



Designation: E2986 – 22

## Standard Guide for Evaluation of Environmental Aspects of Sustainability of Manufacturing Processes<sup>1</sup>

This standard is issued under the fixed designation E2986; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This guide provides guidance to develop manufacturer-specific procedures for evaluating the environmental sustainability performance of manufacturing processes. This guide introduces decision support methods that can be used to improve sustainability performance.

1.2 The scope of this guide is constrained by the manufacturing phase of the life cycle. The guide addresses specifics related to the processes and procedures within this phase.

1.3 This guide will allow manufacturers to make effective evaluations during plant and enterprise-wide decision-making within the manufacturing phase.

1.4 This guide focuses on environmental sustainability impacts, though social and economic impacts are not explicitly excluded.

1.5 This guide addresses:

1.5.1 Setting boundaries for the evaluation of environmental sustainability of a process or processes,

1.5.2 Identifying the process and equipment-related parameters necessary for environmental sustainability-driven process evaluation,

1.5.3 Creating process models using these parameters,

1.5.4 Utilizing process models to support consistent evaluations and sustainability-driven decision-making in a manufacturing enterprise.

NOTE 1—See ULE 880 for additional guidance at enterprise-level decision-making.

1.6 This guide may be used to complement other standards that address sustainability and the product life cycle. This guide most closely relates to the inventory component as discussed in the ISO 14040 series (ISO 14040, ISO 14044) standards, efficiency as discussed in the ISO 50000 series (ISO 50001) standards, and resource management as discussed in the ISO 55000 series (ISO 55001) standards.

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.13 on Sustainable Manufacturing.

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1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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.*

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:*<sup>2</sup>

E1808 Guide for Designing and Conducting Visual Experiments

E2114 Terminology for Sustainability Relative to the Performance of Buildings

E2629 Guide for Verification of Process Analytical Technology (PAT) Enabled Control Systems

E2987/E2987M Terminology for Sustainable Manufacturing

2.2 *ISO Standards:*<sup>3</sup>

ISO 14001 Environmental management systems -- Requirements with guidance for use

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

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

ISO 50001 Energy management

ISO 55001 Asset management -- Management systems -- Requirements

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

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

2.3 *UL Standard*:<sup>4</sup>

**ULE 880 Sustainability for Manufacturing Organizations**

### 3. Terminology

3.1 For definitions of terms used in this guide, refer to Terminologies **E2114** and **E2987/E2987M**.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *manufacturing resource, n*—any equipment, personnel, fixtures, gages, tooling, external accessories, software and control programs, and required operational settings used in manufacturing a product.

3.2.2 *metric, n*—measurable quantity on which processes are evaluated and/or compared.

3.2.2.1 *Discussion*—For instance, CO<sub>2</sub> equivalent emissions in metric tons or total energy consumption in kWh. Metrics provide a measure for which indicators can be evaluated.

3.2.3 *process model, n*—structured representation of the information associated with a manufacturing process.

3.2.3.1 *Discussion*—See Guide **E2629** for process models specific to material use.

### 4. Significance and Use

4.1 This guide provides a reference to the manufacturing community for the evaluation of environmental sustainability aspects of manufacturing processes. This guide is intended to improve efficiencies and consistencies of informal methods by providing procedures for consistent evaluations of manufacturing processes.

4.2 This guide describes a procedure to identify parameters and models for evaluating sustainability metrics for a particular process. Users of this guide will benefit from insight into the sustainability implications of selected processes as well as the contributing factors.

### 5. Method for Manufacturing Process Evaluation

5.1 To evaluate the sustainability of manufacturing processes for improvement, organizations need to develop and implement a consistent, organization-wide sustainability measurement process. The following sections provide guidelines for such a process.

5.2 *Setting Sustainability Objective*:

5.2.1 Sustainability assessment starts with a statement of the sustainability goals, including the area of opportunity to be addressed. In this step, an organization identifies the opportunities from several perspectives: organizational, environmental, external and internal stakeholders.

NOTE 2—To define the objective(s), various methods for data collection and analysis can be used, such as interviewing managers, sustainability auditors, the study of past sustainability reports of the organization, or various external guidelines.

5.3 *Identifying Indicator*:

5.3.1 Indicators provide a context to measure, analyze, and score the sustainability aspects of manufacturing processes.

Indicators can be defined internally, or can be selected from various indicator repositories.

5.3.2 Indicators are selected based on the sustainability objective, such as energy consumption for efficiency or CO<sub>2</sub> equivalent emissions for climate considerations. Factors that may influence indicator selection include the type of product, type of process, type of resource, quantity of resource, final reporting format, budget, approvals required, market, time availability, or other external guidelines.

5.3.3 An indicator is characterized by the following attributes:

5.3.3.1 *Name*—The word(s) for the distinctive designation of an indicator.

5.3.3.2 *Definition*—The statement expressing the essential characteristics and function of an indicator.

5.3.3.3 *Measurement Type*—The type of an indicator (quantitative or qualitative).

5.3.3.4 *Unit of Measure*—The unit value of the indicator.

5.3.3.5 *References*—Citable documents of existing indicator set(s) or specific indicator(s), based on which an indicator is adopted from existing set(s) or newly developed.

5.3.3.6 *Application Level*—The level in a hierarchical organization at which the indicator is applied.

5.3.4 Using this information, an organization may also set up their own sustainability indicators based on their business strategies.

5.4 *Identifying Process(es)*:

5.4.1 Process identification establishes the specific process or set of processes that contribute to the identified indicator.

5.4.2 Process identification should be guided through the set objectives and the associated indicators selected.

5.4.3 The process or set of processes under evaluation should fall within the governing process or production plan. The order in which a process is selected or an objective is determined will vary depending on the production plan and organizational goals.

5.4.4 Relevant documentation should be collected and may include:

5.4.4.1 Engineering drawings.

5.4.4.2 Routing sheets with several processes.

5.4.4.3 Safety data sheets.

5.4.4.4 Quality control plans that provide product and process specifications.

5.4.4.5 Setup sheets for individual machines. Setup sheets include the operating parameters of the machine.

5.5 *Identifying Evaluation Metrics*:

5.5.1 Evaluation metrics associate the process or processes to be evaluated with the identified indicator. Metrics provide a measure for which indicators can be evaluated.

5.5.2 Evaluation metrics are dependent on the selected indicator (example: waste for material efficiency and energy usage for energy efficiency), the equipment and processes being evaluated, and the availability of data.

5.5.3 Evaluation metric identification should take into consideration the capabilities and limitations of available measurement equipment.

<sup>4</sup> Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, <http://www.ul.com>.