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AATCC Style Guide for Writing Test Methods

1. Introduction

1.1 AATCC test methods are used in many different ways, and by many different types of users. Hence, it is important that they be written in as precise a manner as possible.

1.2 AATCC policy prohibits endorsement of commodity specifications. The results obtained by the methods should not be construed as commodity specifications.

2. Organization of Test Methods

2.1 Scope

2.1.1 All AATCC test methods are required to contain the sections identified in the list below by an asterisk. Test methods may also contain the additional sections shown in the list. However, in order to promote uniform style, the additional sections may only be used in the sequence shown. And, the titles or headings of the sections may not be replaced with other terms.

2.2 Subdivisions

2.2.1 The following is the prescribed order for the text of AATCC test methods:

*Title
*Activity History
Foreword
*Purpose and Scope
*Principle
Referenced Documents
*Terminology
*Safety Precautions
Uses and Limitations
Apparatus, Reagents, Materials**
Verification, Calibration**
Sampling
*Specimens
Conditioning
Preparation of Apparatus, Specimens, Reagents**
*Procedure
*Calculations, Interpretation, Evaluation**
Report
*Precision and Bias
Additional References
Notes
Appendices

*Required for all test methods.
**Use appropriate heading.

2.3 Numbering of Sections

2.3.1 Using the modified decimal system, number each series of sections and subdivisions serially and set off these numbers by periods (decimal points) to indicate the particular part of the method from the largest division or section, down to the individual paragraphs. For example: "2." indicates the second principal section of a method; "2.3 and 2.14" designate respectively the third and fourteenth subdivisions of primary division 2.; similarly, "2.14.10" designates the tenth paragraph or subdivision of the fourteenth division of the second section of the method.

2.3.2 Use no longer than three-place numbers. For example: A two-place number means 2.14; a three-place number means a symbol such as 2.14.1 or 2.14.10. This numbering not only shows at a glance the arrangement of the written material, but also permits simple and specific cross referencing. Numbers with more than three places defeat the purpose of simplicity. The need for more than three places can usually be avoided by making more primary and secondary subdivisions of the subject or by using fewer subdivisions.

2.4 Title

2.4.1 Name the property to be measured, not some quality to be inferred. Keep the title explicit and terse. For example: "Loss of Strength in Rayon Cloth by Exposure to Sulfurous Acid"; not "Resistance of Fabric to Acid Damage." "Biological Oxygen Demand in Textile Mill Effluents" not "Stream Sanitation."

2.4.2 In order to simplify finding methods in alphabetical listing, key words that describe the general nature of the test should be used in the beginning of the title followed by more specific descriptive terms. For example, AATCC Method 162, Colorfastness to Water: Chlorinated Pool.

2.5 Activity History

2.5.1 State briefly the history of the test method including the number of the committee which developed it, the first year of publication and the year of all subsequent reaffirmations, editorial revisions and technical revisions. Also list any similar test methods of other organizations such as ISO.

2.6 Foreword

2.6.1 A history of the rational for the development of the method may be included to help clarify the need for the method.

2.7 Purpose and Scope

2.7.1 Name the properties to be tested, the material to which the tests are applicable and the characteristics to be inferred. If the method contains a series of tests on several attributes, list them.

2.7.2 Keep all methods anonymous; they are pronouncements of AATCC.

2.8 Principle

2.8.1 Briefly sketch the technique, outlining the fundamental physical and chemical concepts involved.

2.9 Referenced Documents

2.9.1 List any AATCC, ASTM, ISO or other test method cited in the test method, by numerical designation, and title.

2.9.2 To cite references, use the format of Chemical Abstracts.

2.10 Terminology

2.10.1 Define all terms not found in the ordinary desk dictionary, and all terms used in some specialized sense. Define terms that are used only in one restricted branch of the textile industry. If a definition is taken from some other publication, quote it in full and give due credit by complete attribution.

2.10.2 Define all key terms in titles to ensure that all persons referring to or using the test method understand its intent.

2.11 Safety Precautions

2.11.1 A generic caveat on precautions shall appear in all test methods.

2.11.2 This generic caveat shall appear in the Safety Precautions section of the appropriate test methods.

2.11.3 The generic caveat shall be: NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific

details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

2.11.4 Where the test method does not involve the use of hazardous materials, operations and equipment, an exception to the inclusion of the generic caveat may be presented to AATCC Committee RA100 on Safety, Health and Environmental Technology.

2.11.5 Specific precautionary statement(s), where appropriate, shall be included in the body of the test method. These statements shall not prescribe specific remedial measures and actions. However, reference may be made to authoritative sources where reliable information concerning remedial measures can be obtained.

2.11.6 When a specific precautionary statement(s) exists in a test method, reference to the appropriate section(s) shall be made following the generic caveat.

2.12 Uses and Limitations

2.12.1 Show how the test results may best be used, and discuss inferences that may legitimately be drawn from the data. Point out where the results are not useful and particularly where they might be misleading.

2.12.2 State categories wherein the method should not be attempted. Particularly where they might be misleading.

2.13 Apparatus, Reagents, Materials

2.13.1 Separate the subject into two or three separate sections if there will be more than 10 items per section. In a text note, show where any unusual item may be procured. Check the source for availability.

2.13.2 Do not include preparation of reagents or calibration of apparatus in this section.

2.13.3 Include as apparatus only special equipment which is not in the catalogs of laboratory supply houses, or apparatus which is rarely used. Include spectrophotometers, projection microscopes and Launder-Ometers. Do not include such ordinary items as scissors. Common glassware, such as beakers, burettes, and flasks, need not be listed, but may be listed, if it is felt test method efficacy is enhanced.

2.13.4 List all reagents—acids, bases, salts, etc.—using chemical names not trade names; for example, sodium hydroxide, not caustic soda. Include chemical formulae for all reagents. If a complex organic compound is used the formula may be omitted but the proper name as accepted by the Geneva Convention should be used.

2.13.5 Unless otherwise stipulated, assume all chemical reagents are of ACS Reagent quality; and construe "water" as distilled or deionized to not over 15 ppm total solids and not less than 50,000 ohms resistance.

2.13.6 Among materials, include unusual things like multifiber test fabric, standard color swatches, standard photographs of defects and reference spectra.

2.14 Verification, Calibration

2.14.1 Instruments and equipment must be periodically verified to protect against any drift due to time, wear or accident. Such checks may be made by the operator every time a test is performed, or perhaps daily, like checking the zero point of analytical balances. The check may be rarely performed, as when installing new apparatus or setting up after a major relocation; or the check may be part of good laboratory management that is performed as weekly or monthly routine. Include day-to-day verification in PROCEDURE. Infrequent checks belong in a separate appendix. Include verifications that are part of laboratory routine and which should be put on a regular schedule.

2.14.2 Besides mechanical adjustments, include calibration curves, standard curves and verification of normality (or molarity) of standard solutions.

2.14.3 Describe the preparation of standard reagents; also standard curves or tables relating the quantity of an unknown with reference to color transmission, conductance, pH or other property of a standard solution.

2.15 Sampling

2.15.1 Test results are valid only when the samples are statistically representative.

2.15.2 Sampling must be random. Every unit of product must have a mathematically equal chance of becoming a sample; and every portion of each sample must be equally likely to become a test specimen.

2.15.3 All specimens must be alike within the variations due to pure chance. There must be no differences within samples assignable to known causes. If test results are not in a normal or other recognizable distribution, the test method is not in control.

2.15.4 Include in each method a brief sampling plan. State either the number of specimens to test per sample and the number of samples per product, or else state the required coefficient of variation of the mean, and permit the operator to determine the number of specimens.

2.15.5 If the number of tests is stipulated in a method, state the expected precision of the mean and the probability. If the operator is to compute the number of tests, to meet a stipulated precision of a mean, provide an expected coefficient of variation (CV) from background experience. If (CV) is unknown, provide for its estimation by methods in any standard test on statistics, or consult ASTM Standard D 2905, Statements on Number of Specimens Required to Determine the Average Quality of Textiles.

2.16 Specimens

2.16.1 Describe the size, shape and weight of specimens. Include any limitations on the location or choice of test material; but put details of trimming, mounting and conditioning in other sections.

2.17 Conditioning

2.17.1 Specify the atmospheres in which the specimens must be pre-conditioned and conditioned for testing.

2.17.2 If the samples or specimens must reach moisture equilibrium, state it something like: "Let specimens reach moisture equilibrium with atmosphere at [(a) ± (b)] C, [(x) ± (y)] F, and [(m) ± (n)]% Relative Humidity. Approach equilibrium from the dry side (but not ovendry)." If the final moisture regain is critical, stipulate also the preconditioning time, temperature and relative humidity.

2.17.3 Define moisture equilibrium as having been attained when the progressive gain in weight does not exceed (k)% of conditioned weight per hour of exposure.

2.18 Preparation of Apparatus, Specimens and Reagents

2.18.1 Include here all preparatory or preliminary steps. Include trimming edges of specimens, pulling threads to trace weave patterns, leveling and adjusting equipment, etc.

2.19 Procedure

2.19.1 Procedures are operating instructions for technicians and must permit trained technicians, working in separate laboratories, to obtain results that are comparable within agreed limits, with little or no other guidance.

2.19.2 State all operating instructions clearly, simply and unequivocally. Leave no room for differing techniques. Recite every needed detail in proper sequence.

2.19.3 If the container is a critical item, name it, such as "a 250-mL widemouthed Erlenmeyer flask." If time is important, state narrow limits. Specify the temperature of the water as "water at

140-160°F," not "hot water"; "water at room temperature" not "rinse in cold water." State the measure as "add 10.00 ± 0.02 mL" not "add exactly 10 mL."

2.19.4 Indicate the number of significant figures to record in observations. Be sure the accuracy is mathematically justified.

2.19.5 When two equally acceptable procedures give statistically interchangeable results, spell out each procedure and state that either may be used.

2.19.6 Write procedures in the second person imperative format.

2.20 Calculation, Interpretation, Evaluation

2.20.1 Calculation involves straightforward computation without exercise of opinion. Include as calculation all requisite algebra and arithmetic. State exactly what is to be computed and how. State the number of significant figures required in all calculations.

2.20.2 For subsequent reference in texts, number each equation in a sequence by a numeral in parentheses at the right margin of the line.

2.20.3 Indicate multiplication by parentheses ( ) ( ) and division by the solidus (/). Write:

$x = 100\ (A - B)/C$

$y = 100\ (0.00587)\ (A - B)/C$

2.20.4 Keep formulas on one line of typescript if possible. Write:

$x = (A - B)/C$

2.20.5 Use symbols in current use. For x is less than or equal to y, write:

$x \leq y$

2.20.6 Restrict equations to symbols and numerals. Write:

$x = 100\ (A - B)/C$

where:

x = iron as Fe, percent of oven dry specimen weight.

2.20.7 Keep all numerals at the left side of expressions that contain both numerals and letters. Write:

$x = 100\ (0.00587)\ (A - B)/C$

2.20.8 Do not condense chemical or physical equations. It makes checking of computations difficult. Write:

$x = 100\ (0.00587)\ (A - B)/C$

2.20.9 Confirm the position of the decimal point in all decimal fractions by putting a zero in the units column. Write:

$a = 0.3010B$

2.20.10 When a mathematical development requires two or more lines, place the statements in column, repeating only the equality sign. Write:

$$n = (t^2)\ (v^2)/(e^2)$$
$$= (1.96^2)\ (7.5^2)/(5^2)$$
$$= 8.6$$
$$= 10 \text{ (to the nearest higher multiple of 5)}$$

2.20.11 Show the basis of percentage statements. Write:

"Moisture content, % of conditioned weight"

2.20.12 Include a sample computation whenever an equation is long, involved or in the least degree difficult to reduce to English.

2.20.13 Use the heading "Interpretation" in place of or in addition to "Calculation" when the results are expressed in descriptive form, relative terms or as abstract values. Such results may be expressed in terms of a 5 to 1 rating scale with 5 being best and 1 being worst.

2.20.14 Evaluation of test results implies consideration of several factors, pro and con, and arrival at a considered decision in view of the whole situation. For example color transfer is evaluated against the International Gray Scale, in which hue, brightness and saturation of color in a stained specimen is translated against a scale of graduated neutral gray chips that have neither hue nor brightness but solely the property of saturation.

2.21 Report

2.21.1 Specify the detailed information to be reported.

2.21.2 Require that the test method be cited, and the procedure if there is a choice.

2.21.3 Report in tabular form series of test results involving several samples, several products or numerous replicates. Include a sample work sheet or report form and include typical computations.

2.21.4 Each report must contain, as a minimum:

(a) Arithmetic mean or average ($\overline{X}$)

(b) The number of tests (n)

(c) Standard deviation (s) or coefficient of variation (*%CV*)

Statement of a mean without the number of tests and precision is essentially useless.

2.21.5 AATCC policy prohibits endorsement of commodity specifications. The ratings suggested in some of the methods serve as a guide; but they are not intended for and must not be construed as commodity standards.

2.22 Precision

2.22.1 *Precision.* A statement on precision allows potential users of the test method to assess in general terms its usefulness in proposed applications. (For an extended discussion, see ASTM D 2906, Statements on Precision and Bias for Textiles.) A statement on precision is not intended to contain values that can be exactly duplicated in every user's laboratory. Instead the statement provides guidelines as to the kind of variability that can be expected between test results when the method is used in one or more reasonably competent laboratories, and when the test method's use is in statistical control. No valid statement can be made about precision unless the use is in statistical control.

2.22.2 Variation in test results is a consequence of variation of the material tested, variation in application of the test method and the character of the test method or a combination of any of these variables. With respect to a test method, the statement about precision shall refer to the variation that results from application of the test method to material in which the variation is as small as can reasonably be attained.

2.22.3 The measures of precision discussed below and the presence or absence of statistical control shall be estimated with an interlaboratory test program. When the test results appear to come from certain discrete distributions, precision could be calculated without an interlaboratory test but statistical control could not be established.

2.22.4 Where testing is required to determine precision, every test method shall strive to contain a statement (1) about the precision of test results obtained in the same laboratory under specifically defined conditions of *within-laboratory* variability, and (2) about the precision of test results obtained in different laboratories. The specifically defined *within-laboratory conditions* may concern test results obtained on the same material by the same operator using the same equipment within a short period of time, or *within-laboratory* precision may be reported for other specific conditions; for example, between days or between operators. Describe the particular within-laboratory variability for which precision is reported in detail. The statement regarding *between-laboratory* variability must pertain to test results obtained in different laboratories on the same material.

2.22.5 If the test result data are continuous variates, give the standard deviation or coefficient of variation, whichever is appropriate, and the applicable components of variance for each type of precision that is reported. In any case, the precision statement shall give the 95% critical difference for *within-laboratory* and for *between-laboratory* test data. If the precision is not the same for all materials, then give the precision for each material used in the interlaboratory test that was used to obtain the precision measurements.

2.22.6 File the data obtained in the interlaboratory study and the detailed analysis of the data at the AATCC Technical Center.

2.22.7 The required statement of precision shall contain the information specified above or an explanation as to why a statement is not practicable. The absence of a statement on precision is not war-

ranted if the reason is that an interlaboratory test has revealed that the precision is poor.

2.22.8 If the precision varies with the test level, describe this variation.

2.22.9 Include other related information that may help users assess the degree of applicability of the statement to the materials of interest to them. It may be desirable to note the presence of other types of variability in test results on which information can be derived by supplemental studies.

2.22.10 In most cases of arbitrary grades that are limited and not continuous, or for which meaningful transformations may not be practicable, refer to ASTM Standard D 2906, Recommended Text 8—Special Cases of Ratings (see below). Most rating scales in AATCC methods are limited and not continuous. If analysis of variance is used with such data, statistical errors may occur and the possibility should be noted in the precision statement.

Recommended Text 8—Special Cases of Ratings

17. Statements Based on Special Cases of Ratings

17.1 In the case of arbitrary grades or classifications and of scores for ranked data, the observations may have such a complex nonlinear relationship that meaningful transformations may not be practicable. If this is so, use the text illustrated as XX.1 and XX.2 as a guide in giving a subjective basis for evaluating the precision of test results:

XX.1 Precision and Bias

111.1 *Interlaboratory Test Data*[4]—An interlaboratory test was run in 19XX in which randomly drawn samples of two materials were tested in each of five laboratories. Each laboratory used two operators, each of whom tested four specimens of each material. Calculation of components of variance was thought to be inappropriate due to the restricted and discontinuous rating scales, the non-linear relationships between the rating scales and color difference units, and the increased variability in color difference units as the true value of the ratings decrease.

111.2 *Precision*—Based on the observations described in 111.1 and on general practice in the trade, a lot or consignments is generally considered as having a rating that is significantly worse than a specified value when a specimen from the lot or consignment has a rating for (insert here the name of the property) that is more than one-half step below the specified rating on the AATCC Gray Scale for Color Change.

2.22.11 New or current methods which do not generate data, should contain the following statement: A precision statement is not applicable because data are not generated by this test method. An alternative for combined Precision and Bias Statement: Precision and Bias statements are not applicable because data are not generated by this test method.

2.22.12 Methods which state only *within-laboratory* precision, add the following as a separate statement: *Between-laboratory* precision has not been established for this test method. Until such precision information is available, users of the method should use standard statistical techniques in making any comparison of test results for *between-laboratory* averages (see 2.22.13).

2.22.13 Analysis of variance or *t*-tests may be used to compare averages. See any standard statistical text for more information.

2.22.14 Any new AATCC test method that produces data shall contain, as a minimum, a statement of single operator precision when first submitted to committee and TCR ballots, but full conformance with 2.22.4 and 2.22.7 are encouraged.

2.22.15 At its first five year reaffirmation, any AATCC test method that produces data shall be brought into full conformance with 2.22.4 and 2.22.7 prior to submission to committee and TCR ballots.

2.22.16 It is the policy of AATCC that no longstanding test methods will be dropped due to the lack of a precision statement. The research committee responsible for any longstanding AATCC test method which is not currently in conformance with the provisions of 2.22.4 and 2.22.7, should endeavor to develop as a minimum, a statement of single operator precision prior to being submitted to committee and TCR ballot for reaffirmation, but full conformance is encouraged.

2.22.17 At its next five year reaffirmation, the research committee responsible for any longstanding test method, which was previously reaffirmed under 2.22.16, should endeavor to bring the method into full conformance with 2.22.4 and 2.22.7 prior to being submitted to committee and TCR ballot for reaffirmation.

2.22.18 Test methods that do not contain a precision statement shall contain the following statements. Precision for this test method has not been established. Until a precision statement is generated for this test method, caution should be used when testing materials with this method. In most cases the use of standard statistical techniques in making any comparisons of test results for either *within-laboratory* or *between-laboratory* averages have been found to be generally accepted.

2.22.19 Research committees are responsible for timely conformance to precision and bias policy, initiation of interlaboratory studies, writing required precision and bias statements, tracking the need for revisions, and keeping to the reaffirmation timetables contained in 2.22.14.

2.22.20 In any AATCC test method that produces data in which more than one testing option is allowed, a precision statement based on the most used option satisfies the requirement. A committee may include precision for the other options, and is encouraged to do so, especially single laboratory precision for each option available.

2.22.21 Research committees should continue to work to develop precision data as described in 2.22.4.

2.22.22 Precision Statement Format. The precision statement included in a test method must contain three basic sections: (1) a brief description of the testing plan from which the data set was derived, citing the number of materials tested, the number of laboratories participating, the number of operators per laboratory, the number of tests per operator, and any other pertinent information; (2) a listing of the components of variance derived from the data set; and (3) a listing of the precision parameters calculated from the components of variance, usually in the form of critical differences, or confidence intervals. (see ASTM D 2906)

2.23 Bias

2.23.1 *Bias.* A statement on bias furnishes guidelines as to whether the test method can be used when comparisons with accepted reference values are to be made. (For an extended discussion, see ASTM D 2906, Statements on Precision and Bias for Textiles.) If the bias is known, the method can be modified to include a correction for the bias, and thus the corrected method would be without known bias.

2.23.2 If bias varies with the test level, describe the bias.

2.23.3 Any statement on bias shall describe the bias and how the method has been modified to provide corrected test results. If bias cannot be determined, include a statement to this effect.

2.23.4 File the data and details of the experiment to determine bias at the AATCC Technical Center.

2.23.5 For test methods that do not generate data, the statement on bias should read as follows: *Bias.* A bias statement is not applicable because data are not generated by this test method.

2.23.6 For test methods that generate data, the statement on bias should read as follows: *Bias.* The <property name> can be defined only in terms of a test method. There is no independent method for determining the true value. As a means of

estimating this property, the method has no known bias.

When applicable, include the following or similar separate statement: AATCC Method XXXX generally is accepted by the textile and apparel industries as a referee method.

2.24 Explanatory Notes

2.24.1 Notes should contain only explanatory matter, never any mandatory detail of performing the test.

2.24.2 Number notes in sequence as they appear in the text.

2.24.3 Place notes in a separate section at the end of the method, before the appendices. *Exception:* Notes that are part of tables belong with the tables.

2.25 Tables

2.25.1 Use tables to avoid repetition in the text.

2.25.2 Number tables in sequence by Roman numerals.

2.25.3 Place tables in proper sequence in the text, not in the appendices.

2.25.4 Head each table with a terse explicit title. Head each column of figures with a pertinent legend. Below the table, add all necessary notes. Identify the notes by lower case letters. Put the corresponding letter in the body of the table within parentheses.

2.26 Figures and Photographs

2.26.1 Title every line drawing or photograph.

2.26.2 Number figures and photographs in sequence with arabic numerals.

2.26.3 Preferably, use line drawings, with all lettering and the figure drawn to double scale. Drawings usually are clearer than photographs, and have the advantage of showing dimensions and interior surfaces. Have drawings and lettering made by a professional draftsman. The printer will size the illustration to fit the printed page.

2.26.4 Use professional quality glossy photographs with any legend typed on an attached slip of paper.

2.26.5 Place figures and photographs in proper sequence in the text, not in an appendix.

2.27 Appendices

2.27.1 Include in appendices supplementary information that might be needed but which is too voluminous to put in the text for fear of interrupting the sequence of thought.

2.27.2 The following are typical information for appendices:

Amplifications of text discussions.

Flow charting of test methods.

Glossaries of special terms.

Lists of chemical or mathematical symbols.

Detailed descriptions of apparatus of specialized nature.

Verification or calibration procedures.

Derivations of mathematical equations.

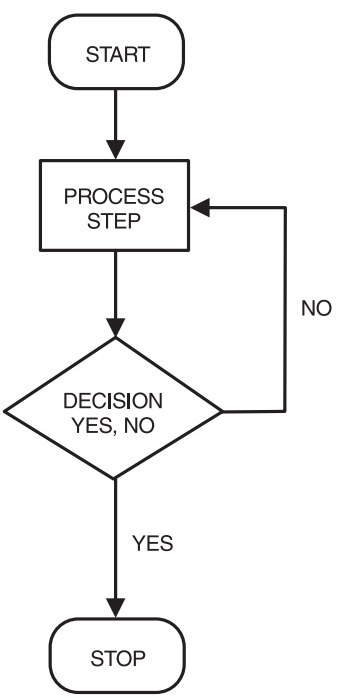
Charts and nomographs.

Report forms.

2.28 Flow Charting (Optional Appendix Item)

2.28.1 Flow Chart. A flow chart is not a replacement for a written test procedure, but is a diagram illustrating the flow and logic of any process, or system (i.e., test procedure, interlaboratory studies, etc.). It is a drawing made up of various, but specific, shapes of boxes connected by directional straight lines. Flow charting (1) gives a bird's-eye view of the flow and logic of a procedure in a pictorial fashion, (2) facilitates communication and understanding among individuals having different areas of expertise, (3) makes more obvious some of the strong and weak points of a system, (4) helps to generate ideas and provides a basis of discussion for improving a system, and (5) aids in the writing of new methods.

2.28.2 The box shapes of a proper flow chart are simple, but specific. The start and stop of a flow chart are denoted by a horizontal ellipse, with the appropriate word, START or STOP, within the ellipse. A process step, where no decision (yes or no) is required, is denoted by a rectangle. A process box usually has just one output arrow. If a decision is required, a diamond is used and two output arrows are required (yes or no). An example flow chart is as follows:



2.28.3 Flow charts should be used to illustrate major pieces of equipment, all inputs to processes (i.e., raw materials, utilities, etc.), all points where measurements are taken, and all points where adjustments can be made. The step number within the test method should be in the appropriate box or diamond of the flow chart.

3. The Manuscript

3.1 Purpose and Scope

3.1.1 Submit all manuscripts to the AATCC Technical Center in electronic format, Word Document, doubled spaced.

3.2 Designation of Colors

3.2.1 In presenting textile color data, use the method of color nomenclature developed by the Inter-Society Color Council and the National Bureau of Standards, commonly referred to as the ISCC-NBS method. See THE ISCC-NBS METHOD OF DESIGNATING COLORS AND DICTIONARY OF COLOR NAMES, K. L. Kelly and D. B. Judd, NBS Circular No. 553, U.S. Government Printing Office, 200 pp, Washington, D.C. (1955). Also STANDARDIZATION OF COLOR NAMES, Dorothy Nickerson, ASTM Standards on Textile Materials, p340 et seq., Philadelphia PA, 1940.

3.2.2 Identify colors by the three attributes of hue, lightness and chroma. Do not use the words shade, tint, depth of color and intensity. For example: rose and vermillion are hues of red, not tints or shades.

3.3 Units of Measurements

3.3.1 Use metric or SI units wherever feasible. Use English units only where they are the accepted trade practice.

3.3.2 Do not mix systems in one paragraph; for example, "a specimen 2 × 3 in. and weighing 2.0-2.5 g."

3.3.3 State measurements in both systems when both are in current American usage. Round off conversions to comparable accuracy. 1.0 in. becomes 2.5 cm, not 2.54 cm; but 1.00 in. is converted to 25.4 mm not 25 mm.

3.3.4 For liquid measure and for volumetric glassware, use milliliter (mL), not the obsolete (cc) cubic centimeter. For measures of capacity or volume, use the cubic centimeter, for which the accepted abbreviation is cm^3.

3.3.5 Laboratory procedures require metric measurement and Celsius temperatures. Fahrenheit temperature is permissible for physical testing. Mill and dyehouse practices govern units for process control, even if they are obsolescent, such as Baumé, Twaddell, Brix and Rohmer in place of specific gravity hydrometers.

3.3.6 For cases when it is necessary to express measurements when range and accuracy must be included, say for example, weigh to within ± 0.001 g a specimen with weight in the range of 4-6 g.

3.4 Numbering

3.4.1 Use numbers instead of words in every case, unless confusion will ensue. Say "4 samples," "5 days," as well as to define exact quantities like "15.43 grams."

3.4.2 Designate tables by Roman numerals, and figures or drawings by Arabic numerals. Write Table IV not Table 4; Fig. 6 not Fig. VI.

3.4.3 Do not begin a sentence with a numeral.

3.4.4 Use decimal fractions.

3.4.5 Place a zero before decimal numbers to ensure that no digit has been omitted or misplaced. Write "0.36 cm," not ".36 cm."

3.4.6 Point off numbers in excess of 4 digits with commas in the text (1,234,567) but with spaces in tabulated material (1 234 567). Do not point off numbers of 4 digits except when they occur in columns containing numbers of more than 4 digits.

3.5 Spelling

3.5.1 In general, use the preferred spelling in the Merriam-Webster INTERNATIONAL DICTIONARY.

3.5.2 Use American forms, such as "color" not "colour," "liter" not "litre."

3.5.3 Hyphenate compound adjectives, particularly such forms as "2-gram specimens."

3.6 Punctuation

3.6.1 Use a comma in a series of words but not before a conjunction. Write "wash, dry and condition specimens." Always place commas and periods *inside* of quotation marks. Place semicolons and colons *outside* quotation marks.

3.7 Capital Letters

3.7.1 When in doubt, use lower case letters.

3.7.2 Capitalize the principal words in headings and titles of standards, names of books or papers. Use lower case for prepositions and conjunctions in titles.

3.7.3 Use initial capital "C" for "committee" when used as a title, but not when used as a collective noun. Say "Committee RA60" or "Committee on Industrial Pollution"; but "the committee recommends."

3.7.4 Use capital letters in referring to tables, figures, inserted plates and volumes; as: Table III, Fig. 2, Plate VI, Vol. 25.

3.8 Abbreviations

3.8.1 Use abbreviations in the singular number only. Say "2 in." not "2 ins." Exception: Abbreviations preceding numerical values, such as Figs. 1 and 2, Vols. I and II, Nos. 1 and 2.

3.8.2 Use abbreviations only after numbers denoting a definite quantity, except in tabulations. Do not say "mix rinse liquor in a *bbl.*" nor, "wash in H_2O."

3.8.3 Abbreviate "percentum" or "percent" with the symbol (%) which is far easier to read.

3.8.4 Do not use the symbol (#) to mean "pounds" or "number."

3.8.5 Put a period (.) after an abbreviation only when the omission would cause confusion. The principal examples are "in." not "in" for inches, "no." not "no" for number, "Fig." not "Fig" for figure, and "vol." not "vol" for volume.

3.8.6 A list of acceptable conventional abbreviations is shown in Appendix A.

3.8.7 Besides the conventional abbreviations, frequently repeated series of words may be abbreviated if the words are spelled out before the abbreviation at the first use. Examples: TNT (trinitrotoluene); BOD (biochemical oxygen demand); TCE (trichloroethylene).

3.8.8 Use chemical symbols only to represent chemical entities, never as abbreviations. Write "water" not H_2O unless water is used as a reagent. Write "rinse in water," not "rinse in H_2O; say "platinum crucible," not Pt crucible." Spell out the names of unusually complex or of uncommon organic or inorganic reagents if the chemical formula will waste space or obscure clarity of text. Write $CuSO_4 \cdot 5H_2O$ rather than cupric sulfate pentahydrate. Similarly, it is simpler to write "aspirin" than "acetylsalicylic acid" and certainly simpler than to write the structural formula.

3.8.9 Do not, as a general rule, abbreviate terms that are infrequently used without spelling out the entire word or phrase the first time the expression appears.

Appendix A
Abbreviations

absolute	abs
alternating current (noun)	ac
(adjective)	a-c
ampere	amp
angstrom unit	Å
anhydrous	anhyd
average	avg
barrel	bbl
Birmingham wire gage	Bwg
British thermal unit	Btu
Brown and Sharpe (gage)	B&S
calorie	cal
Celsius	°C (Note 1)
centigram	cg
centimeter	cm
centipoise	cp
centistoke	cs
chemically pure (discontinued)	CP
coefficient of variation	*%CV*
Colour Index	C.I.
concentration	conc.
cubic centimeter (volume)	cm^3 (Note 2)
day	Spell out
degree	deg (Note 3)
diameter	diam
direct current (noun)	dc
(adjective)	d-c
equation	Eq
Fahrenheit	°F (Note 1)
figure	Fig.
foot	ft
foot-pound	ft-lb
formula weight	FW
gallon	gal
grain	gr
gram	g
horsepower	hp
hour	h
inch	in.
inside diameter	ID
Kelvin	K (Note 1)
kilocycle	kc
kilogram	kg
kilojoule	kJ
kilometer	km
kilovolt	kV
kilowatt	kW
kilowatt-hour	kW-h
linear	lin
liter	L
logarithm (common)	log
lux	lx
maximum	max.
meter	m
microamperes	µa
microgram	µg
microliter	µL
micromicron	µµ
micron (micrometer)	µm
microvolt	µV
microwatt	µW
mile	mi
miles per hour	mph
milliampere	ma
milliequivalent	meq
milligram	mg
milliliter	mL (Note 2)
millimeter	mm
millivolt	mV
minimum	min.
minute	min (Note 4)
molal	*m* (Italic)
molar	*M* (Italic)
molecular weight	MW
nanometer	nm
normal	*N* (Italic)
number	No.
ohm	ohm
on weight of fiber	owf
ounce	oz
ounces per square yard	oz/sq yd
outside diameter	OD

page	p
pages	pp
parts per billion	ppb
parts per million	ppm
per	Spell out or use solidus (/)
percent	%
pint	pt
pound	lb
pounds per square foot	lb/sq ft
pounds per square inch	psi
quart	qt
radian	rad
relative humidity	RH
revolutions per minute	rpm
second	s
solution	soln.
specific gravity	sp gr
square	sq
standard deviation	*s*
ton	T
Twaddell	Tw
United States (wire gage)	US
United States Pharmacopeia	USP
volt	V
volume	vol.
watt	W
watt-hour	W-h
week	wk
yard	yd
year	yr

Notes

Note 1. Always use the abbreviation for the temperature scale °F, °C or K in statements of numerical temperatures, but omit the abbreviation "deg" for "degrees." Write "69°F," not "69 deg F."

Note 2. Use the abbreviations "cm^3" rather than "cc" as the unit of capacity. Use "mL" for milliliter" as the unit of volume.

Note 3. Restrict the use of the degree symbol (°) to °API, °BRIX, °Baumé, °Twaddell, °C, °F, °Rohmer and to degrees of angle or of arc.

Note 4. Spell out "minute" and "minimum" if there is any danger of confusion by use of the abbreviation "min."