
**Railway applications — Recyclability
and recoverability calculation method
for rolling stock**

*Applications ferroviaires — Méthode de calcul de recyclabilité et
valorisabilité pour matériel roulant*

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Published in Switzerland

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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).

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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 269, *Railway applications*, Subcommittee SC 2, *Rolling stock*.

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.

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Introduction

Rolling stock products are generally designed for operational safety, availability and reliability with the consideration to minimize any impact on society and environment. The treatment and environmentally sound disposal of end-of-life products are the desirable environmental priority of railway industry. This needs a common method to describe the end-of-life treatment of rolling stock products.

In order to benchmark the theoretical recyclability and recoverability of rolling stock, common calculation rules have been introduced in this document, which has been developed considering the work of UNIFE Life Cycle Assessment topical group between 2009 and 2011^[5].

The calculation approach is based on common recycling practice. Throughout a life cycle perspective, the method adopts railway specific requirements for necessary material information.

End-of-life treatment processes are divided into three stages; pre-treatment, dismantling and shredding. Pre-treatment and dismantling calculations consider recycling and recoverability properties of the materials specific to these stages. At each stage, individual material flows are split into materials for recycling and materials for recoverability, depending on the availability of appropriate technology for recycling and/or recoverability. Therefore, knowledge of materials and dismantling of rolling stock or equipment is essential. The entire supply chain needs to be involved because material information is crucial when using this calculation method. This harmonized calculation method for recyclability and recoverability for rolling stock is intended to prevent misleading data gaps and contradictions.

The primary aim of this calculation method is for the rolling stock domain and other related interfaces with other subsystems.

The calculation method introduced by this document considers different end-of-life paths such as reuse, recycling and recoverability as well as treatment efficiencies at each stage. This means that this method is developed in order to take into account the efficiencies of recycling and recoverability technologies with regard to each material at the different end-of-life treatment stages. The recyclability and recoverability rates of rolling stock are each expressed as a percentage by mass (mass fraction in percent) after applying efficiency factors for each material of the rolling stock, which can potentially be reused, recycled or recovered.

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Railway applications — Recyclability and recoverability calculation method for rolling stock

1 Scope

This document specifies a calculation method of recyclability and recoverability rates for rolling stock.

The method defined in this document applies to the design of new rolling stock. However, it can be applied to other existing rolling stock depending on available information. If calculation of recyclability or recoverability is applied to separate parts and/or products used in rolling stock and a specific calculation standard or method exists for the part and/or product, such standard or method can be applied, if relevant.

This calculation method is applicable regardless of any geographical concern.

This calculation method is applicable to any stage of life cycle of rolling stock. The calculated recyclability and recoverability rates are valid at the point of delivering the rolling stock products or equipment. Future recycling technologies or predicted trends with respect to the recycling industry are excluded from any consideration for this calculation method.

This calculation method considers the four main treatment processes, which are reuse, recycling, energy recovery and disposal (Figure 1). Process losses of recycling are treated in the disposal stage. The residue substances of the energy recovery stage (mostly ash and slag) and the residue of the incineration process of the disposal stage are most likely landfilled.

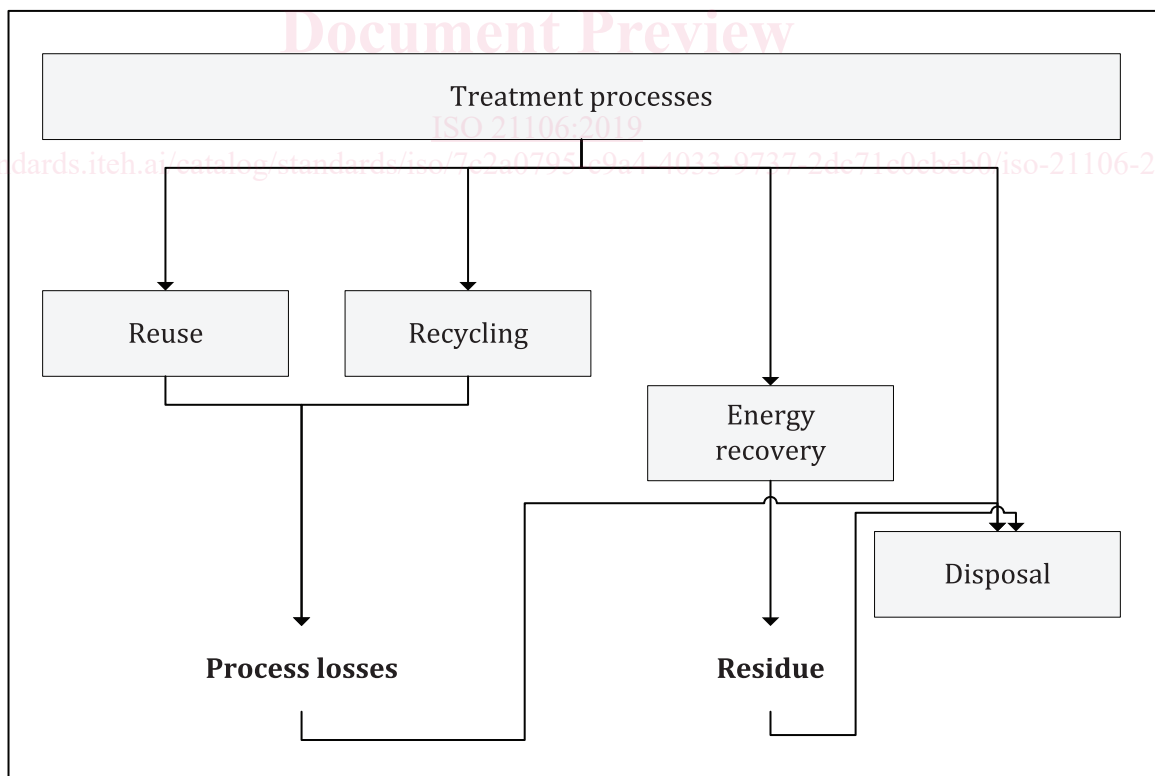


Figure 1 — End-of-life treatment

The application of this calculation method considers the rolling stock or equipment as delivered. Spare parts and/or maintenance parts necessary to keep the rolling stock in service over the entire life cycle,

e.g. brake pads, are not taken into account. Also, infrastructure systems like stations, electrification, signal and control units, etc. are excluded from the calculation (Figure 2).

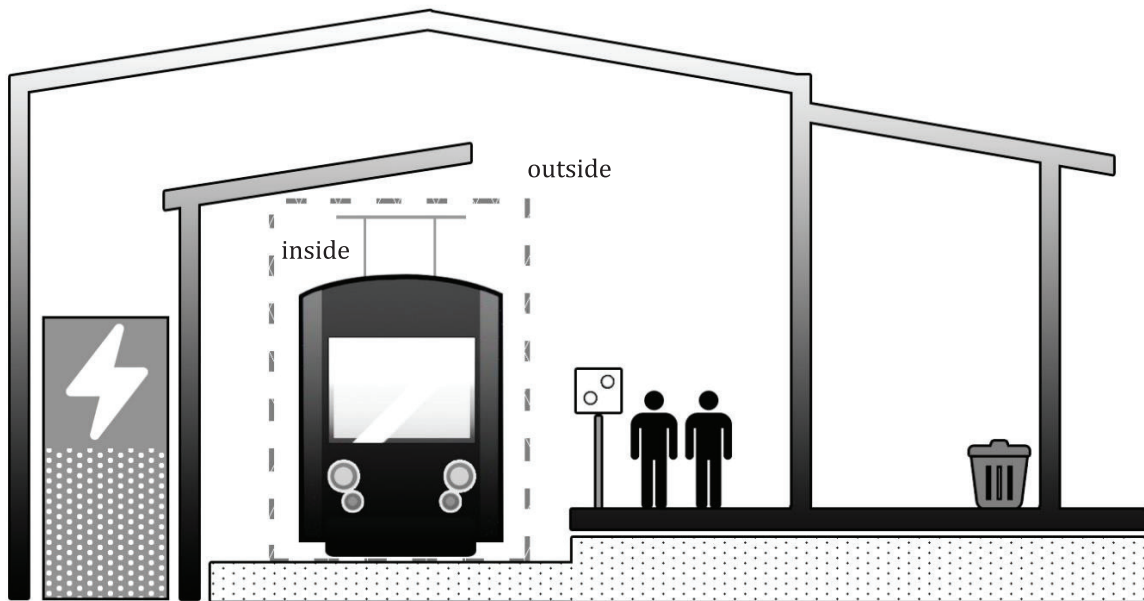


Figure 2 — Scope of the calculation

2 Normative references

There are no normative references in this document.

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 design mass of rolling stock in working order

m_v
state of the complete mass of rolling stock equipped with all the consumables (e.g., fuel, oil, water, etc.) and without staff, passengers, and payload

[SOURCE: EN 15663:2017, 2.1.2.1, modified — The symbol has been amended and the mass of the staff is not included in the definition.]

3.2 reuse

use components of end-of-life rolling stock for the same purpose as that for which they were designed

Note 1 to entry: See ISO 22628.

3.3**recycle**

process the waste materials for the original purpose or for other purposes, excluding processing as a means of generating energy

3.4**recover**

process the waste materials for the original purpose or for other purposes, including processing as a means of generating energy

Note 1 to entry: “energy recovery” differs from recovery in that it does only include processing the waste materials with the aim to generate energy.

3.5**reusable**

<of a component> suitable to be diverted from an end-of-life treatment to be *reused* (3.2)

3.6**recyclability**

suitability of components, materials or both to be diverted from an end-of-life treatment to be *recycled* (3.3)

Note 1 to entry: See ISO 22628.

3.7**recyclability rate**

R_{cyc}

percentage by design mass (mass fraction in percent) of the rolling stock potentially able to be *recycled* (3.3), *reused* (3.2) or both

Note 1 to entry: See ISO 22628.

3.8**recoverability**

suitability of components or materials to be diverted from an end-of-life treatment to be *recovered* (3.4)

Note 1 to entry: See ISO 22628.

3.9**recoverability rate**

R_{cov}

percentage by design mass (mass fraction in percent) of the rolling stock potentially able to be *recovered* (3.4), *reused* (3.2) or both

Note 1 to entry: See ISO 22628.

3.10**residue**

mixture of materials remaining from the end-of-life treatment that is not *reused* (3.2), *recycled* (3.3) or *recovered* (3.4)

3.11**shredding loss factor**

F_{SL}

shredder process efficiency indicating material mass losses during the process

3.12**shredder heavy fraction**

metal fraction from the shredding process that can be further divided into ferrous metal fraction or ferrous fraction composed of pure ferrous materials like steel and iron and its alloys and a non-ferrous metal fraction or non-ferrous fraction containing different metals like aluminium, copper, brass, etc.

3.13

shredder light fraction

non-metallic *residue* (3.10) from the shredding process composed of plastics, rubber, foam, residual metal pieces, paper, fabric, glass, sand, etc.

3.14

material recycling factor

MRF

$$F_{MR}$$

suitability of material to be *recycled* (3.3) as materials for secondary products depending on the availability of recycling processes

3.15

energy recovery factor

ERF

$$F_{ER}$$

efficiency of process based on material weight to be recovered as usable energy

Note 1 to entry: Energy recovery from material is the conversion of materials into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolysis, anaerobic digestion and landfill gas recovery.

Note 2 to entry: As shown in Table 1, the *recyclability rate* (3.7) embraces the percentage by design mass of the rolling stock that can potentially be reused and recycled, while the *recoverability rate* (3.9) includes the percentage by design mass of the rolling stock that can potentially be reused, recycled and recovered as energy.

Table 1 — Overview of key terms

	Recovery		Residue
(Components) Reuse	(Materials) Recycling	(Materials) Energy recovery	(Materials) Disposal
Recyclability rate ^a			
Recoverability rate ^a			
Design mass of rolling stock			
^a As a percentage of rolling stock mass.			

4 Symbols and abbreviated terms

Table 2 describes the symbols of the mass variables used in calculating the recyclability and recoverability rates.