Designation: E3027 – 23

Standard Guide for Making Sustainability-Related Chemical Selection Decisions in the Life-Cycle of Products[1]

This standard is issued under the fixed designation E3027; 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 sustainability factors for product manufacturers to consider when comparing alternative chemicals or ingredients across the life cycle of a product. Such an analysis could be used in product development, answering customer inquiries, or replying to regulatory requests, among others.

1.2 This guide integrates many of the principles of green chemistry and green engineering in evaluating the factors across the social (including human health), economic, and ecological attributes in the use of a particular material and potential alternatives in a particular product.

1.3 This guide provides an outline for the contents of a report of the results of the analysis, including an executive summary, detailed report, and retrospective.

1.4 This guide does not provide guidance on how to perform chemical risk assessment, alternatives assessment, life-cycle assessment, or economic analysis, or how the alternatives decision-making framework will be completed.

1.5 This guide does not suggest in what order the social, ecological, or economic attributes of sustainability should be evaluated or which one is most important. This is a decision of the company performing the decision-making evaluation.

1.6 *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.*

1.7 *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]

E2114 Terminology for Sustainability

2.2 *NSF/ANSI Standard:*[3]

NSF/ANSI Standard 61: Drinking water system components – Health effects

2.3 *Other Standards:*

US EPA Design for the Environment (DfE) Alternatives Assessment Criteria for Hazard Evaluation[4]

Clean Production Action GreenScreen for Safer Chemicals[5]

3. Terminology

3.1 *Definitions:* For definitions related to sustainability not defined within this guide, refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alternatives decision-making framework, n*—process by which the alternatives are evaluated in any product life-cycle stage with the goal of creating a product with an improved or less impactful result.

3.2.2 *assessment, alternative, n*—the activity of comparing the existing material and the material identified as a possible alternate.

3.2.3 *confidential business information, n*—business details including, but not limited to financial data, business relationships, product ingredients, or manufacturing processes that are unique to and held as proprietary to an organization.

3.2.3.1 *Discussion*—Confidential business information may also be referred to as trade secret information, especially as it relates to product formulation and manufacturing processes.

[1] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.80 on General Sustainability Standards.

Current edition approved Nov. 1, 2023. Published December 2023. Originally approved in 2015. Last previous edition approved in 2018 as E3027 – 18a. DOI: 10.1520/E3027-23.

[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] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, http://www.nsf.org.

[4] Available from US EPA, Safer Choice Program, Office of Pollution Prevention & Toxics, 1200 Pennsylvania Avenue, NW, Mail Code 7406-M, Washington, DC, http://www.epa.gov/sites/production/files/2014-01/documents/aa_criteria_v2.pdf. Safer Choice is the new name for EPA's Design for the Environment Program.

[5] GreenScreen is available from and a registered trademark of Clean Production Action, 1310 Broadway, Suite 101, Somerville, MA 02144, http://www.greenscreenchemicals.org/method/method-documents.

3.2.4 *data gap, n*—lack of information, quantitative data, modeled data, or estimations based upon read-across evidence used to determine the relative impact measure of an ingredient, process, or product.

3.2.5 *economic assessment, n*—assessment which takes account of internal and external costs and benefits relative to the organization, generally those that can be valued in monetary terms.

3.2.5.1 *Discussion*—This could include a comparative cost study of production, material, and end-product costs of two or more ingredients, production methods, or products.

3.2.6 *exposure, n*—contact with a chemical, biological, or physical agent by an ecosystem or living organism, and the duration and level of intensity of that contact.

3.2.7 *feasibility, n*—overall ability of an alternative to be used based on human and ecological safety profiles, economics, performance, social benefits, compliance with regulatory requirements, and consumer acceptance.

3.2.8 *green chemistry and green engineering, n*—the philosophy of chemical research and design that encourages creating products and processes that minimize the use or generation, or both, of hazardous substances, hazardous process conditions, resources, energy, wastes, and water throughout the product life-cycle.

3.2.8.1 *Discussion*—Green chemistry and green engineering are often referenced separately. Refer to *Green Chemistry: Theory and Practice*[6] and "Design through the Twelve Principles of Green Engineering"[7] for a more detailed discussion of both.

3.2.9 *hazard, n*—a source of potential harm or damage to life, health, property, or environment due to exposure to a substance.

3.2.10 *impact, n*—an effect, which can be positive or negative.

3.2.10.1 *Discussion*—An impact can be across more than one aspect of sustainability. However, any specific impact should be addressed consistently within the analysis.

3.2.10.2 *impact, environmental, n*—changes on ecosystems or living organisms, other than humans, attributed to a chemical, biological, or physical interaction.

3.2.10.3 *impact, human health, n*—changes to the health or well-being of a group of individuals or the entire population attributed to a chemical, biological, or physical interaction.

3.2.10.4 *impacts, social, n*—effects of an activity on the well-being of a group of individuals, families, community, or other social group.

(1) Discussion—In the context of sustainability, observed changes in social well-being result from actions made by one or more groups that make up society as a whole. Impacts can be positive (better), negative (worse), or neutral (no effect).

3.2.11 *life-cycle, n*—the stages of a product or process defined as: (*1*) the raw material production or acquisition stage, (*2*) the material transport stage, (*3*) the manufacturing stage (which includes transportation to the point of sale), (*4*) the use stage, and (*5*) the end-of-life stage.

3.2.12 *manufacturing stage, n*—the segment of the life-cycle under the responsibility of the manufacturer, including activities such as formulation and production, through the transport of the final product to the point of purchase.

3.2.13 *product-chemical pair, n*—specific chemical ingredient or material that is being evaluated in a specific product and use application.

3.2.14 *read-across evidence, n*—data that is inferred from a chemical that is similar in structure to the chemical being considered that can be used to fill data gaps.

3.2.15 *risk, n*—the probability or chance of harmful effects to human or ecological health resulting from exposure to a stressor including any physical, chemical, or biological entity that can induce an adverse response.

3.2.15.1 *Discussion*—Risk is a function of hazard and exposure and therefore actions that impact either will impact risk.

3.2.16 *risk, residual, n*—potential danger that is theoretically possible after taking safety measures or precautions, or both, to minimize exposure to a stressor, such as a chemical, biological, or other agent.

3.2.17 *sensitive subpopulation, n*—a subset of the general population that is more likely to endure negative physiological impacts from exposure to a hazard than the average individual.

3.2.17.1 *Discussion*—Examples of affected subsets may include but are not limited to the elderly, children, or pregnant women.

3.2.18 *stressor, n*—a chemical, physical or biological agent that causes stress to an organism.

3.2.19 *sustainability attributes, n*—characteristics and their related effects that identify economic, social, health, and ecologic factors for consideration at each stage of the life-cycle.

3.2.20 *use stage, n*—the period between when a product is placed into service until it reaches the end of its useful life.

4. Significance and Use

4.1 This guide outlines sustainability factors for manufacturers to consider when comparing alternative chemicals or ingredients across the life cycle of a product.

4.2 Methods exist for the evaluation of chemical hazards for product-chemical pairs. These methods are referenced in several regulatory, non-regulatory, and green building schemes and should be conducted as part of an analysis of this type.

NOTE 1—Evaluation methods include, but are not limited to, Clean Production Action's GreenScreen for Safer Chemicals,[5] The United States Environmental Protection Agency's Design for the Environment (DfE) Alternatives Assessment Criteria for Hazards Evaluation (Safer Choice) methodology and the National Academy of Sciences' *A Framework to*

[6] Anastas, P. and Warner, J., *Green Chemistry: Theory and Practice,* Oxford University Press, 1998.

[7] Anastas, P.T., and Zimmerman, J.B., "Design through the Twelve Principles of Green Engineering," *Env. Sci. and Tech.*, 37, 5, 94A-101A, 2003.