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Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment —

Part 1: Overview and general principles

Systèmes d'automatisation et intégration — Évaluation de l'efficacité énergétique et autres facteurs de fabrication des systèmes qui influencent l'environnement —

Partie 1: Aperçu et principes généraux

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*.

This second edition cancels and replaces the first edition (ISO 20140-1:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— updates to the text to maintain consistency with other parts of ISO 20140;

— transfer of some content to other parts of ISO 20140;

— improvements to Figures 1 and 2 and deletion of Figures 3 and 4;

— deletion of Annexes A, B, D, E and F and renumbering of Annex C as Annex A.

A list of all parts in the ISO 20140 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 20140 specifies a method for evaluating the energy efficiency and other factors of a manufacturing system that influence the environment, such as energy consumption, waste and release.

ISO 20140 is applicable to manufacturing systems for discrete, batch, and continuous manufacturing.

ISO 20140 focuses on manufacturing systems that have a hierarchical structure.

ISO 20140 can be used for:

— benchmarking of environmental performance against a generic reference manufacturing system or comparing between different manufacturing systems;

— alternative studies for improving environmental performance;

— setting target of environmental performance improvement;

— monitoring the shop floor operations by visualizing the environmental performance of a manufacturing system.

Expected users of ISO 20140 are:

a) managers who are responsible for environmental conditions of a manufacturing system;

b) engineers who plan manufacturing process for each product;

c) planners and designers who design a manufacturing system;

d) engineers and foremen who are responsible for manufacturing products.

This document provides the overview and general principles of the method.

The environmental performance of a manufacturing system significantly contributes to the overall life cycle environmental performance of the manufactured product. The environmental performance evaluation of the manufacturing process in smart industries is a substantial contribution to the product life cycle environmental performance evaluation and thus an important contribution to a circular economy.

Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment —

Part 1: Overview and general principles

1 Scope

This document provides the overview and general principles of a method for evaluating environmental performance, including energy efficiency and other factors, of a manufacturing system that influence the environment.

This document is applicable to manufacturing systems for discrete, batch, and continuous manufacturing. This document is applicable to an entire manufacturing system and to a part of the manufacturing system.

Life cycle assessment of products manufactured by the manufacturing system is outside the scope of ISO 20140.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20140-2:2018, *Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment — Part 2: Environmental performance evaluation process*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
construction, reconfiguration or retirement step
CRR step
step of a *life cycle* (3.11) of a *manufacturing system* (3.15) other than an operation step

3.2
energy
electricity, fuels, steam, heat, compressed air, and other similar media

[SOURCE: ISO 50001:2018, 3.5.1, modified — Note to entry has been removed.]

3.3
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods, commodities, or *energy* (3.2), and an input of energy

EXAMPLE Conversion efficiency; energy required/energy consumed.

Note 1 to entry: Both input and output should be clearly specified in terms of quantity and quality and be measurable.

[SOURCE: ISO 50001:2018, 3.5.3]

3.4
environment
surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelationships

[SOURCE: ISO 14001:2015, 3.2.1, modified — Notes to entry have been removed.]

3.5
environmental aspect
element of an organization's activities or products or services that interacts or can interact with the *environment* (3.4)

[SOURCE: ISO 14001:2015, 3.2.2, modified — Notes to entry have been removed.]

3.6
environmental characteristics data
ECD
characteristics and/or performance specifications related to an *environmental aspect* (3.5), both acquired by measurement and declared by the equipment suppliers

3.7
environmental impact
change to the *environment* (3.4), whether adverse or beneficial, wholly or partially resulting from an organization's *environmental aspects* (3.5)

[SOURCE: ISO 14001:2015, 3.2.4]

3.8
environmental influence
result of *manufacturing process* (3.14) that can cause *environmental impacts* (3.7) and that is considered throughout the *life cycle* (3.11) of the *manufacturing system* (3.15) associated with the process

Note 1 to entry: Environmental influence, such as *energy* (3.2) consumed and CO2 emitted, can cause environmental impacts, such as global warming and sea level rise.

EXAMPLE Amount of electric energy consumed; amount of CO2 emitted; amount of hazardous substance discharged.

[SOURCE: ISO 20140-2:2018, 3.3]

3.9
environmental performance
measurable result related to *environmental aspects* (3.5)

[SOURCE: ISO 14045:2012, 3.5]

3.10
environmental performance evaluation data
EPE data
data that are used to evaluate the *environmental performance* (3.9)

[SOURCE: ISO 20140-5:2017, 3.6, modified — The word "can" has been replaced with "are" and the words "for environmental performance evaluation" have been replaced with "to evaluate the environmental performance".]

3.11
life cycle
evolution of a system, product, service, project or other human-made entity from conception through retirement

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.23]

3.12
life cycle phase
sub-division of a *life cycle* (3.11)

EXAMPLE Life cycle phases of a *manufacturing system* (3.15) are design, construction/reconfiguration, operation and retirement.

3.13
life cycle step
occurrence or instance of generic *life cycle phase* (3.12)

3.14
manufacturing process
structured set of activities involving a flow and/or transformation of material, information, *energy* (3.2), or any other element in a manufacturing area

[SOURCE: ISO 18435-1:2009, 3.16, modified — The words “set of processes in manufacturing” have been replaced with “structured set of activities” and the word “control” has been deleted.]

3.15
manufacturing system
system for performing *manufacturing processes* (3.14)

3.16
other resource
input to a *manufacturing system* (3.15) other than equipment and material

EXAMPLE *Energy* (3.2); coolant and lubricant; air conditioning and lighting.

3.17
release
emission to air and discharge to water and soil

[SOURCE: ISO 14040:2006, 3.30, modified — The term has been changed to the singular form and the words "emissions" and "discharges" have been replaced with "emission" and "discharge" respectively.]

3.18
residual CRR influence
environmental influence (3.8) of equipment, which is still residual after offset through the specific term of construction, reconfiguration or retirement influence charge/offset process and/or at the time of retirement

3.19
waste
substances or objects which the holder intends or is required to dispose of

[SOURCE: ISO 14040:2006, 3.35, modified — Note to entry has been removed.]

4 Environmental performance evaluation of manufacturing systems

4.1 Manufacturing system life cycle phases and product life cycle phases

Every manufacturing system has a life cycle comprised of the phases of design, construction/ reconfiguration, operation and retirement.

A manufacturing system manufactures products during the manufacturing system operation phase, which includes the product manufacturing phase at the intersection point of the life cycle of both the manufacturing system and the product, respectively, as illustrated in Figure 1.

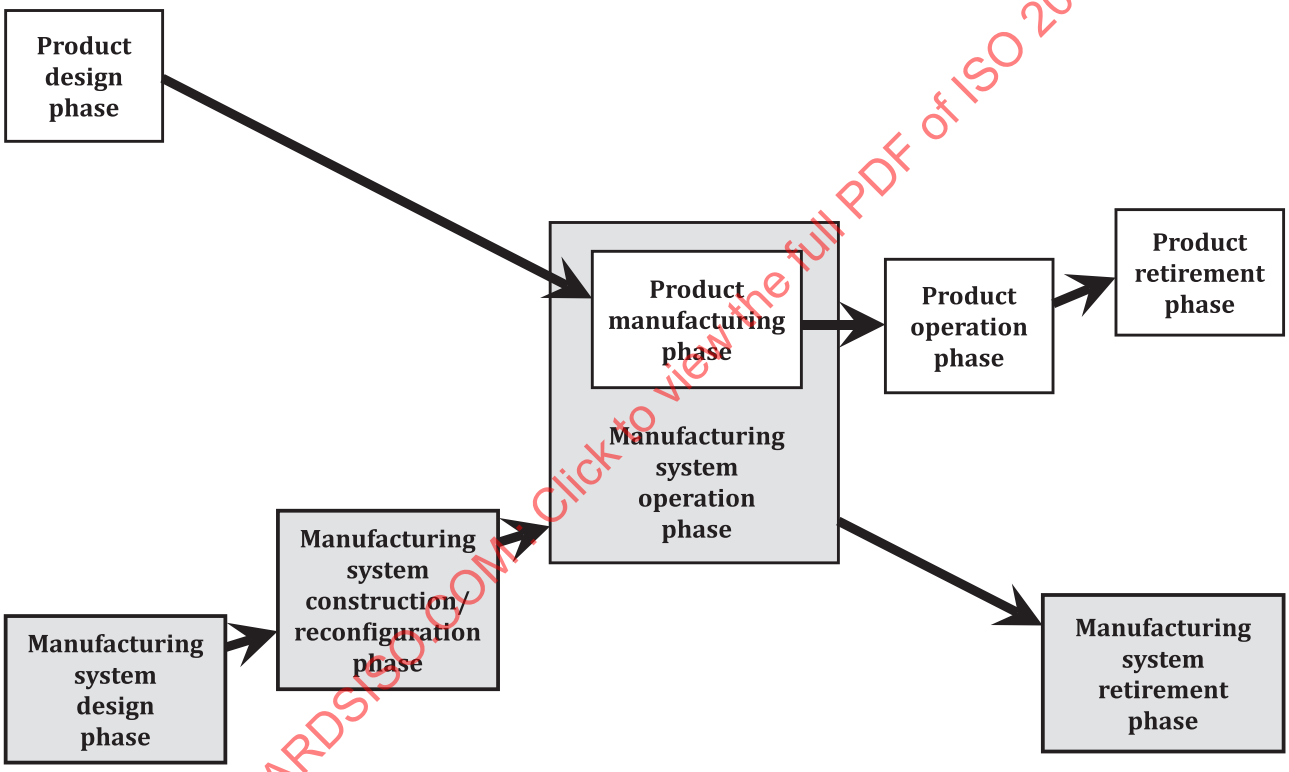

Figure 1 — Interconnection of life cycle phases of manufacturing system and product

The following conditions of a manufacturing system should be taken into account in the environmental performance evaluation, because they can affect the environmental performance:

— type and quantity of product manufactured;

— manufacturing process;

— configuration of manufacturing system.

The environmental performance of a manufacturing system changes depending on the changes of the manufactured products, such as changes of product quantity and/or product mix, changes in process plans for manufacturing of products, and the changes of the manufacturing system configuration. It also changes because of the changes in manufacturing execution control.

4.2 Manufacturing system life cycle steps and their environmental influence

Manufacturing systems experience a long lifetime. They also have different environmental influences resulting from iterative changes by their reconfiguration, such as layout changes, equipment specification changes, retrofits for improving the capability or realizing the product mix change or improving the compatibility or manufacturing performance and environmental performance. The concept of a "life cycle step" is useful for explicitly identifying which occurrence or instance of the manufacturing system configuration to evaluate.

Among the life cycle steps of a manufacturing system, two categories [the operation step and the construction, reconfiguration or retirement (CRR) steps] are of particular interest for evaluating environmental influence. The manufacturing system CRR steps decompose into construction steps, reconfiguration steps and retirement steps.

Environmental influences resulting from the life cycle steps of a manufacturing system are illustrated in Figure 2.

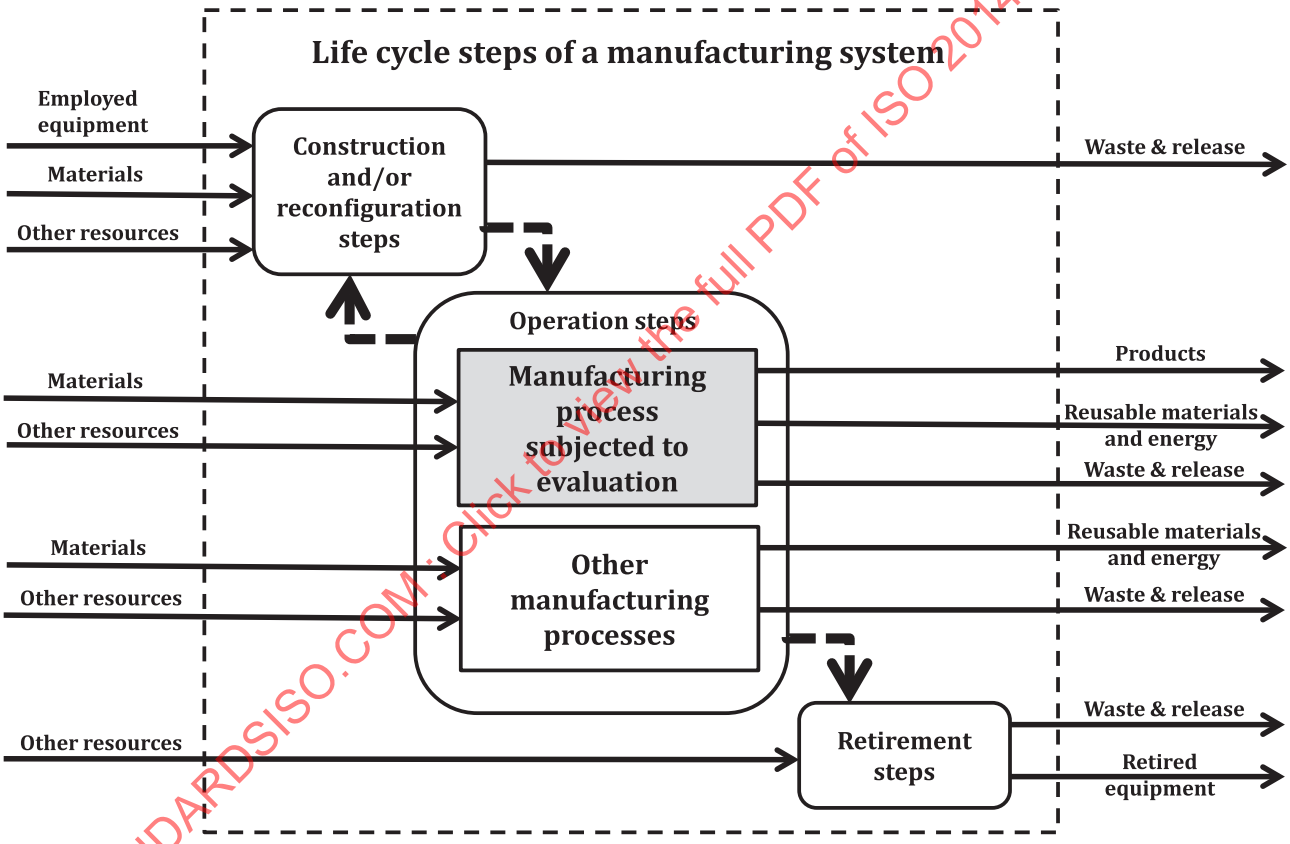

Figure 2 — Environmental influence resulting from the life cycle steps of a manufacturing system

Regarding environmental influences in the operation step, materials and other resources are the inputs to the manufacturing process, and the product, reusable materials and energy, and waste and release are the outputs from the manufacturing process. Those inputs to and outputs from the manufacturing process influence the environment and they can cause environmental impacts.

Manufacturing systems can have equipment that is not directly involved in the manufacturing process, such as power distribution system, on-site power generation system, coolant and lubricant supply and treatment system, lighting and air conditioning.

In the construction steps and the reconfiguration steps, environmental influences occur from:

— employed equipment;

— other resources used;

— waste and release.

In the retirement steps, environmental influences occur from:

— residual CRR influence of retired equipment;

— other resources;

— waste and release.

NOTE Use cases of ISO 20140 are shown in Annex A.

5 Requirements for environmental performance evaluation

This clause specifies requirements for the environmental performance evaluation.

NOTE Detail specifications can be found in other parts of ISO 20140.

The environmental performance evaluation should consider the entire life cycle of the manufacturing system, including all life cycle steps.

Since a manufacturing system manufactures products during the operation step, the operation step is the most critical part of a life cycle of a manufacturing system, when considering its environmental influence. Environmental aspects in the CRR steps should also be taken into account for evaluating environmental influence of a manufacturing system, if necessary.

The environmental performance evaluation under the operation steps shall include:

— all operation modes of the manufacturing system;

— all inputs and outputs associated with manufacturing process subjected to evaluation.

Evaluation of the environmental performance of a manufacturing system shall conform to the environmental performance evaluation process specified in ISO 20140-2.

