 Valves for crosslinked polyethylene (PEX) water distribution tubing systems
360 Wastewater treatment systems – Field performance verification
372 Drinking water treatment system components – Lead content
14159-1 Hygiene requirements for the design of meat and poultry processing equipment
14159-2 Hygiene requirements for the design of hand held tools used in meat and poultry processing equipment
14159-3 Hygiene requirements for the design of mechanical belt conveyors used in meat and poultry processing equipment

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SPES HOMINUM

***THE HOPE OF MANKIND** rests in the ability of man to define and seek out the environment which will permit him to live with fellow creatures of the earth, in health, in peace, and in mutual respect.*

October 31, 2013