BRITISH STANDARD

BS EN
1622:2006

Water quality — Determination of the threshold odour number (TON) and threshold flavour number (TFN)

The European Standard EN 1622:2006 has the status of a British Standard

ICS 13.060.60

National foreword

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

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Water quality - Determination of the threshold odour number (TON) and threshold flavour number (TFN)

Qualité de l'eau - Détermination du seuil d'odeur (TON) et du seuil de flaveur (TFN)

Wasserbeschaffenheit - Bestimmung des Geruchsschwellenwerts (TON) und des Geschmacksschwellenwerts (TFN)

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CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 1622:2006) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2007, and conflicting national standards shall be withdrawn at the latest by February 2007.

This document supersedes EN 1622:1997.

The forced choice test method has been moved into Annex B. Annex C has been added. The standard has been completely editorially revised.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard gives quantitative methods for the determination of the threshold odour number (TON) and the threshold flavour number (TFN). The main methodology (unforced choice) widely used in Europe is described in this European Standard.

Another methodology, used by a limited number of member state (forced choice) is described in Annex B.

A simplified qualitative method is also described in Annex C.

The methods specified in this European Standard are based on the standard methods for sensory analysis. However, some differences are noted, as compared with those methods, due to water specificity.

This European Standard is primarily intended to give a quantitative measure of odour and flavour of a water sample at a temperature of 23 °C.

NOTE The method can be used to determine the odour and flavour of a water sample at other temperatures but there will be no correlation between results obtained at different temperatures.

WARNING — Persons using this European Standard should be familiar with normal laboratory practice. This European Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

IMPORTANT — It is absolutely essential that tests conducted according to this European Standard be carried out by suitably trained staff.

1 Scope

This European Standard specifies quantitative methods for determining the TON and TFN of waters and also a qualitative method for determining any abnormal odour and/or flavour. It is essential that the safety remarks in Clause 5 are taken into account.

Two quantitative methods are described:

— a short method applicable when either a sample has no odour and flavour or when the odour and flavour are to be compared with a specified threshold number;

— a full method applicable when the threshold number for the sample is to be determined.

For both quantitative methods, two different methodologies are described:

— unforced choice in the standard;

— forced choice in Annex B.

Both methods are applicable for quantifying the odour and flavour of drinking water and/or migration waters from materials in contact with waters.

NOTE The choice of the quantitative or qualitative method is depending on the national regulations, and on the type of water to be assessed (raw water, distribution water, migration water ….)

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.

ISO 7393-2, *Water quality — Determination of free chlorine and total chlorine — Part 2: Colorimetric method using N,N-diethyl-1,4-phenylenediamine, for routine control purposes*

3 Terms and definitions

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

3.1
odour
organoleptic attribute perceptible by the olfactory organ on sniffing certain volatile substances (see ISO 5492)

3.2
flavour
complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting. The flavour may be influenced by tactile, thermal, painful and/or kinaesthetic effects (see ISO 5492)

3.3
threshold odour number (TON)
dilution ratio beyond which the diluted sample does not have any perceptible odour

$$TON = \frac{A + B}{A} \quad (1)$$

where

A is the volume of sample;

B is the volume of reference water

3.4
threshold flavour number (TFN)
dilution ratio beyond which the diluted sample does not have any perceptible flavour

$$TFN = \frac{A + B}{A} \quad (2)$$

where

A is the volume of sample;

B is the volume of reference water

3.5
reference water
water described as without any perceptible odour and flavour by test panel

3.6
test panel
group of selected assessors used to evaluate flavour and odour

NOTE For guidance on the selection of the test panel, see Annexes E or G.

3.7
selected assessor
assessor chosen for his/her ability to perform a sensory test (see ISO 5492)

3.8
sample
water intended for odour and flavour assessment

3.9
triangle test
three test samples, two of which are reference water, and the third the sample or a dilution of it, (or two of which are the sample or a dilution of it, and the third one is reference water), are presented to the selected assessors

3.10
paired test
two test samples, one is the sample or a dilution of it, and the other is reference water are presented to the selected assessors

3.11
forced choice
even if the selected assessor is unable to perceive a difference between the two or three samples, the selected assessor shall chose one sample as having the stronger flavour or odour and record his/her choice

3.12
unforced choice
selected assessor recording if he/she notes or does not note a difference between the two or three samples

3.13
migration water
test water which has been in contact with a test piece under specified conditions

4 Principle

The odour and flavour of a water sample are quantitatively assessed by a test panel by comparing that sample and/or dilutions of that sample with a reference water.

The odour and flavour of a water sample may also be assessed qualitatively by only one selected assessor or a test panel to detect any abnormal odour and/or flavour.

5 Hazards

Care shall be taken to ensure that the samples are safe for selected assessors. If there is any suspicion of the presence of harmful microorganisms or of toxic substances at a toxic concentration, the samples shall not be tested without further precautions being taken.

The selected assessors shall be instructed not to swallow any test sample.

In case a toxicity risk is suspected, samples should be evaluated for possible risks to the assessors by consideration of previous reports on toxicity tests, made with the sample or samples of similar kind, e.g. by using one of the existing standard methods for aquatic toxicity.

In case the risk for presence of human pathogens (bacteria, viruses, parasite eggs) is suspected, it shall be assessed by adequate biological standard methods before conduction of this test. This is not necessary for waters disinfected by chlorinous disinfectants, ozone or UV.

6 Test environment

The room used for odour and flavour assessment has to be free from obtrusive draughts and noise and the general environment such that the selected assessors shall perform their task without being influenced by other selected assessors.

No air fresheners or room deodorisers shall be used in the room. The room shall be sited away from any activity that could generate interfering odours. The temperature of the room shall be maintained with a system for the regulation of temperature at (23 ± 2) °C. It is advisable that this room is only used for odour and flavour assessment. Suggestions on the design of suitable facilities are given in ISO 8589.

7 Apparatus and reagents

7.1 Glassware, reserved solely for TON and TFN assessment.

Glassware shall be cleaned separately from other laboratory items and, when not in use, shall be stored in clean conditions in order to avoid accidental contamination.

Sample bottles, tasting glasses and volumetric glassware shall be cleaned before use so that they have no perceptible influence on the result of the assessment.

Tasting glasses can be as specified by ISO 3591.

NOTE Sample bottles should be of glass and of a suitable capacity. Stoppers should be of glass or polytetrafluoroethene (PTFE) and capable of yielding no headspace in the sample.

7.2 Water bath or incubator, capable of maintaining a homogeneous temperature of (23 ± 2) °C.

7.3 Reference water

Reference water (3.5) shall be used for rinsing, dilution and reference.

NOTE Reference water can be tap water, mineral bottled water, or prepared according to Annex D. Preferably it should be appropriate to the area and where possible similar in mineral character to the type of water being tested.

7.4 Cleaning liquids; use one of the following cleaning liquids for glassware.

7.4.1 Non-perfumed biodegradable laboratory detergent

7.4.2 Hydrochloric acid, $c(HCl) \approx 2$ mol/l.

7.4.3 Hydrogen peroxide, $w(H_2O_2)$, approximately 3 %.

NOTE Other cleaning liquids such as acetic acid can be used before the rinsing procedure of the glassware, provided they yield glassware free from interfering taste and odour.

8 Sampling and sample preservation

Collect the samples (with no headspace) in the clean, well stoppered sample bottles (7.1). Keep the samples cool and in the absence of light during transportation and storage. If storage is necessary, store in a refrigerator at (4 ± 2) °C. Storage time shall be as short as possible, in no case longer than 72 h, and be specified with the result.

9 Test panel and selected assessors

A test panel shall consist of at least three selected assessors (3.7) for unforced choice (see Clause 10 and eight selected assessors (3.7) for forced choice (see Annex B).

For the simplified qualitative method (see Annex C), only one selected assessor may perform the assessment.

NOTE 1 When a new test panel is started, the selected assessors will be untrained but will undergo training with flavours and odours to increase their precision. It is accepted that after a period of training and experience, the test panel will become both more selective and more precise than the general population.

NOTE 2 Guidance on training the selected assessor is given in Annex E.

New selected assessors shall be introduced to the odour and flavour test method by an experienced selected assessor or consultant. Selected assessors shall have gained experience in the method before being integrated into regular test panel sessions.

Selected assessors shall be willing to serve, and shall be disqualified if they suffer from allergy or of unusual sensitivity. It is desirable that the sensitivities in a test panel to odour and flavour do not differ widely.

The performance of individual selected assessors and test panels shall be monitored. This shall be done by interlaboratory tests depending on the laboratory objectives.

NOTE 3 If the laboratory has to determine TON/TFN for approving drinking water materials, the need for interlaboratory test seems obvious. Intra-laboratory exercises on a regular basis may also be carried out with the use of a common spiking tasty or odorous solution. This can be done as a part of interlaboratory quality control of the panellists.

This need is not obvious if the laboratory is only checking for the presence/absence of abnormal taste or odour.

The precision of the result is dependant on the test panel size.

NOTE 4 Even if it is desirable to have a minimum of 5 selected assessors for a paired test and a minimum of 6 for a triangle test, this is not realistic for most water laboratories and utilities. The present standard can be used with a smaller number of panellists for unforced choice, provided the response of the panel is homogenous (see criteria in 10.3.1.4 and in 10.3.2.4).

See Annexes E and G for information.

10 Procedure for unforced choice

10.1 General

The principle of the method is to quantify the odour and flavour of a sample by the use of a test panel, comparing sample or dilution of it with the reference water. A coordinator organises the activities of the test panel.

Before testing, samples of chlorinated water shall be de-chlorinated according to the procedure described in Annex A.

10.2 Type of test

10.2.1 The triangle test

Three samples (3.8) two of which are reference water (7.3) and the third the sample or a dilution of it (or two are a sample or a dilution of it and the third is a reference water) are presented simultaneously to the selected assessors. The selected assessors shall select the sample perceived as different.

10.2.2 The paired test

Two samples (3.8) one of which is reference water (7.3) and the second the sample or a dilution of it are presented simultaneously to the selected assessors. The selected assessors shall select the sample perceived to have the stronger odour and flavour.

10.3 Type of method

10.3.1 Short method

10.3.1.1 Applicability

This short method is applicable when either a sample has no odour and flavour or for compliance of odour and flavour with a specified level. Only one dilution is prepared.

10.3.1.2 Test procedure

Prepare a dilution of the water sample to be evaluated using reference water (7.3), according to the threshold of interest. Adjust the temperature of this dilution and one reference water (for paired test) or two reference waters (for triangle test) at (23 ± 2) °C by placing them in a temperature controlled device (7.2).

In order to avoid unnecessary quantity of glassware, only one large flask per sample can be used for all selected assessors.

An appropriate volume shall be prepared in order that all the selected assessors could have a sufficient volume for the assessment of odour and flavour.

NOTE Instead of the preliminary preparation of the dilutions in flasks, intended for comparison with reference water, another equivalent procedure can be applied. The selected assessor(s) can prepare in a measuring cylinder the appropriate dilution just before the odour and flavour assessment. The sample or dilution of it should be compared directly with the reference water.

10.3.1.3 Assessment of the sample

Each selected assessor shall assess the sample and its dilution by comparing it with reference water (7.3) independently and without knowledge of the results obtained by other selected assessors.

Remove the sample, sample dilution and the reference water from the water bath or incubator.

For TON assessment, ask each of the selected assessor to shake each flask (and/or measuring cylinder) thoroughly, remove the stopper, smell, replace the stopper and record his/her decision.

All the selected assessors will perform the TON assessment on the same flask (and/or measuring cylinder).

For TFN assessment, ask each of the selected assessor to transfer a suitable volume of water in his/her own glass, and to hold it in the mouth for several seconds before discharging it without swallowing, before recording his/her decision.

If the selected assessor is unable to perceive a difference between the sample or its dilution and the reference water, the selected assessor shall note it. This individual TON or TFN is less than the dilution proposed.

NOTE Care should be taken to ensure that the length of the session does not fatigue the selected assessor and cause a lowering of sensitivity. It can be helpful between samples for the selected assessor to eat a water biscuit to recover sensitivity of flavour.

The precision of the result is dependant on the size of the test panel and the range of the individual results.

10.3.1.4 Determination of Threshold Number

If there is no perceived difference between the sample dilution and the reference water, describe the result as less than the threshold number. There shall be a minimum of three selected assessors contributing a score.

If at least 66 % of the selected assessors agree, the test is valid.

If not, the test shall be repeated or completed by an additional selected assessor.

When necessary, when the result is greater to the specified threshold, the full method (10.3.2) shall be used to quantify the threshold number of the sample.

10.3.2 Full method

10.3.2.1 Applicability

The full method is applicable when the threshold number for a sample is to be determined. A series of successive dilutions are prepared and assessed.

Make a preliminary evaluation of the threshold number and then prepare a minimum of three dilutions around this expected threshold number with reference water (7.3).

If the selected assessor is unable to perceive a sample as different, the last dilution where a difference was perceived represents his/her individual TON or TFN for this sample.

10.3.2.2 Test procedure

Prepare a series of clearly labelled dilutions of the sample with reference water (7.3) in the series

$_{x}$p

where

x is the ratio of the concentration of successive dilutions in the series;

p is a series of whole numbers, 0, 1, 2, ... i…, indicating the position of each dilution in the test series.

The value of x shall be between 1,3 and 3 (see Annex F).

NOTE This test procedure gives a dilution series where the concentrations form a geometric progression, i.e. the ratio of the concentrations of each pair of successive dilutions is constant. The use of a geometric series ensures that the change in perceived level of odour or flavour is equal between successive dilutions.

Maintain the temperature of all the dilutions and reference water (7.3) in a temperature controlled water bath or incubator (7.2).

10.3.2.3 Assessment of samples

Each selected assessor shall assess the samples independently and without knowledge of the results obtained by other selected assessors.

Remove the sample or sample dilution and the reference water from the water bath or incubator.

For TON assessment, ask each of the selected assessor to shake each flask (or measuring cylinder) thoroughly, remove the stopper, smell, replace the stopper and record his/her decision.

All the selected assessors may perform the TON assessment on the same flask. Are more than 4 selected assessors active, the laboratory shall check that the TON of the last group of the assessors is equivalent to the TON of the first group of assessors.

For TFN assessment, ask each of the selected assessor to transfer a suitable volume of water in his/her own glass, and to hold it in the mouth for several seconds before discharging it without swallowing, before recording his/her decision.

NOTE Care should be taken to ensure that the length of the session does not fatigue the selected assessor and cause a lowering of sensitivity. It can be helpful between samples for the selected assessor to eat a water biscuit to recover sensitivity of flavour.

The precision of the result is determined by the size of the test panel, the range of the individual results, the range of the dilutions chosen.

10.3.2.4 Calculation of Threshold Number

Complete Table 1 for each sample.

Table 1 — Threshold numbers

Selected assessor	Threshold Number (TON) and (TFN)	Within one dilution interval of the geometric mean Yes/No
1	TON_1, TFN_1	
2	TON_2, TFN_2	
3	TON_3, TFN_3	
4	TON_4, TFN_4	
5	TON_5, TFN_5	
-		
-		
-		
n	TON_n, TFN_n	

Calculate the TON and TFN for each sample as the geometric mean of all individual results, using Equations 3 and 4 respectively:

$$TON = \sqrt[n]{TON_1 \times TON_2 \times TON_3 \times .... \times TON_n} \quad (3)$$

$$TFN = \sqrt[n]{TFN_1 \times TFN_2 \times TFN_3 \times .... \times TFN_n} \quad (4)$$

where

TON_n and TFN_n are the results of the nth selected assessor.

Consider the result of acceptable precision if at least 66 % of the selected assessors obtain individual results within one dilution interval of the geometric mean.

11 Expression of results

11.1 The short method

The result (threshold number) shall be expressed as either less than or greater than/equal to the threshold number of interest.

11.2 The full method

The result (threshold number) shall be expressed to the nearest whole number.

12 Test report

The test report shall make reference to this European Standard, i.e. EN 1622, and shall give the following information:

a) all information allowing complete identification of the sample;

b) storage time before test;

c) the date and time of the test;

d) the description of the source of reference water;

e) all the test conditions, in particular whether the short or full method, the unforced choice test and the triangle or paired test were chosen. The number of selected assessors and if necessary the de-chlorination will be mentioned;

f) the test temperature;

g) the result obtained.

Annex A
(normative)

Chlorinated water

A.1 General

Samples of chlorinated water shall be de-chlorinated according to one of the two following methods:

A.2 Dechlorination by addition of sodium thiosulfate

A.2.1 Preparation of reagent

Dissolve (3,5 ± 0,1) g of sodium thiosulfate pentahydrate ($Na_2S_2O_3$ 5 H_20) in distilled water and make up with water to 1 l. Store in a dark glass bottle in a refrigerator for not more than 7 d.

A.2.2 Procedure

Measure the residual chlorine in the sample according to ISO 7393-2. Add 2 ml of the thiosulfate reagent (see A.2) for each milligram per litre of chlorine present in the sample.

A.3 Dechlorination by addition of ascorbic acid

A.3.1 Preparation of reagent

Dissolve (5,0± 0,1) g of L-ascorbic acid (ACS reagent, 99 %) in distilled water and make up with water to 1 l. Store in a dark glass bottle in a refrigerator for not more than 7 d.

A.3.2 Procedure

Measure the residual chlorine in the sample according to ISO 7393-2. Add 1,2 ml of the ascorbic acid reagent for every milligram per litre of chlorine as Cl_2, shake the sample flask, then wait at least 5 min before the odour and/or flavour is analysed.

NOTE Ascorbic acid can be used as an alternative de-chlorination method, due to the fact that sodium thiosulfate may lead in some cases to interfering odours. Nevertheless, ascorbic acid can not be used in chloraminated water because ammonia will be released.

Annex B
(normative)

Forced choice test method

B.1 General

Although most of the member states are using the test method “unforced choice“ (see Clause 10), this “forced choice test method” has been used in a limited number of member states for a very long time.

The basic differences with the “unforced choice test method” are the following:

— for this test, a minimum of eight selected assessors is needed;

— even if the selected assessor is unable to perceive a difference between the two or three samples, the selected assessor shall choose one sample as having the greater flavour or odour;

— the individual result is incorporated into a statistical evaluation with results of the other selected assessors (see Annex G);

— so, this method is not easily applicable to routine controls.

The procedure described in Clause 10 shall be applied, except for the determination of Threshold number (10.3.1.4 and 10.3.2.4).

B.2 Determination of TON and TFN

The test panel results obtained at each dilution are then corrected to take into account those results obtained by chance (see Annex G).

In order to do this, the Equation B.1 shall be used for each dilution level:

$$S = \frac{X - Y}{100 - Y} \times 100 \qquad \text{(B.1)}$$

where

S is the percentage of answers corrected for chance;

X is the percentage of correct answers identifying the sample at a given dilution;

Y is the percentage of answers expected by chance (50 % for paired test and 33 % for triangle test).

A graph shall then be drawn of S against dilution for positive values. The threshold number is the dilution at which S = 50 %.

NOTE A correct answer is obtained when the selected assessor successfully identifies the dilution. Only the coordinator knows which glasses or flasks contain sample and reference water respectively.

If $X = Y$, S = 0.

B.3 Expression of results

B.3.1 The short method

The result (threshold number) shall be expressed as either less than or greater than/equal to the threshold number of interest.

B.3.2 The full method

The result (threshold number) shall be expressed to the nearest whole number.

B.3.3 Test report

The result (threshold number) shall be expressed to the nearest whole number.

The test report shall make reference to this European Standard, i.e. EN 1622 and shall give the following information:

a) all information allowing complete identification of the sample;

b) storage time before test;

c) the date and time of the test;

d) if desired, the description of the source of reference water;

e) all the test conditions, in particular whether the short or full method, the forced choice test and the triangle or paired test were chosen. The number of selected assessors and if necessary the de-chlorination will be mentioned;

f) the test temperature;

g) the result obtained.

Annex C
(normative)

Qualitative simplified procedure

In European and some member states regulations relative to water intended for human consumption, the only requirement for odour and flavour is “acceptable for the consumer and no abnormal change“.

In these cases, no quantitative odour (TON) and/or flavour (TFN) assessment is required.

This annex describes a qualitative simplified procedure that can be used to check for the above requirements on a routine basis and also in cases of consumer complaints.

Samples shall be taken directly from the consumer tap and shall be assessed immediately without any dilution. The selected assessor shall judge whether the test environment is appropriate (absence of odours likely to mask the sample odours). If not, the selected assessor should carry out the test in another room. If no other appropriate room is available, the sample shall be brought back to the laboratory for assessment according to Clause 10 or Annex B.

The selected assessor shall shake thoroughly each flask, remove the stopper, smell, and then transfer a suitable volume of water in his/her glass, hold in the mouth for several seconds before discharging it without swallowing.

The selected assessor shall record if there is abnormal odour and/or flavour. If it is not the case, he/she will note “no abnormal odour and/or flavour”.

If an abnormal odour and/or flavour is detected, take a fresh sample for assessment according to Clause 10 or Annex B.

Annex D
(informative)

Method for the preparation of reference water[1)]

D.1 Apparatus and reagents

D.1.1 Glass column, with a diameter of 80 mm and a length of 500 mm and filled with fresh activated carbon (D.1.2).

D.1.2 Activated carbon, technical grade, grain size 1,5 mm to 2,5 mm.

D.2 Procedure

Set up the glass column (D.1.1) with fresh activated carbon (D.1.2). The system should be protected from light.

Pass the water through the column with a continuous flow not exceeding 30 l/h. Discard the first three bed volumes of treated water.

Collect the water in clean glass-stoppered containers (7.1).

NOTE 1 This odourless and flavourless reference water should be prepared on the day of use.

NOTE 2 Care should be taken that the activated carbon does not dry out.

NOTE 3 Steps should be taken where appropriate to ensure the microbiological quality of the reference water from the activated carbon column is acceptable.

NOTE 4 Care should be taken that the activated carbon does not influence odour and flavour of the treated water.

[1)] This annex describes a method to prepare odourless and/or flavourless reference water if this is necessary.

Annex E
(informative)

Selection of the test panel

E.1 General

The screening method outlined is designed to produce a list of people acceptable as selected assessors for flavour and odour evaluations. There are two stages to the process:

a) a self-evaluation;

b) a screening test.

Using all of these stages, a list of suitable selected assessors can be drawn up for each day's testing.

E.2 Self-evaluation

A list of candidates is compiled and entered onto a long-term constraint form (for example, see Table E.1) in order to check their ability to be selected assessors. Candidates are asked whether they have any allergies or no/very poor sense of flavour and smell.

E.3 Screening test

Prepare a series of dilutions of a sample which is known/believed to have a flavour/odour. Carry out determination of individual threshold number (TON/TFN) for the sample according to 10.3.2, by the candidate, and by at least two selected assessors who are already in the test panel.

Record the individual threshold numbers using Table E.2 for both the candidate and the other selected assessors. Calculate the mean threshold number for the sample (see 10.3.2.4, but quote to one decimal place) by calculating the geometric mean of the threshold numbers of the selected assessors and the candidate. Record the difference between the mean threshold number of the sample and the candidate's threshold number (do not record the sign of the difference — it is not required).

Repeat the complete screening test using at least nine more samples, again preferably samples with a flavour/odour covering the most significant types of descriptors. Fill in the relevant results into Table E.2.

Again on Table E.2, carry out the following calculations:

a) total the differences (ignoring the sign) between the threshold number obtained by the candidate and the mean threshold number, for all the samples. This gives D_{m} (Equation E.1);

b) divide D_{m} by the total number of samples analysed (t) (usually 10) to give D_{S} (the mean difference per sample) (Equation E.2);

c) calculate the overall geometric mean of the mean threshold numbers of the samples to give $\mathrm{TN_a}$ (Equation E.3);

d) convert the mean difference per sample (D_{S}) to a percentage of the overall geometric mean to give D_{p} (Equation E.4).

Values obtained for D_p and D_S should not exceed defined values. These values can be for example 0,7 for D_S and 20 % for D_p. Any candidate exceeding the stipulated values would not be accepted.

Enter the result of the screening test onto the long-term constraints form (see Table E.1). Successful candidates should be re-screened at least every two years.

It is better to use samples with a flavour/odour for screening tests because with flavourless/odourless samples, there is a risk that a candidate with a poor sense of flavour/smell obtains non-representative and inaccurate results. However, it can be difficult in practice to find suitable samples.

It is possible to establish a system based on the above screening test for retrospective analysis of the performance of selected assessors on routine samples.

Table E.1 — Long term constraints form

Name	Self-evaluation [a]	Date	Screening [b]	Date

[a] In the self-evaluation column enter "yes" if a candidate does not suffer from allergies and has not admitted lack of, or excessive, sensitivity to flavour and odour (i.e. candidate is suitable). If a person is unsuitable, enter "no" and do not consider for use as a selected assessor.

[b] In the screening column, enter either "yes" (i.e. candidate passed screening procedure) or "no" (i.e. candidate failed the screening procedure).

Table E.2 — Test report form for individual candidates

Name of the candidate: _____

Sample Number	*TN* of the candidate	*TNs* of other selected assessors	Mean *TN* of the sample	Difference between *TN* of the candidate and mean *TN* of the sample
1	$TN_{a,1}$	$TN_{b,1}, TN_{c,1}$	TN_1	$TN_{a,1}$-$TN_1 = D_{m,1}$
2	$TN_{a,2}$	$TN_{b,2}, TN_{c,2}$	TN_2	$TN_{a,2}$-$TN_2 = D_{m,2}$
3				
4				
5				
6				
7				
8				
9				
10	$TN_{a,10}$	$TN_{b,10}, TN_{c,10}$	TN_{10}	$TN_{a,10}$-$TN_{10} = D_{m,10}$
t =			TN_a =	D_m =

Calculate D_m in adding the differences for each sample, using Equation E.1:

$$D_m = D_{m,1} + D_{m,2} + ... D_{m,10} \quad \text{(E.1)}$$

Calculate D_S, the mean difference per sample, using Equation E.2:

$$D_s = D_m / t \quad \text{(E.2)}$$

where

t is the total number of samples analysed.

Calculate TN_a, the overall geometric mean of the mean TN_s of the samples, using Equation E.3:

$$TN_a = \sqrt[10]{TN_1 \times TN_2 \times \ldots \times TN_{10}} \quad \text{(E.3)}$$

Calculate D_p, the mean difference per sample expressed as a percentage of the overall geometric mean, using Equation E.4:

$$D_p = \frac{D_s}{TN_a} \times 100 \quad \text{(E.4)}$$

Annex F
(informative)

Preparation of dilutions

The permitted range for x is between 1,3 and 3. If x < 1,3, problems are likely to occur because selected assessors will be unable to perceive any change in levels of odour and flavour. If x > 3, the resolution of the method will be insufficient for most purposes. For most purposes, x = 2 will produce satisfactory data. The table below indicates various ranges of x^p.

The concentration of a dilution in terms of the concentration of substances in the original sample is equal to (original concentration) / x^p.

Thus p = 0 represents the original sample. The value x = 1,468 is the Boyer factor, $10^{1/6}$.

Table F.1 —Examples of successive dilutions, x^p (10.3.2.2)

p \ x	1,3	1,468	1,6	2	2,5	3
0	1	1	1	1	1	1
1	1,3	1,47	1,6	2	2,5	3
2	1,7	2,15	2,6	4	6,3	9
3	2,2	3,16	4,1	8	15,6	27
4	2,9	4,65	6,6	16	39	81
5	3,7	6,85	10,5	32	98	240
6	4,8	10	17	64	240	730
7	6,3	14,7	27	128	610	2 200
8	8,2	21,5	43	256	1 500	6 600
9	10,6	31,6	69	512	3 800	20 000
10	13,8	46,5	110	1 024	9 500	59 000

Annex G
(informative)

Interlaboratory test by forced choice methodology

This annex describes an example of interpretation of results obtained by forced choice methodology (Table G.1 and Figure G.1) and reports the results of an interlaboratory test carried out using this method (Tables G.2 and G.3).

Interlaboratory tests are recommended to compare the test panel members in different laboratories and ensure that similar results are obtained.

In interlaboratory trials, it is preferable to use real samples with odour and flavour of character similar to samples that are to be tested. This is especially valid in the testing, for example, of rubber or plasticizer odours and flavours when no defined descriptor can be used.

An alternative is to use as descriptors well defined chemical substances at known concentrations which have characteristic odours and flavours.

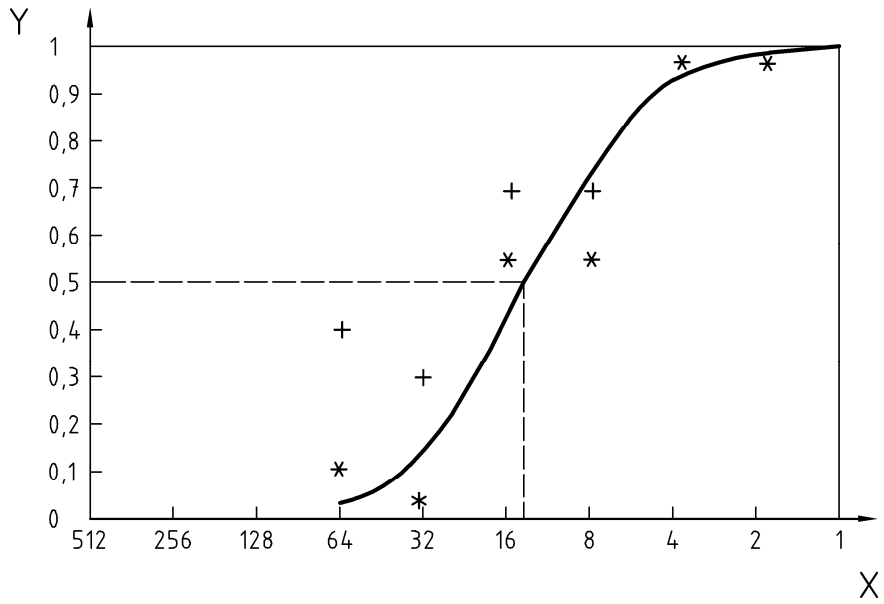
Examples of these descriptors and the corresponding characteristic flavours are:

sodium chloride	– salty
sucrose	– sweet
caffeine	– bitter
citric acid	– acidic or sour
2-methyl isoborneol	– musty
geosmin	– earthy
2,6-dichlorophenol	– medicinal

However, significant differences in sensitivity to some odours and flavours can be obtained by experiments by selected assessors in laboratories in different countries for nutritional or cultural reasons, as shown in Tables G.2 and G.3.

Table G.1 — Statistical evaluation by forced choice triangle test (TFN), concerning the measurements obtained by 10 selected assessors, for assessment of drinking water (x=2)

Dilution x^p	Fraction X [a]	Fraction corrected S [a]
1	1,000	0,967
2	1,000	0,967
4	1,000	0,967
8	0,700	0,550
16	0,700	0,550
32	0,300	0,033
64	0,400	0,100
[a] As defined in B.2.		



Key

X dilution
Y fraction
+ observed
* corrected

Figure G.1 — Graphical presentation of threshold flavour number; calculated threshold flavour number is 13,5

The results of an interlaboratory trial carried out using forced choice methodology are as follows:

Examined material: A 500 ng/l solution of geosmin. Participants in each country were instructed to prepare dilutions corresponding to 0 ng/l, 10 ng/l, 20 ng/l, 30 ng/l, 40 ng/l, 50 ng/l and 60 ng/l and to determine the odour and taste thresholds in ng/l, which were calculated back as TON and TFN.

Results of analysis: the results of measurements on odour and flavour in geosmin solutions are given in Tables G.2 and G.3.

Table G.2 — Measurements on odour and flavour on geosmin solutions (forced choice, triangle test)

Participants	Odour geosmin TON	Confidence interval 95 %	Flavour geosmin TFN	Confidence interval 95 %
Laboratory 1	11,5	5,8 to 14,5	11,5	5,8 to 14,5
Laboratory 2	> 50	no information	42,5	17,5 to > 50
Laboratory 3	18,7	7,6 to 23,3	18,8	no interval
Laboratory 4	8,5	3,0 to 17	45	14,8 to > 50
Laboratory 5	3,65	1,5 to 5,8	2,8	1,5 to 5,5
Laboratory 6	4,37	1,8 to 6,0	9,2	2,0 to 11,5

Table G.3 — Measurements on odour and flavour on geosmin solutions (forced choice, paired test)

Participants	Odour geosmin TON	Confidence interval 95 %	Flavourgeosmin TFN	Confidence interval 95 %
Laboratory 1	11,5	5,8 to 14,0	11,5	5,8 to 14,0
Laboratory 2	50	11,5 to > 50	11,4	4,1 to 19,0
Laboratory 3	12,0	2,3 to 23,1	4,5	1,5 to 7,4
Laboratory 4	11,6	5,1 to 23	10,9	5,2 to 19
Laboratory 5	4,55	1,5 to 7,9	2,43	1,5 to 4,6
Laboratory 6	< 1,5	no information	2,43	1,5 to 4,6

Bibliography

[1] ISO 3591, *Sensory analysis — Apparatus — Wine-tasting glass*

[2] ISO 5492, *Sensory analysis — Vocabulary*

[3] ISO 8589, *Sensory analysis — General guidance for the design of test rooms*

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