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Standard Guide for Assessing the Efficacy of Consumer Products in Reducing the Perception of Malodor[1]

This standard is issued under the fixed designation E1593; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers standard procedures for the quantitative sensory assessment of perceived olfactory intensity of malodors for the purpose of assessing the malodor reduction efficacy of consumer products including, but not limited to, air care, fabric care, home care, pet care, and similar products.

1.2 This guide is not intended to cover axillary deodorancy; refer instead to Guide E1207.

1.3 Malodors may be from natural or synthetic sources.

1.4 This guide is a compendium of information or series of options that does not recommend a specific course of action. The user of this guide is responsible for identifying the most appropriate test design and using the appropriate statistical tools to address the experimental design.

1.5 This guide is designed to provide guidance in product formulation and new product development, and for quality control issues.

1.6 The scope of this guide does not include all guidance necessary to support claims. For further guidance the researcher may refer to Guide E1958. The usage of methods described in this guide can be used as part of a comprehensive claims support strategy for technical types of claims (such as claims that the product will create a sensory change when used on malodor). However, this guide does not address other important elements of the claim support strategy, including determining the statistical confidence requirements, or determination of the consumer relevance of the data obtained, as discussed in 1.7.

1.7 The testing of products designed to reduce malodors via sensory testing as outlined in the present Guide can yield technical support for products' efficacy claims. The methods described in this guide—assesors with identified sensory acuity and trained, malodors that may be lab-created or synthetic, and controlled exposure to malodors in a controlled indoor environment—can deliver results with high internal validity. Internal validity refers to studies designed so that variables that may obscure the finding of an effect are controlled or managed. It is important to recognize that internal validity does not assure external validity. A robust support strategy for a malodor efficacy claim is stronger with additional evidence that the sensory effect is consumer perceivable. Such evidence of product's malodor reduction efficacy may be, for example, drawn from studies where consumers serve as evaluators, or where the product is used to reduce malodors in a more representative environment (for example, at home).

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 6 and X3.6.3.7.

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E253 Terminology Relating to Sensory Evaluation of Materials and Products

E544 Practice for Referencing Suprathreshold Odor Intensity

E1207 Guide for Sensory Evaluation of Axillary Deodorancy

E1958 Guide for Sensory Claim Substantiation

E2263 Test Method for Paired Preference Test

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 The definitions in this section are specific to this standard for the purpose of interpreting this standard; in some cases they may be different than those found in Terminology E253. For other definitions, see terms described in Terminology E253

3.2 *Definitions:*

3.2.1 *activation time*—the length of time between when a product is used (or activated) and its evaluation by assessors.

3.2.2 *dose*—a general term for the amount of product used

3.2.3 *malodor control*—a test sample or experimental treatment consisting of a chamber or substrate containing a malodor without any malodor reducing treatment (sometimes called a negative control).

3.2.4 *malodor counteraction*—a reduction in malodor perception achieved by physical removal or chemical alteration of the malodor molecule.

3.2.5 *malodor masking*—the reduction or elimination of olfactory perception of a defined odor stimulus by means of another volatile substance without the physical removal or chemical alteration of the defined stimulus from the environment.

3.2.6 *malodor reduction efficacy*—the degree to which a product treatment or process reduces perceived malodor intensity.

3.2.7 *positive control*—a blinded sample known to have low or no malodor. This may be, for example, a productonly sample or a reference product known to be effective at removing malodor.

3.2.8 *product control*—a treatment consisting of a chamber or treated substrate containing product only (no malodor).

3.2.9 *synthetic or surrogate model*—a mixture of chemical components formulated to represent an odor.

3.2.10 *treatment*—within this guide, treatment refers to the act or manner in which the product or process being investigated is dispensed into the volume of air or topically applied to the study substrate for testing.

4. Summary of Guide

4.1 This guide is limited to the assessment of a specific malodor intensity by trained assessors under controlled laboratory conditions. Methods that reflect actual consumer environmental conditions are valid for selected sensory tasks, but they may be less sensitive. Methods that include highly controlled environmental conditions will increase the chances of detecting small differences among treatments. The degree of control of extraneous experimental factors in an experiment is variable and is governed by the purpose of the test, amount of resources available to provide that degree of control, and desired level of statistical sensitivity (see Appendix X3).

4.2 The procedures described herein provide for the selection and training of individuals to perform the functions of trained assessors, and for the presentation of treated or untreated samples, or both, to these trained assessors, in order to evoke an assessment of perceived malodor intensity. These assessments are performed under controlled conditions in order to determine the effect of a given product in reducing the malodor intensity.

4.3 Products should be tested in a manner that maximizes test sensitivity while remaining consistent with normal product usage.

5. Significance and Use

5.1 The purpose of this guide is to assess the ability of consumer products to reduce malodor intensity from a control state. Several experimental hypotheses are possible, depending on the objective of the test. Possible objectives with respective hypotheses are given in Appendix X1.

5.2 Many consumer products are sold commercially with the intent of providing a means of improving the odor quality of a volume of air, or the odor quality of a substrate such as fabric or household surfaces, relative to some existing environmental condition. In the case of air care products, this typically involves the application of an odorous substance into the air space by means of some active or passive mechanism (for example, by spraying, or by evaporation). This procedure is also applicable to other mechanisms of odor reduction (for example, air filtration, chemical reactions, etc.).

5.3 Selection of representative malodor sources is of critical importance. The malodor source must be readily available and of a consistent odor quality. A reasonable malodor source should be chemically and aesthetically correct. The experimenter and client must agree upon the appropriateness of a malodor source before further details of the test design are worked out. Experimental variation will be reduced by using uniform malodor sources. Information collected on malodor reduction will thus be more comparable from experiment to experiment and from laboratory to laboratory.

5.4 The procedure recommended can be used for assessment of the malodor reduction and elimination efficacy of consumer products including: air fresheners, air filtration products, aerosol/spray and continuous/solid air freshener products, candles, fabric care products including detergents and fabric enhancing/conditioning products, surface care products including carpet care products, surface cleaning products such as sprays etc., pet care products, and other products intended to deliver a malodor reduction benefit. It should be noted that while product evaluations are fundamentally the same, different treatment or measurement techniques may be necessary because of inherent differences in the product delivery systems.

5.5 *Temporal Aspects*—The procedures herein can be applied to evaluate temporal aspects of product performance, such as determining how long it takes for a product to work, or how long it takes malodor to develop (for example, after treatment, etc.).

5.6 These procedures can be used to assess efficacy against any standard malodor, regardless of the mechanism of odor removal.

5.7 This guide is designed to provide guidance in product formulation and new product development, and for quality control issues.

6. Precautions

6.1 Extreme care should be taken when handling and preparing samples under conditions that will maintain the odorless state of the laboratory area.

6.2 Appropriate safety precautions should be taken when handling all chemical compounds.

7. Selection of Assessors

7.1 *Purpose*—The purpose of this series of tests is to screen potential assessors for a malodor efficacy panel. The screening determines olfactory acuity, specific anosmia to malodorants and fragrance ingredients that are likely components in consumer products, interest, and, if so, availability for testing. It is very important to know if assessors have any anosmias and, if so, to what particular odors. This will allow them to be excused from evaluating odor control products used against that particular odor. This screening of potential assessors should be divided into two phases (interview and testing). The two phases should be conducted as separate sessions (see *STP 758* (**1**)[3] for assessor selection considerations).

7.2 *Assessor Recruitment*—In order to ensure an adequate number of assessors for testing, a larger number should be recruited. This is to offset the attrition experienced in interviewing, testing, and training based on the assumption that roughly half the number of recruits will fail. A final number of assessors should be selected in advance. A panel size of 20 is typically recommended for a scaling experiment. However, through monitoring panel performance, the researcher may determine that fewer than 20 assessors are acceptable. Refer to *ASTM MNL26* (**2**) or Kraemer and Thieman (**3**), or both, for other considerations affecting sample size.

7.3 *Interview* (15 min)—During the interview, it is important that the trained assessors fully understand the nature of the testing for which he/she is volunteering, including the types of malodors to be used in malodor testing. If the potential assessor does not feel he/she can overcome any negative biases in experiencing such malodors, they should not participate. In addition, he/she should be made aware of and agree to the time commitment expected, scheduling of testing, and "good testing practices" such as the following: refraining from smoking, refraining from wearing perfumed or fragranced personal care products on the day of testing, and so forth. A short questionnaire regarding the person's physical health should be administered to determine whether the candidate has nasal or upper respiratory allergies, asthma, or is prone to frequent colds. These conditions may result in a decrease in an assessor's sensitivity and performance.

7.4 *Testing*—The key concept in this phase of screening is to ensure that the panel is able to (*1*) discriminate, and (*2*) detect the designated malodorant(s). A sequential analysis technique is one way to accomplish this (**4**).

7.4.1 Recruits should be tested to determine their ability to detect and discriminate the malodors of interest. Appropriate testing methods for assessing ability include discrimination, ranking, or intensity scaling, or a combination thereof. It is good practice to conduct such assessments in the manner in which the assessors will ultimately make evaluations, for example on fabric or in chambers.

7.4.2 The malodorant(s) in question should be the focus of the screening. Several concentrations of each of the malodorant(s) should be chosen for this testing. The concentrations should be representative of intensities experienced during regular malodor efficacy testing to include high and low levels.

7.4.3 Selected concentrations of each of the malodorants should be presented to recruits in a manner consistent with the difference testing procedure described in *ASTM MNL26* (**2**).

7.4.4 The selection of assessors should first rest on the results of the acuity testing. Additional subjective tests for selected assessors may be necessary to accept or reject them (that is, attitude, timeliness, and compliance). If the number of recruits is greater than required, the additional subjective information gained from the interview process should be applied.

8. Training of Panel

8.1 *Purpose*—The purpose of the experimental procedures discussed here is to recommend a program of training for a group of qualified individuals to perform malodor reduction efficacy assessment. Malodor reduction can be measured as changes in detection, discrimination, intensity, characterization, or combinations thereof.

8.2 Panel training is accomplished in three phases: (*1*) orientation, (*2*) mock efficacy studies, and (*3*) regular monitoring of assessor performance (see *STP 758* (**1**) for panel training considerations).

8.2.1 *Orientation*—One or more orientation sessions should be held for the trainees. The objective of the orientation is to familiarize the assessors with the task of evaluating malodor reduction efficacy as objectively as possible in order to reduce the experimental error. Orientation should include introducing the assessors to each other and to test personnel involved in conducting malodor efficacy, explaining the purpose of malodor reduction efficacy testing in the company, orienting and training assessors to the selected rating scale, discussing typical testing procedures, describing assessor's responsibilities, and providing a tour of the facilities used to conduct malodor efficacy testing.

8.2.2 *Mock Efficacy Study*—One or more mock studies for training may be arranged to give the assessors the opportunity to practice making efficacy evaluations. Such practice tests should include treatments with known efficacy against the selected malodor and may include all types of products that will be tested by the panel. The study may be similar to an actual efficacy test in order to smooth the transition from training to regular testing. Assessors should be given the opportunity to practice and demonstrate the ability to make the required odor measurements, which may include intensity judgments, discrimination tests, odor characterizations, or combinations thereof. In addition, through discussion and feedback, assessors should be trained to "smell through" any extraneous odor(s), such as the fragrance of the product, to

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

evaluate malodor intensity. Individual assessor performance can be monitored during the training phase by analyzing for individual assessor variability. Individuals who exhibit errant results should undergo additional training and monitoring. However, repeated underperformers should be dropped from the panel.

8.2.3 *Replications (for Assessor Monitoring)*—After initial training, performance of assessors should be monitored to ensure consistency over time. This may be done by using replications. The number of replications obtained varies with the degree of experience of the panel. A group that is being used for the first time or is in the orientation stage may require more replications. The task, the intensity of the malodor, the test facility capacity, and the olfactory fatigue all need to be considered when determining the number of replications. A minimum of two replications is required in order to ensure that the data are reproducible and one can monitor the assessor's performance.

9. Selection and Qualification of Malodor Sources

9.1 Synthetic malodors are used widely in odor testing involving the determination of product efficacy. The synthetic malodor is used to represent the actual odor. Synthetic malodors have several advantages, most of which center on avoiding logistical and safety difficulties associated with using the actual malodor source (for instance, fecal odors). Another advantage is better reproducibility. In general, laboratory efficacy testing involves the screening of various materials for their efficacy in reducing the perceived level of malodor intensity.

9.1.1 When synthetic malodors are used, they must be developed to be as similar as possible to the odor experienced by the consumer, in both the chemical and perceptual sense. Thus, any synthetic malodor sample model used should have been tested previously for its validity as a sample of the actual odor.

9.1.2 There are many potential techniques for accomplishing validation. The application of each technique, be it descriptive, discrimination, or consumer testing, must be evaluated on its own merit. It is not within the scope of this guide to enumerate the details of all techniques; however, it is imperative that the results should indicate clearly that the synthetic malodor is reasonably similar to the actual malodor as experienced by the consumer.

9.2 The use of surrogate malodors may also be appropriate. Surrogates are created to represent natural odors when preparation of the natural odor would be too complex or raise safety concerns. Surrogate malodors may be created for example, by using a standard set of microbes, nutrients, and incubation conditions to represent a malodor that may be naturally formed under more complex conditions. Wood smoke may be considered as surrogate for tobacco smoke.

9.2.1 The development of surrogate malodor should follow the same principles as outlined above for synthetic odors regarding consumer relevance and chemical behavior. Results of the tests with surrogate malodors will need validation to verify that the response of the surrogate is the same as the actual malodor.

9.3 Natural malodors must also be chosen with care and may require validation similar to synthetic odors. For example, the malodor source may require heating, or blending of ingredients such as in the case of a cooking odor. Odors on fabric that are produced by microbial action may be influenced by storage temperature, time, and moisture conditions. Such preparation methods and ingredient choices must be developed to produce odors that are as similar as possible to those experienced by the end consumer.

9.4 The following criteria may be used to validate the choice of malodorant(s). One or all of these criteria may be appropriate, depending on the specific mode of action of the products.

9.4.1 *Chemical Composition*—If the product is meant to function by some physical method (other than masking), the chemical composition of the malodor sample is critical. The chemical compositions of the malodor sample and samples of the actual malodor source should be determined by appropriate analytical methods. Similarities and differences should be noted and evaluated for relative importance.

9.4.2 *Multiple Choice Data*—The data generated from a multiple choice descriptor panel can be used to support a potential malodor sample. Malodor samples should be presented at appropriate intensities. The number of assessors, malodor samples, and possible descriptors should be considered before beginning any such test. Other factors to consider include the sample presentation, descriptor terms, and acceptance criteria. For an example ballot and profiles, see Appendix X2.

9.4.3 *Odor Profile Data*—The data generated from an odor profile panel can also be used to support a potential malodor sample. Although this procedure is more time and resource intensive, it will provide more detailed information on major and minor odor descriptors that are detected in a potential malodor sample. The considerations discussed relative to the multiple-choice tests should also be considered for odor profile tests. For information concerning odor profiling, see Dravnieks (**5**) or Jeltema and Southwick (**6**), or both.

9.5 *Toxicological Review*—The malodor sample should be subjected to a safety review by the appropriate health and safety professionals to ensure that human health is not endangered, and that assessors are not being exposed to regulated substances at levels exceeding those allowed by law.

10. Sample Preparation Procedure

10.1 *Sample Preparation:*

10.1.1 Sample preparation is dependent on the use of the product and nature of the individual malodor standard.

10.1.2 Measurement of product performance requires a minimum of two test samples: (*1*) a (usually blinded) untreated malodor control, and (*2*) a combination of malodor and product. If desired, the test can include a sample consisting of a product alone, that is, without malodor. Several different test samples may be evaluated in the same panel session. The test samples are in addition to any identified control such as described in 11.2.1.

10.1.3 The number of test samples that can be evaluated in a single session will depend on the number of chambers or

substrates available, nature of the malodor, and skill of the panel. The experimenter will need to determine empirically the limitations imposed by the malodor and by the trained assessors. The study protocol may need to include one or more approaches to address odor adaptation/fatigue. Approaches may include time between samples, the number of samples evaluated between breaks in testing, smelling a neutral substance, and/or others. Verification of adequate recovery time, and appropriate number of total samples can be accomplished by, for example, looking for order effects in the results of replicated test samples.

10.1.4 The application of malodor and treatment to the chambers or substrates usually occurs sequentially chronologically. The application order will depend on the specific treatment use. Typical treatments are as follows: (*1*) malodor is applied first, and product is applied second, and (*2*) product is applied first, and malodor is applied second. Depending on the objective of the testing, test chambers may be re-dosed one or more times by the malodor or fragrance. In tests where either the malodor or treatment need to be re-applied to assess product performance, the treatment sequence can be repeated or modified. Modifications include re-dosing of the malodor only, re-application of the treatment only, or some combination the two steps, which will depend on experiment design and product being tested. Testing products where treatment effects improve with additional applications is one example where re-dosing may be important. An additional example where re-dosing is applicable is when testing for the prevention of a malodor from re-occurring after an initial, larger dose has been mitigated.

10.1.5 For chamber studies: after the appropriate exposure time for the malodorant or product, or both, has elapsed, both the malodorant and the product may or may not be removed from the chamber(s). This decision must be made considering the goal of the specific test. While removing the odorants, take care to preserve the odorless state of the surrounding laboratory.

10.1.6 For chamber testing, the appropriateness of controlled air flow or static air conditions must be determined based on the specific test objectives. A mixer may be needed if static conditions are selected. Care should be taken in selecting materials of the mixer (refer to X3.5) and to understand any impacts of the mixer on performance of the product being evaluated. For example, air flows may influence the emission rate of evaporation-type air care devices.

10.1.7 *Toxicological Review*—The product exposure should be subjected to a safety review by the appropriate health and safety professionals to ensure that human health is not endangered, and that assessors are not being exposed to regulated substances at levels exceeding those allowed by law.

10.2 *Malodor Treatments:*

10.2.1 The selection of a representative malodor source is of critical importance. No agreed-upon standards exist. Review 5.3, Section 9, and Appendix X2.

10.2.2 Tests are typically set up to evaluate a single malodor at a time. Tests in which assessors are exposed to multiple malodors can be confusing and may reduce test sensitivity.

10.2.3 The selection of the malodor dosage and activation time will depend upon the objective of the test. A dose-response study of the malodor may be useful to help determine the malodor dose relevant for the test objective. Depending upon the conditions and length of the test, it may be necessary to periodically re-dose. The re-dose amount for the malodor may be different than the initial dose depending on the test conditions and can also be evaluated with a dose-response study. Activation time will depend on the chemical or biological processes involved in the generation of the malodor. A time-intensity study may be useful for determining the activation time for the malodor to reach a consumer, or technology, relevant intensity level.

10.3 *Product Treatment Examples*—The following guidelines provide illustrations for some specific product forms; the principles of this guide are not limited to only these examples.

10.3.1 *Aerosol Spray and Trigger Pump-type Delivery Systems:*

10.3.1.1 Prior to applying product to the malodor in the chamber or on to a substrate, spray the products for 1 to 2 s (aerosol type sprayer) or 2 to 3 pumps (trigger type sprayer) into a fume hood to clear the dip tubes.

10.3.1.2 There are two generally used methods of application: equal spray time and equal weights. Note the weights when using equal spray time. Adjust the spray time or weight amount according to the volume of the chamber or area of substrate. Regardless of brand, valve type, actuator type, etc., equal spray time will provide an estimate of product efficacy that will be representative of the total product being evaluated (not including appearance attributes). Reminder: care should be taken when selecting the spray time to ensure concentrations do not get too high, especially if using small chambers.

10.3.1.3 Apply the product to the chamber atmosphere using a broad, sweeping motion and by directing the spray toward the ceiling. This should be completed at least 5 min prior to evaluation by the assessors.

10.3.2 *Continuous/Solid-type Delivery Systems*—Prior to conducting a test for effectiveness, determine a proper activation time. This interval may vary from a few minutes to several hours, depending on the mode of action and the volume of the test room.

10.3.3 *Air Filtration Products Systems*—Prior to conducting a test for effectiveness, determine a proper operating time and device settings for the air filtration device. This time may vary from several minutes to several hours, depending on the mode of action and the volume of the test room.

10.3.4 *Fabric Care Products*—Prior to conducting a test for effectiveness, determine the proper fabric type, application method, fabric condition for evaluation (for example, pre-wash, post wash, post-dry, etc), and laundry cycle conditions for the fabric care product. These conditions may include, but are not limited to, the proper water hardness, time, wash temperature, any pretreatment, and type of drying method. Pretreatment, such as soaking the fabric or applying product directly to the fabric, will require determining the incubation time and the amount of product to be used. Recommendations from the manufacturer of the fabric should be considered when setting the test protocols. The amount and type of fabric drying

should be established in the test protocol. For non-laundering applications, use equal application time or amount depending on the product type. The type of product can be a fabric spray, foam, solid, gel, liquid, or powder.

10.3.5 *Pet Care Products*—Prior to conducting a test for effectiveness, determine the proper operating time, application amount, and method of application. Operating time may vary from several hours to several weeks in the case of litter-type products depending on the mode of action, soil amount, amount of product used, and the volume of the test room. In the case where the product is directly applied, such as a spray, foam, gel, liquid, or lotion, equal spray time or total amount may be used as appropriate.

10.3.6 *Household Cleaning Products*—Prior to conducting a test for effectiveness, determine the proper application amount, application method, activation time, and operating time. Equal dispensing time or application amount may be suitable depending on the product form and purpose, such as a powder compared to a liquid carpet cleaner. Activation time can range from immediate to several hours and operating time can vary from several hours to several weeks depending on the mechanism of action, cleaning surface area, cleaning surface material, and product design. Product types include liquid, powders, sprays, gels, sticks, sponges, and foams.

10.3.7 *Personal Care Products*—(Not including axillary deodorants (Test Method E1207.) Prior to conducting a test for effectiveness, determine the proper application amount, application method, activation time, and operating time. Equal dispensing time or equal amounts of applied material may be appropriate depending on the form of the deodorizing product, which may include, for example, gels, foams, liquids, solids, pastes, and creams. Application can be by way of a spray, bar, drop, sponge, or dispensed from a container (powder, for example). Depending on the product, activation time can range from an immediate response to several minutes depending on the mechanism of action, the region of the body, and individual physiology. Note that care must be taken to follow all applicable ethical guidelines and regulations when conducting research with human subjects.

10.4 *Cleaning*—Re-used test facilities such as chambers must be thoroughly cleaned and free from any odors or residual contaminants before beginning a subsequent test. Cleaning procedures should be validated by for example, assessing the empty, cleaned chambers or other testing equipment for odor intensity.

11. Sample Presentation to Assessors

11.1 For air evaluations, samples are presented to assessors in odor evaluation chambers. For substrate samples, substrates may be presented directly to assessors. The samples should be labeled with randomly generated, three-digit codes. Temperature and relative humidity conditions should be controlled as much as possible in the area where evaluations are taking place. Typical conditions are 22 °C and 50 % relative humidity. Conditions should be recorded and be equivalent for all samples. Each assessor evaluates the samples following a randomization plan. It should be noted that in order to maintain independence of judgments between samples, assessors rest in between each sample as described in 11.2.3. Chambers are evaluated in a manner that minimizes dilution of the chamber contents. This is usually accomplished for chamber tests by having assessors smell the contents of the chamber through a small port. For substrate tests, air flow in the room is minimized during testing evaluations to minimize dilution. Verification of limited dilution may be accomplished by, for example, examining the evaluations for order effects.

11.2 *Smelling Procedure:*

11.2.1 A malodor control (for example, nil-product) sample, which all assessors smell first, can be used as a reference. This sample is identified as containing the malodor of interest without treatment. Assessors then smell each test sample for that particular odor. Tests may contain a blind malodor control in addition to the identified sample (see Section 10). The data from the identified, reference malodorcontrol sample is usually not used in any analyses. In addition to acquainting the assessors with the malodor in question, this approach may reduce the order of presentation effect between samples as well as the effect of fatigue.

11.2.2 Smell the sample and evaluate the intensity of the malodor using an appropriate sensory method (see *ASTM MNL26* **(2)** or Practice E544). Other attributes such as overall intensity and qualitative change may also be assessed at this time.

11.2.3 The amount of time between samples depends on many factors (for example, adaptation and fatigue; see discussion at 10.1.3) and should be determined through experience using good experimental techniques. A minimum of 1 minute is recommended and the time between samples is adjusted up depending on the adaptation of that particular malodor. Verification of adequate recovery time, and appropriate number of total samples can be accomplished by, for example, looking for order effects in the results of replicated test samples.

11.2.4 Repeat 11.2.2 and 11.2.3 until all of the samples are evaluated. It is good practice for samples to include positive controls (such as product-only controls) or reference products (with known performance) and negative controls (such as malodor without product), other controls (such as blank chamber or clean substrate), and market targets, in addition to test products.

11.3 Whenever possible, the test should be scheduled in such a way that only one assessor is in the chamber area at a time. If not possible, measures should be taken to ensure the independent nature of each evaluation, avoiding even unintentional communication between assessors.

12. Data Collection and Analyses and Interpretation of Results

12.1 Sensory malodor intensity evaluations are obtained by using any industry recognized method (paired comparisons, ranking, or scaling).

12.2 The statistical analyses to be conducted depend on the objective of the test and the procedure used as well as test design (see Appendix X1).

12.3 The interpretation of test results after statistical analysis of the data are given in Appendix X1.

13. Keywords

13.1 air care products; consumer; indoor air; malodor counteraction; sensory facilities; sensory test chamber construction

APPENDIXES

(Nonmandatory Information)

X1. EXPERIMENTAL DESIGNS AND ANALYSES FOR SELECTED EXPERIMENTAL OBJECTIVES

X1.1 Introduction

X1.1.1 Experimental designs and statistical analyses are given for several experimental objectives that are encountered commonly in malodor counteraction efficacy testing. All of the designs in this section require the use of intensity rating scales. However, designs using ranking or paired comparisons may also be appropriately used. For further information on these techniques, see *ASTM MNL26* (**2**).

X1.1.2 Before designing any study, several factors should be considered carefully. Factors such as the background of the test, specific use for the data, resources available, and stage of development will influence the choice of experimental design and risk levels. The sensory professional should consult with a statistician to consider alternate designs or supplementary objectives if they do not have relevant statistical expertise. See also Kraemer and Thiemann (**3**).

X1.2 Basic Test Designs

X1.2.1 *Design No. 1:*

X1.2.1.1 *Objective*—Determine the efficacy of Product A on a given malodor.

X1.2.1.2 *Research Question*—Does Product A reduce the perception of malodor?

X1.2.1.3 *Experimental Design*——Two samples are evaluated: (*1*) malodor alone (MAL); and (*2*) malodor plus Product A (A + MAL).

X1.2.1.4 *Statistical Approach*—Null hypothesis (malodor level): MAL ≤ A + MAL; and statistical test: Student's paired *t* test (one-tailed).

X1.2.1.5 *Possible Outcomes:*

(1) Reject Null Hypothesis—Conclude that Product A is effective in reducing the perception of malodor.

(2) Do Not Reject Null Hypothesis—Conclude that Product A has not been demonstrated to be effective in reducing malodor, within the sensitivity of the experiment.

X1.2.2 *Design No. 2:*

X1.2.2.1 *Objective*—Determine the relative efficacy of two products (A and B) on a given malodor.

X1.2.2.2 *Research Question*—Does one of the products reduce the perception of malodor more than the other?

X1.2.2.3 *Experimental Design*—Two samples are evaluated: (*1*) malodor plus Product A (A + MAL); and (*2*) malodor plus Product B (B + MAL).

(1) Malodor plus Product A (A + MAL), and

(2) Malodor plus Product B (B + MAL).

X1.2.2.4 *Statistical Approach*—Null hypothesis (malodor level): A + MAL = B + MAL; and statistical test: Student's paired *t*test (two-tailed).

X1.2.2.5 *Possible Outcomes:*

(1) Reject Null Hypothesis—Conclude that one product is more effective than the other in reducing the perception of malodor.

(2) Do Not Reject Null Hypothesis—Conclude that a difference has not been demonstrated between the two products in effectiveness, within the sensitivity of this experiment.

X1.2.3 *Design No. 3:*

X1.2.3.1 *Objective*—Determine whether assessors are identifying the malodor accurately (this is a panel maintenance and screening test).

X1.2.3.2 *Research Question*—Do the assessors indicate correctly that a malodor difference exists between the malodor alone and the product alone?

X1.2.3.3 *Experimental Design*—Two samples are evaluated: malodor alone (MAL); and Product A alone (no malodor).

X1.2.3.4 *Statistical Approach*—Null hypothesis (malodor level): MAL ≤ A; and statistical test: Student's paired t test (one-tailed).

X1.2.3.5 *Possible Outcomes:*

(1) Reject Null Hypothesis—Conclude that the assessors are identifying the malodor correctly.

(2) Do Not Reject Null Hypothesis—Conclude that assessors may not be identifying the malodor correctly. This may indicate the need for retraining of the assessors on that malodor. The malodor level should also be evaluated, as a very low malodor level can cause this type of effect.

X1.2.3.6 This test is often combined with another product and malodor test.

X1.3 Complex Test Designs

X1.3.1 Often, more than one of the objectives discussed in X1.3 may be addressed in a given design. This is achieved by combining the basic test designs that were discussed in X1.3. Some of these are illustrated as follows:

X1.3.2 *Design No. 1:*

X1.3.2.1 *Objectives:*

(1) Determine the efficacy of each of three products on a given malodor.

(2) Determine the relative efficacy of each product against the other products on a given malodor.

X1.3.2.2 *Research Questions:*