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**Environmental management—
Life cycle assessment—
Requirements and guidelines**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

This Standard, together with **JIS Q 14040:2010**, cancels and replaces **JIS Q 14040:1997**, **JIS Q 14041:1999**, **JIS Q 14042:2002** and **JIS Q 14043:2002**, which have been technically revised.

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Environmental management— Life cycle assessment— Requirements and guidelines

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 14044** published in 2006 without modifying the technical contents.

The portions underlined with dots are the matters not stated in the corresponding International Standard.

The increased awareness of the importance of environmental protection, and the possible impacts associated with products, both manufactured and consumed, has increased interest in the development of methods to better understand and address these impacts. One of the techniques being developed for this purpose is life cycle assessment (hereafter referred to as “LCA”).

NOTE 1 In this Standard, the term “product” includes services.

LCA can assist in

- identifying opportunities to improve the environmental performance of products at various points in their life cycle,
- informing decision-makers in industry, government or non-government organizations (e.g. for the purpose of strategic planning, priority setting, product or process design or redesign),
- the selection of relevant indicators of environmental performance, including measurement techniques, and
- marketing (e.g. implementing an ecolabelling scheme, making an environmental claim, or producing an environmental product declaration).

LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product’s life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave).

NOTE 2 The “potential environmental impacts” are relative expressions, as they are related to the functional unit of a product system.

There are four phases in an LCA study:

- a) the goal and scope definition phase,
- b) the inventory analysis phase,
- c) the impact assessment phase, and
- d) the interpretation phase.

The scope, including system boundary and level of detail, of an LCA depends on the subject and the intended use of the study. The depth and the breadth of LCA can differ considerably depending on the goal of a particular LCA.

The life cycle inventory analysis phase (LCI phase) is the second phase of LCA. It is an inventory of input/output data with regard to the system being studied. It involves the collection of the data necessary to meet the goals of the defined study.

The life cycle impact assessment phase (hereafter referred to as “LCIA”) is the third phase of the LCA. The purpose of LCIA is to provide additional information to help assess a product system’s LCI results so as to better understand their environmental significance.

Life cycle interpretation is the final phase of the LCA procedure, in which the results of an LCI or an LCIA, or both, are summarized and discussed as a basis for conclusions, recommendations and decision-making in accordance with the goal and scope definition.

There are cases where the goal of an LCA may be satisfied by performing only an inventory analysis and an interpretation. This is usually referred to as an LCI study.

This Standard covers two types of studies: life cycle assessment studies (LCA studies) and life cycle inventory studies (LCI studies). LCI studies are similar to LCA studies but exclude the LCIA phase. LCI are not to be confused with the LCI phase of an LCA study.

Generally, the information developed in an LCA or LCI study can be used as part of a much more comprehensive decision process. Comparing the results of different LCA or LCI studies is only possible if the assumptions and context of each study are equivalent. Therefore this Standard contains several requirements and recommendations to ensure transparency on these issues.

LCA is one of several environmental management techniques (e.g. risk assessment, environmental performance evaluation, environmental auditing, and environmental impact assessment) and might not be the most appropriate technique to use in all situations. LCA typically does not address the economic or social aspects of a product, but the life cycle approach and methodologies described in this Standard may be applied to these other aspects.

This Standard, like other Standards, is not intended to be used to create non-tariff trade barriers or to increase or change an organization’s legal obligations.

1 Scope

This Standard specifies requirements and provides guidelines for life cycle assessment (LCA) including

- a) the goal and scope definition of the LCA,
- b) the life cycle inventory analysis (LCI) phase,
- c) the life cycle impact assessment (LCIA) phase,
- d) the life cycle interpretation phase,
- e) reporting and critical review of the LCA,
- f) limitations of the LCA,
- g) relationship between the LCA phases, and
- h) conditions for use of value choices and optional elements.

This Standard covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies.

The intended application of LCA or LCI results is considered during the goal and scope definition, but the application itself is outside the scope of this Standard.

This Standard is not intended for contractual or regulatory purposes or registration and certification.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows:

ISO 14044:2006 *Environmental management—Life cycle assessment—Requirements and guidelines* (IDT)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitutes provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS Q 14040 *Environmental management—Life cycle assessment—Principles and framework*

NOTE : Corresponding International Standard: ISO 14040 *Environmental management—Life cycle assessment—Principles and framework* (IDT)

3 Terms and definitions

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

NOTE : These terms and definitions are taken from **JIS Q 14040** and are repeated for the convenience of users of this Standard.

3.1 life cycle

consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal

3.2 life cycle assessment, LCA

compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

3.3 life cycle inventory analysis, LCI

phase of LCA involving the compilation and quantification of inputs and outputs for product throughout its life cycle

3.4 life cycle impact assessment, LCIA

phase of LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product

3.5 life cycle interpretation

phase of LCA in which the findings of either the inventory analysis or the impact assessment, or both, are evaluated in relation to the defined goal and scope in order to reach conclusions and recommendations

3.6 comparative assertion

environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function

3.7 transparency

open, comprehensive and understandable presentation of information

3.8 environmental aspect

element of an organization's activities, products or services that can interact with the environment

[JIS Q 14001:2004; 3.6]

3.9 product

any goods or service

NOTE 1 The product can be categorized as follows:

- services (e.g. transport);
- software (e.g. computer program, dictionary);
- hardware (e.g. engine mechanical part);
- process materials (e.g. lubricant);

NOTE 2 Services have tangible and intangible elements. Provision of a service can involve, for example, the following:

- an activity performed on a customer-supplied tangible product (e.g. automobile to be repaired);
- an activity performed on a customer-supplied intangible product (e.g. the income statement needed to prepare a tax return);
- the delivery of an intangible product (e.g. the delivery of information in the context of knowledge transmission);
- the creation of ambience for the customer (e.g. in hotels and restaurants).

Software consists of information and is generally intangible and can be in the form of approaches, transactions or procedures.

Hardware is generally tangible and its amount is a countable characteristic. Processed materials are generally tangible and their amount is a continuous characteristic.

NOTE 3 Adapted from **JIS Q 14021:2000** and **JIS Q 9000:2006**.

3.10 co-product

any of two or more products coming from the same unit process or product system

3.11 process

set of interrelated or interacting activities that transforms inputs into outputs

[JIS Q 9000:2006, definition 3.4.1 (without notes)]

3.12 elementary flow

material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation

3.13 energy flow

input to or output from a unit process or product system, quantified in energy units

NOTE: Energy flow that is an input may be called an energy input; energy flow that is an output may be called an energy output.

3.14 feedstock energy

heat of combustion of a raw material input that is not used as an energy source to a product system, expressed in terms of higher heating value or lower heating value

NOTE: Care is necessary to ensure that the energy content of raw materials is not counted twice.

3.15 raw material

primary or secondary material that is used to produce a product

NOTE: Secondary material includes recycled material.

3.16 ancillary input

material input that is used by the unit process producing the product, but does not constitute part of the product

3.17 allocation

partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems

3.18 cut-off criteria

specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product system to be excluded from a study

3.19 data quality

characteristics of data that relate to their ability to satisfy stated requirements

3.20 functional unit

quantified performance of a product system for use as a reference unit

3.21 input

product, material or energy flow that enters a unit process

NOTE: Products and materials include raw materials, intermediate products and co-products.

3.22 intermediate flow

product, material or energy flow occurring between unit processes of the product system being studied

3.23 intermediate product

output from a unit process that is input to other unit processes that require further transformation within the system

3.24 life cycle inventory analysis result, LCI result

outcome of an LCI analysis that catalogues the flows crossing the system boundary and provides the starting point for LCIA

3.25 output

product, material or energy flow that leaves a unit process

NOTE : Products and materials include raw materials, intermediate products, co-products, and releases.

3.26 process energy

energy input required for operating the process or equipment within a unit process, excluding energy inputs for production and delivery of the energy itself

3.27 product flow

products entering from or leaving to another product system

3.28 product system

collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of a product

3.29 reference flow

measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit

3.30 releases

emissions to air and discharges to water and soil

3.31 sensitivity analysis

systematic procedures for estimating the effects of the choices made regarding methods and data on the outcome of a study

3.32 system boundary

set of criteria specifying which unit processes are part of a product system

NOTE : The term “system boundary” is not used in this Standard in relation to LCIA.

3.33 uncertainty analysis

systematic procedure to quantify the uncertainty introduced in the results of an LCI due to the cumulative effects of model imprecision, input uncertainty and data variability

NOTE : Either ranges or probability distributions are used to determine uncertainty in the results.

3.34 unit process

smallest element considered in the LCI for which input and output data are quantified

3.35 waste

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

NOTE : The definition is taken from the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal* (22 March 1989) but is not confined in this Standard to hazardous waste.

3.36 category endpoint

attribute or aspect of natural environment, human health, or resources, identifying an environmental issue giving cause for concern

3.37 characterization factor

factor derived from a characterization model which is applied to convert an assigned LCI result to the common unit of the category indicator

NOTE : The common unit allows calculation of the category indicator result.

3.38 environmental mechanism

system of physical, chemical and biological processes for a given impact category, linking the LCI results to category indicators and to category endpoints

3.39 impact category

class representing environmental issues of concern to which LCA results may be assigned

3.40 impact category indicator

quantifiable representation of an impact category

NOTE : The shorter expression “category indicator” is used in this Standard for improved readability.

3.41 completeness check

process of verifying whether information from the phases of an LCA is sufficient for reaching conclusions in accordance with the goal and scope definition

3.42 consistency check

process of verifying that the assumptions, methods and data are consistently applied throughout the study and are in accordance with the goal and scope definition performed before conclusions are reached

3.43 sensitivity check

process of verifying that the information obtained from a sensitivity analysis is relevant for reaching the conclusions and giving recommendations

3.44 evaluation

element within the life cycle interpretation phase intended to establish confidence in the results of the LCA

NOTE : Evaluation includes completeness check, sensitivity check, consistency check, and any other validation that may be required according to the goal and scope definition of the study.

3.45 critical review

process intended to ensure consistency between a LCA and the principles and requirements of the Standards on LCA

NOTE 1 The principles are described in **JIS Q 14040, 4.1.**

NOTE 2 The requirements are described in this Standard.

3.46 interested party

individual or group concerned with or affected by the environmental performance of a product system, or by the results of the LCA

4 Methodological framework for LCA

4.1 General requirements

See **JIS Q 14040** for the principles and framework to be used to conduct an LCA.

LCA studies shall include the goal and scope definition, inventory analysis, impact assessment and interpretation of results.

LCI studies shall include definition of the goal and scope, inventory analysis and interpretation of results. The requirements and recommendations of this Standard, with the exception of those provisions regarding impact assessment, also apply to life cycle inventory studies.

An LCI study alone shall not be used for comparisons intended to be used in comparative assertions intended to be disclosed to the public.

It should be recognized that there is no scientific basis for reducing LCA results to a single overall score or number.

4.2 Goal and scope definition

4.2.1 General

The goal and scope of an LCA shall be clearly defined and shall be consistent with the intended application. Due to the iterative nature of LCA, the scope may have to be refined during the study.

4.2.2 Goal of the study

In defining the goal of an LCA, the following items shall be unambiguously stated:

- the intended application;
- the reasons for carrying out the study;
- the intended audience, i.e. to whom the results of the study are intended to be communicated;
- whether the results are intended to be used in comparative assertions intended to be disclosed to the public.

4.2.3 Scope of the study

4.2.3.1 General

In defining the scope of an LCA, the following items shall be considered and clearly described:

- the product system to be studied;
- the functions of the product system or, in the case of comparative studies, the systems;
- the functional unit;
- the system boundary;
- allocation procedures;
- LCIA methodology and types of impacts;
- interpretation to be used;
- data requirements;
- assumptions;
- value choices and optional elements;
- limitations;
- data quality requirements;
- type of critical review, if any;
- type and format of the report required for the study.

In some cases, the goal and scope of the study may be revised due to unforeseen limitations, constraints or as a result of additional information. Such modifications, together with their justification, should be documented.

Some of the items above are specified in detail in **4.2.3.2** to **4.2.3.8**.

4.2.3.2 Function and functional unit

The scope of an LCA shall clearly specify the functions (performance characteristics) of the system being studied. The functional unit shall be consistent with the goal and scope of the study. One of the primary purposes of a functional unit is to provide a reference to which the input and output data are normalized (in a mathematical sense). Therefore the functional unit shall be clearly defined and measurable.

Having chosen the functional unit, the reference flow shall be defined. Comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit(s) in the form of their reference flows. If additional functions of any of the systems are not taken into account in the comparison of functional units, then these omissions shall be explained and documented. As an alternative, systems associated with the delivery of this function may be added to the boundary of the other system to make the systems more comparable. In these cases, the processes selected shall be explained and documented.

4.2.3.3 System boundary

4.2.3.3.1 The system boundary determines which unit processes shall be included within the LCA. The selection of the system boundary shall be consistent with the goal of the study. The criteria used in establishing the system boundary shall be identified and explained.

Decisions shall be made regarding which unit processes to include in the study and the level of detail to which these unit processes shall be studied.

The deletion of life cycle stages, processes, inputs or outputs is only permitted if it does not significantly change the overall conclusions of the study. Any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated, and the reasons and implications for their omission shall be explained.

Decisions shall also be made regarding which inputs and outputs shall be included and the level of detail of the LCA shall be clearly stated.

4.2.3.3.2 It is helpful to describe the system using a process flow diagram showing the unit processes and their inter-relationships. Each of the unit processes should be initially described to define

- where the unit process begins, in terms of the receipt of raw materials or intermediate products;
- the nature of the transformations and operations that occur as part of the unit process, and
- where the unit process ends, in terms of the destination of the intermediate or final products.

Ideally, the product system should be modelled in such a manner that inputs and outputs at its boundary are elementary and product flows. It is an iterative process to identify the inputs and outputs that should be traced to the environment, i.e. to identify which unit processes producing the inputs (or which unit processes receiving the outputs) should be included in the product system under study. The initial identification is made using available data. Inputs and outputs should be more fully identified after additional data are collected during the course of the study, and then subjected to a sensitivity analysis (see **4.3.3.4**).

For material inputs, the analysis begins with an initial selection of inputs to be studied. This selection should be based on an identification of the inputs associated with each of the unit processes to be modelled. This effort may be undertaken with data collected from specific sites or from published sources. The goal is to identify the significant inputs associated with each of the unit processes.

Energy inputs and outputs shall be treated as any other input or output to an LCA. The various types of energy inputs and outputs shall include inputs and outputs relevant for the production and delivery of fuels, feedstock energy and process energy used within the system being modelled.

4.2.3.3.3 The cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly described. The effect on the outcome of the study of the cut-off criteria selected shall also be assessed and described in the final report.

Several cut-off criteria are used in LCA practice to decide which inputs are to be included in the assessment, such as mass, energy and environmental significance. Making the initial identification of inputs based on mass contribution alone may result in important inputs being omitted from the study. Accordingly, energy and environmental significance should also be used as cut-off criteria in this process.

- a) **Mass** an appropriate decision, when using mass as a criterion, would require the inclusion in the study of all inputs that cumulatively contribute more than a defined percentage to the mass input of the product system being modelled.
- b) **Energy** similarly, an appropriate decision, when using energy as a criterion, would require the inclusion in the study of those inputs that cumulatively contribute more than a defined percentage of the product system's energy inputs.
- c) **Environmental significance** decisions on cut-off criteria should be made to include inputs that contribute more than an additional defined amount of the estimated quantity of individual data of the product system that are specially selected because of environmental relevance.

Similar cut-off criteria may also be used to identify which outputs should be traced to the environment, e.g. by including final waste treatment processes.

Where the study is intended to be used in comparative assertions intended to be disclosed to the public, the final sensitivity analysis of the inputs and outputs data shall include the mass, energy and environmental significance criteria so that all inputs that cumulatively contribute more than a defined amount (e.g. percentage) to the total are included in the study.

All of the selected inputs identified through this process should be modelled as elementary flows.

It should be decided which inputs and outputs data have to be traced to other product systems, including flows subject to allocation. The system should be described in sufficient detail and clarity to allow another practitioner to duplicate the inventory analysis.

4.2.3.4 LCIA methodology and types of impacts

It shall be determined which impact categories, category indicators and characterization models are included within the LCA study. The selection of impact categories, category indicators and characterization models used in the LCIA methodology shall be consistent with the goal of the study and considered as described in 4.4.2.2.

4.2.3.5 Types and sources of data

Data selected for an LCA depend on the goal and scope of the study. Such data may be collected from the production sites associated with the unit processes within the system boundary, or they may be obtained or calculated from other sources. In practice, all data may include a mixture of measured, calculated or estimated data.

Inputs may include, but are not limited to, use of mineral resources (e.g. metals from ores or recycling, services like transportation or energy supply, and use of ancillary materials like lubricants or fertilizers).

As part of emissions to air, emissions of carbon monoxide, carbon dioxide, sulfur oxides, nitrogen oxides, etc. may be separately identified.

Emissions to air, and discharges to water and soil, often represent releases from point or diffuse sources, after passing through pollution control devices. These data should also include fugitive emissions, when significant. Indicator parameters may include, but are not limited to,

- biochemical oxygen demand (BOD),
- chemical oxygen demand (COD),
- absorbable organic halogen compounds (AOX),
- total halogen content (TOX), and
- volatile organic chemicals (VOC).

In addition, data representing noise and vibration, land use, radiation, odour and waste heat may be collected.

4.2.3.6 Data quality requirements

4.2.3.6.1 Data quality requirements shall be specified to enable the goal and scope of the LCA to be met.

4.2.3.6.2 The data quality requirements should address the following:

- a) **time-related coverage** age of data and the minimum length of time over which data should be collected;
- b) **geographical coverage** geographical area from which data for unit processes should be collected to satisfy the goal of the study;
- c) **technology coverage** specific technology or technology mix;
- d) **precision** measure of the variability of the data values for each data expressed (e.g. variance);
- e) **completeness** percentage of flow that is measured or estimated;
- f) **representativeness** qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);
- g) **consistency** qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;
- h) **reproducibility** qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study;
- i) **sources of the data**
- j) **uncertainty of the information** (e.g. data, models and assumptions)

Where a study is intended to be used in comparative assertions intended to be disclosed to the public, the data quality requirements stated in **a)** to **j)** above shall be addressed.

4.2.3.6.3 The treatment of missing data shall be documented. For each unit process and for each reporting location where issuing data are identified, the treatment of the missing data and data gaps should result in

- a “non-zero” data value that is explained,
- a “zero” data value if explained, or
- a calculated value based on the reported values from unit processes employing similar technology.

Data quality should be characterized by both quantitative and qualitative aspects as well as by the methods used to collect and integrate those data.

Data from specific sites or representative averages should be used for those unit processes that contribute the majority of the mass and energy flows in the systems being studied, as determined in the sensitivity analysis performed in **4.3.3.4**. Where possible, data from specific sites should also be used for unit processes that are considered to have environmentally relevant inputs and outputs.

4.2.3.7 Comparisons between systems

In a comparative study, the equivalence of the systems being compared shall be evaluated before interpreting the results. Consequently, the scope of the study shall be defined in such a way that the systems can be compared. Systems shall be compared using the same functional unit and equivalent methodological considerations, such as performance, system boundary, data quality, allocation procedures, decision rules on evaluating inputs, and outputs and impact assessment. Any differences between systems regarding these parameters shall be identified and reported. If the study is intended to be used for a comparative assertion intended to be disclosed to the public, interested parties shall conduct this evaluation as a critical review.

An LCIA shall be performed for studies intended to be used in comparative assertions intended to be disclosed to the public.

4.2.3.8 Critical review considerations

The scope of the study shall define

- whether a critical review is necessary and, if so, how to conduct it,
- the type of critical review needed (see clause **6**), and
- who would conduct the review, and their level of expertise.

4.3 Life cycle inventory analysis (LCI)

4.3.1 General

The definition of the goal and scope of a study provides the initial plan for conducting the life cycle inventory phase of an LCA. When executing the plan for the LCI, the operational steps outlined in figure 1 should be performed. (It should be noted that some iterative steps are not shown in figure 1).