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**Life cycle inventory calculation  
methodology for steel products**

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## Contents

|                                                                                                           | Page |
|-----------------------------------------------------------------------------------------------------------|------|
| Introduction .....                                                                                        | 1    |
| 1 Scope .....                                                                                             | 3    |
| 2 Normative references .....                                                                              | 3    |
| 3 Terms and definitions .....                                                                             | 3    |
| 4 Basic conditions for LCI of steel products .....                                                        | 7    |
| 4.1 General requirements .....                                                                            | 7    |
| 4.2 Function and functional unit .....                                                                    | 7    |
| 4.3 System boundary .....                                                                                 | 7    |
| 4.4 Data quality .....                                                                                    | 8    |
| 5 Methodological procedure for LCI calculation of steel products with provision for scrap recycling ..... | 10   |
| 5.1 General .....                                                                                         | 10   |
| 5.2 Calculation of cradle to gate LCI without allocation for scrap input .....                            | 11   |
| 5.3 Allocation for scrap recycling .....                                                                  | 11   |
| 5.4 Collecting data .....                                                                                 | 13   |
| 5.5 Allocation procedure for co-products .....                                                            | 17   |
| 6 Reporting .....                                                                                         | 17   |
| 7 Critical review .....                                                                                   | 18   |
| Annex A (informative) An example for calculating $X_{pr}$ .....                                           | 19   |
| Annex B (informative) Example of LCI result reporting .....                                               | 21   |
| Annex C (informative) Example uses of co-products outside of the system boundary .....                    | 23   |
| Annex D (informative) Comparison among standards .....                                                    | 24   |
| Annex E (informative) Details for calculating the recycling rate .....                                    | 25   |
| Annex F (informative) LCI calculations for electricity and steam .....                                    | 27   |
| Annex JA (informative) Comparison table between JIS and corresponding International Standard .....        | 29   |

## Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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# Life cycle inventory calculation methodology for steel products

## Introduction

This Japanese Industrial Standard has been prepared based on **ISO 20915 : 2018**, Edition 1, with some modifications of the technical contents, taking account of an application of the specifications as **JIS**.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

The life cycle inventory (LCI) of steel products is an important component in the support of life cycle assessments (LCA) for a wide range of products and applications that contain steel or where steel is used to support the manufacture, production or delivery of products. This Standard describes the methodology for the calculation of LCI for steel products. This calculation method can be applied to a wide range of steel products, and represents the main process routes for global steel production. This includes the extraction of raw materials from the earth through to the production of steel products at the factory gate, as well as provision for scrap recycling of steel products and the treatment of steel scrap. The methodology conforms to the principles and framework specified in JIS Q 14040 : 2010 and the requirements and guidelines specified in JIS Q 14044 : 2010, and demonstrates how these principles can be applied to steel product manufacture and steel recycling.

The life cycle of steel products consists of the following stages (see Figure 1) :

- a) sourcing of natural resources (which includes mining, transportation and intermediate processing of raw materials) and external scrap (recovered from both the manufacturing process and the end of life of final products);
- b) production of steel products at the steelworks;
- c) manufacturing of final products by downstream users, for example, by customers of the steel products, such as automotive, construction, engineering and electricity industries;
- d) use of final products, where the environmental performance <sup>1)</sup> of the final product depends on the steel products being used; for example, the fuel (or energy) consumption of an automobile depends partly upon the weight of its steel components;

Note <sup>1)</sup> See 3.16 of JIS Q 14050 <sup>[6]</sup> for environmental performance.

- e) recovery of material from the end of life of final products, external scrap from manufacturing process or end of life of final products;
- f) recycling of external scrap to substitute the use of natural resources.

This Standard covers life cycle stages including sourcing of raw materials from the earth and external scrap, production of steel products at the steelworks, and recycling of ferrous scrap. It does not cover the manufacturing of final products and the use of final products.

All global steel production is sourced from different ratios of ferrous scrap and primary ores. Therefore, an understanding of the value of steel recycling becomes a necessary part of the steel product LCI.

It is generally understood that the recycling of materials makes a positive contribution towards reducing resource consumption and energy requirements, and helps to avoid the potential impacts of natural resources extraction and processing. However, all recycling routes (including the processing and transport of recycled materials) carry environmental burdens, and these shall be considered as part of a life cycle assessment.

A critical factor in the understanding of the benefits of materials recycling is the quality of the materials and products that can be produced from the recycled material. Where the recycled products can be made to the same inherent properties as those sourced from primary materials, this is described as closed-loop recycling.

With the existing process and scrap quality controls, steel products sourced from (scrap based) steel recycling can be made to the same specification as steels sourced from the natural resources (iron ore based). The properties of the different steel grades are achieved through different alloying concepts as well as process steps, such as heat treatment. Steel metallurgy allows the control of alloying and tramp elements <sup>2)</sup> to achieve closed-loop recycling.

Note <sup>2)</sup> Trace amount elements contaminated in steel, such as nickel (Ni), chrome (Cr), molybdenum (Mo), copper (Cu) and tin (Sn). This Standard mainly covers the tramp elements originated from scrap.

LCA is applicable to the quantification of potential benefits by recycling based on JIS Q 14040 and JIS Q 14044.

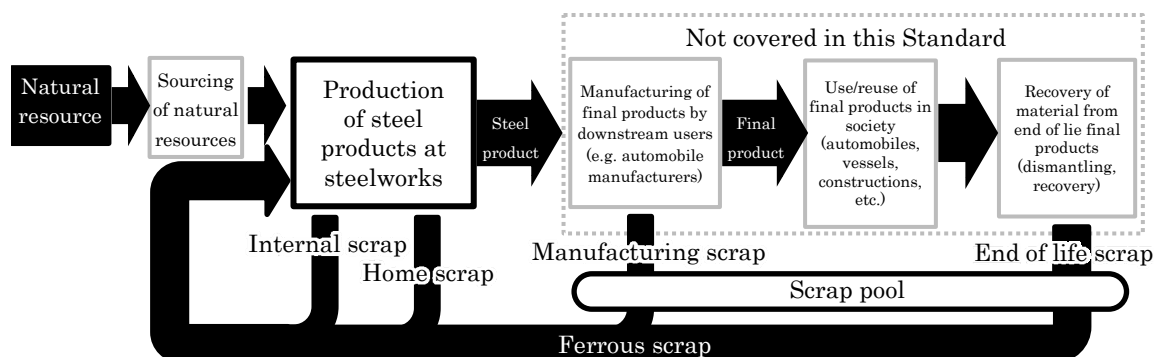


Figure 1 Schematic diagram of the life cycle of steel

## 1 Scope

This Standard specifies guidelines and requirements for LCI studies of steel products reflecting steel's capacity for closed-loop recycling, including :

- a) specification of functional unit used for LCI calculation of steel products;
- b) definition of system boundary used for LCI calculation of steel products;
- c) evaluation of scrap in LCI calculation of steel products;
- d) evaluation of co-products in LCI calculation of steel products;
- e) reporting of LCI calculation results of steel products.

The application of LCI calculation results, including life cycle impact assessment (LCIA), is outside the scope of this Standard.

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

ISO 20915 : 2018 *Life cycle inventory calculation methodology for steel products* (MOD)

In addition, 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 references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent editions (including amendments) shall be applied.

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS Q 14040 : 2010 *Environmental management — Life cycle assessment — Principles and framework*

**NOTE** Corresponding International Standard : ISO 14040 : 2006 *Environmental management — Life cycle assessment — Principles and framework* (IDT)

JIS Q 14044 : 2010 *Environmental management — Life cycle assessment — Requirements and guidelines*

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

## 3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS G 0203** apply.

### 3.1

#### **steel product**

product produced from steel and shipped out from steelworks

**Example** Hot rolled steel plate and strip in cut length and in coil, pickled hot rolled steel plate and strip in cut length and in coil, cold rolled steel plate and strip in cut length and in coil, annealed cold rolled steel plate and strip in cut length and in coil, electrogalvanized rolled steel plate and strip in cut length and in coil, hot-dip galvanized steel plate and strip in cut length and in coil, chromium plated tin-free steel, tinsplate, coated steel plate and strip in cut length and in coil, section, steel plate, bar, rod, seamless steel tube, electric resistance welded steel tubes.

### 3.2

#### **final product**

product that requires no additional transformation prior to its use <sup>[1]</sup>

**Example** Automobiles, building structures, building envelopes, packaging.

### 3.3

#### **scrap**

iron and steel material in metallic form that is recovered in multiple life cycle stages, including steel production processes, the manufacturing processes of final products and the end of life of final products, and is recycled as a raw material for steel production

### 3.4

#### **internal scrap**

scrap from a crude steelmaking unit process that is then recycled within the same unit process (e.g. basic oxygen furnace or electric arc furnace)

### 3.5

#### **home scrap**

scrap from a downstream steel production process within the steelworks (e.g. rolling, coating) that is returned to steelmaking processes

### 3.6

#### **manufacturing scrap**

scrap from the manufacturing processes of final products, such as automobiles and constructions

### 3.7

#### **end of life scrap**

scrap from after the end of life of final products

### 3.8

#### **external scrap**

scrap provided from outside of the steelworks, including manufacturing scrap and end of life scrap

### 3.9

#### **recycling rate, *RR***

ratio of the mass of external scrap recycled to the mass of steel products to be shipped out from the steelworks gate

### 3.10

#### **end of life recycling rate**

ratio of the mass of end of life scrap recycled to the mass of steel in final products

### 3.11

#### **manufacturing yield**

ratio of the mass of steel contained in final products to the total mass of steel products used for manufacturing the final product

### 3.12

#### **ferrous raw material**

raw material from the earth that becomes one of the main constituents of steel products, and which may have undergone intermediate processing to prepare it for iron-making

**Example** Lump ore, iron ore fine, sinter, pellet, hot briquetted iron (HBI), direct reduced iron (DRI).

### 3.13

#### **process coal**

coal used in iron and steel making processes

**Example** Coking coal, injection coal, sintering coal, basic oxygen furnace coal, electric arc furnace coal, DRI coal.

### 3.14

#### **non-ferrous raw material**

non-ferrous ingredient material for steel products other than ferrous raw material or process coal

**Example** Zinc, tin, aluminium.

### 3.15

#### **ferro alloy**

alloy of iron with non-iron alloy metals, such as manganese, silicon or chromium used in the steelmaking process

**3.16****other input material**

material input and consumables for steel production other than ferrous raw material, process coal, non-ferrous raw material, ferro alloy and scrap, which does not ultimately form part of the steel product

**Example** Refractory, electrode, chemical materials, limestone, dolomite.

**3.17****fuel**

energy source for generating heat, steam and power other than process gas

**Example** Boiler coal, fuel oils, natural gas, LPG.

**3.18****industrial gas**

gas for steel production other than fuels or reducing agent

**Example** Oxygen, nitrogen, argon, hydrogen, carbon dioxide, compressed air.

**NOTE** Hydrogen can be used as a fuel, or is included here as an industrial gas when used as an uncombusted industrial gas, e.g. for the provision of reducing atmospheres in production processes.

**3.19****co-product**

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

**3.20****process gas**

gas that is produced as a co-product of steel product in steelmaking processes

**Example** Coke oven gas, blast furnace gas, basic oxygen furnace gas.

**3.21****waste**

materials disposed of in landfills, both internal and external to steel works, or incinerated

**3.22****LCI (life cycle inventory)**

data on the product under study and the process of raw materials/energy (inputs) or of products/emissions (outputs) produced or discharged <sup>[2]</sup>

**3.23****scrap LCI**

LCI credited or burdened according to the recovery or input of scrap, respectively

### **3.24**

#### **primary data**

data taken from the direct investigation for the practical unit process <sup>[3]</sup>

### **3.25**

#### **secondary data**

commonalized data, generally accepted to be used for LCA within a certain range <sup>[3]</sup>

## **4 Basic conditions for LCI of steel products**

### **4.1 General requirements**

The requirements and guidelines on LCI of steel products specified in this Standard shall be followed in addition to those specified in **JIS Q 14040 : 2010** and **JIS Q 14044 : 2010**.

### **4.2 Function and functional unit**

The function of steel products is to form a part of final products, such as automobiles, vessels and constructions.

For an LCI of steel products, the functional unit should be set as a mass-based unit of steel products to be shipped out from the steelworks gate. Where applications are based on other functional unit, suitable explanation and conversion guidance shall be provided.

### **4.3 System boundary**

The system boundary used for the LCI calculation of steel products shall include all of the production steps from natural resources mining to the steel products shipped from the steelworks, including the recycling of steel products (i.e. cradle to gate) (see Figure 2).

This includes production processes at the steelworks and all the upstream processes, including energy conversion, natural resources mining from the earth, material preparation and transportation of materials to the steelworks site. The system boundary does not include the manufacturing of final products using steel products or their use in the society.

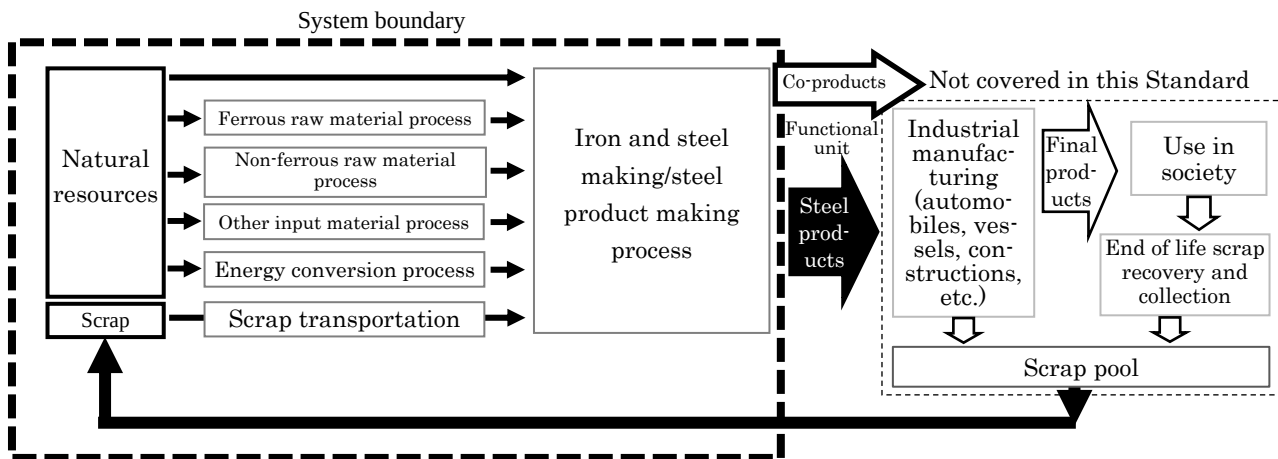


Figure 2 System boundary

The following items should be excluded from the system boundary. If any of them are included in the system boundary, this shall be clearly stated and explained.

- a) Transportation of steel products beyond the gate
- b) Transportation of co-products beyond the gate
- c) Manufacturing of final products
- d) Use of final products
- e) Research and development
- f) Business travel of employees
- g) Production, decommissioning, repair and maintenance of capital goods
- h) Cleaning and legal services
- i) Marketing
- j) Operation of administration offices

#### 4.4 Data quality

##### 4.4.1 General

The data quality requirements specified in 4.2.3.6 of JIS Q 14044 : 2010 should be followed, including time related coverage, geographical coverage and technology coverage.

##### 4.4.2 Time-related coverage

The timeframe of data collection should be one full representative year or longer to adjust for seasonal variations. If the data set is not possible for a full year, this shall be explained and justified. Moreover, since the LCI results are prone to change over time for reasons, such as changes in operational rate due to economic conditions and technological improvements, the time period in which the data are collected shall be stated clearly. Primary data sets used in LCI studies should not be more than five years old.