Designation: E3199 – 22a

Standard Guide for Alternative Allocation Approaches to Modeling Input and Output Flows of Secondary Materials and Related Recycling Scenarios in Life Cycle Assessment[1]

This standard is issued under the fixed designation E3199; 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 illustrates alternative allocation approaches that provide options for modeling secondary material flows and related recycling scenarios within a life cycle assessment (LCA) study. It helps practitioners characterize and understand materials recycling across industries; provides the available methodologies for consideration of the environmental impacts that are attributed to material and product flows in LCA; aids in assessment of the overall life cycle of systems and understanding of materials; and supports life cycle management.

1.2 The guide is not intended to contradict or circumvent the LCA provisions of ISO 14025, ISO 14040, ISO 14044, ISO 14067, ISO/TR 14049, or ISO 21930. When conflicts arise related to LCA, the guidance of those ISO standards takes precedence.

1.3 The following seven material-specific appendixes are included:

Title	Appendix
Recycling of Copper	Appendix X1
Recycling of Flue Gas Desulfurization (FGD) Gypsum	Appendix X2
Recycling of Glass	Appendix X3
Recycling of Plastics	Appendix X4
Recycling of Post-consumer (PC) Gypsum	Appendix X5
Recycling of Stainless Steel	Appendix X6
Recycling of Supplementary Cementitious Materials	Appendix X7

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *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.*

1.6 *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]

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

E2114 Terminology for Sustainability Relative to the Performance of Buildings

2.2 *ISO Standards:*[3]

ISO 14001 Environmental management systems — Requirements with guidance for use

ISO 14025 Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040 Environmental management — Life cycle assessment — Principles and framework

ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines

ISO/TR 14049 Environmental management — Life cycle assessment — Illustrative examples on how to apply ISO 14044 to goal and scope definition and inventory analysis

ISO 14067 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

ISO 15270 Plastics — Guidelines for the recovery and recycling of plastics waste

ISO 21930 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this guide, refer to Terminology E2114. For general terminology

[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 Oct. 1, 2022. Published October 2022. Originally approved in 2022. Last previous edition approved in 2022 as E3199–22. DOI: 10.1520/E3199-22A.

[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 American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

related to life cycle assessment, refer to ISO 14040.

3.1.1 *post-consumer, n*—descriptive term covering material, generated by the end-users of products, that has fulfilled its intended purpose or can no longer be used (including material returned from within the distribution chain). **ISO 15270**

3.1.2 *secondary materials, n*—material recovered from previous use or recovered from waste derived from another product system and used as an input in another product system.

3.1.2.1 *Discussion*—Example: recycled scrap metal, crushed concrete, glass cullet, recycled wood chips, recycled plastic granulate.

3.1.2.2 *Discussion*—Secondary material is measured at the point (that is, system boundary) where the secondary material enters the product system from another product system. **ISO 21930**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *environmental impact, n*—change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activity.

3.2.1.1 *Discussion*—Modified from ISO 14001.

3.3 *Acronym:*

3.3.1 *ISO*—International Organization for Standardization

4. Significance and Use

4.1 LCAs can help to identify some of the potential environmental impacts of products or services throughout the entire life cycle. In a life cycle inventory analysis, emissions into the air; discharges into the water and soil; and product, material, and energy flows at all stages of a product's life cycle are compiled and quantified. The resulting life cycle impact assessment (LCIA) converts the quantified parameters into environmental impact categories.

4.2 Options for managing products at their end of life (EOL) can include, but are not limited to, re-using, recycling, recovering, remanufacturing, converting to energy, incinerating, composting, combustion, digestion/respiration, or discarding as waste. Materials enter subsequent life cycle(s), either in the same or in other applications, reducing the input of primary raw material and impacting the amount of waste. LCA will be required to determine if environmental impact reductions are expected to be realized and to what extent for each specific application. The end-of-life management can impact the overall life cycle assessment.

4.3 The application of an allocation method for recycling in life cycle assessments is useful in assessing potential environmental impacts, which may be either beneficial or adverse.

4.4 As part of good LCA practice, practitioners should consider recycling in the sensitivity analysis.

4.5 LCA practitioners are expected to ensure consistency and conformance with the relevant provisions of ISO standards.

4.6 Allocation for recycling can split the flows and impacts between two different product systems.

5. Summary of Guide (LCA)

5.1 While existing guidelines and standards (for example, ISO 14040 and ISO 14044) consistently recommend allocation to account for the environmental impacts of recycling in LCA, there is no further guidance on the recommended methodologies that apply across industries and sectors outside the building and construction sector (ISO 21930). Due to the variety of products that are recycled and the differences of their life cycles, several allocation methodologies have been developed and are currently applied globally. There is no one approach that can be consistently recommended for all materials and products. ISO has standardized its rules for allocation regarding Environmental Product Declarations (EPD) for Building and Construction Products in ISO 21930 and ISO 14025, the general EPD standard. This guide does not override these rules.

5.2 Appendix X1 to Appendix X7 provide examples of existing methodologies applied in different industries for different recycled raw materials and products. These examples complement specific guidance and case studies for recycling in LCA as provided in ISO/TR 14049 and go beyond the specific focus of ISO 14067 on carbon footprinting.

6. Summary of Methods

6.1 There are three primary frameworks for modeling end-of-life recycling in LCA, which are used most commonly by practitioners globally. For all these frameworks, the guidelines for setting system boundaries should be in line with the ISO 14040 series standards. The selection of a modeling approach for secondary materials and recycling scenarios should reflect the goal and scope of the LCA study.

6.1.1 The Recycled content/"cutoff" approach has been utilized in LCA for many years due to its simplicity and modeling ease. The practitioner essentially places no beneficial environmental impact on the recycled content in the production phase of the life cycle of the product being studied, and recycled materials collected at the end of life are sent to the next product system with no environmental impact (beneficial or adverse). The end-of-life collection remains in product system A. The impacts arising from the end-of-life collection processes/activities remain within and are attributed to the primary product system.

NOTE 1—This approach is mandated in ISO 21930.

6.1.2 The end-of-life recycling approach is based on the concept in ISO 14040 of system expansion. Essentially, the practitioner expands the product system A boundary in order to give credit to the first life cycle for the beneficial impact of utilizing a material that is recyclable in its initial use. The material for recycling is a beneficial impact given to product system A. The end-of life approach covers end-of-life material for recycling. It potentially acknowledges recycling that has not yet taken place. The end-of-life approach is often applied to open-loop product systems where materials are recycled and enter into subsequent product systems. When this approach is used, it should not circumvent other relevant ISO 14000 series standards.