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Interested committees:

Title: BS IEC 63593 Railway applications - Rolling stock - Specification and verification of energy consumption

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



9/3108/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 63593 ED1	
DATE OF CIRCULATION: 2024-06-28	CLOSING DATE FOR COMMENTS: 2024-08-23
SUPERSEDES DOCUMENTS:	

IEC TC 9 : ELECTRICAL EQUIPMENT AND SYSTEMS FOR RAILWAYS	
SECRETARIAT: France	SECRETARY: Mr Denis MIGLIANICO
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Energy Efficiency	

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Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:
Railway applications – Rolling stock – Specification and verification of energy consumption

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS –
ROLLING STOCK –
SPECIFICATION AND VERIFICATION OF ENERGY CONSUMPTION**

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IEC 6XXXX has been prepared by subcommittee **PT 591: Railway Applications - Rolling Stock - Specification and verification of energy consumption**, of IEC technical committee **9: Electrical equipment and systems for railways**. It is an International Standard.

The text of this **International Standard** is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this **International Standard** is **English**.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – ROLLING STOCK – SPECIFICATION AND VERIFICATION OF ENERGY CONSUMPTION

1 Scope

This document supports rolling stock procurement and life cycle cost (LCC) assessments. It is applicable to rolling stock energy consumption specification and verification and establishes a methodology for the calculation of energy consumption which can be used to determine the total net energy consumed from a primary power source (e.g. at current collector or from the fuel tank), over a predefined service profile.

The results obtained from this methodology can be directly compared to, or be representative of, the operation of a train. This document considers the energy consumed and regenerated by rolling stock and the determination methods covered are simulation and measurement.

A framework is given on the generation of common, comparable energy performance values for rolling stock which supports the benchmarking and improvement of the energy efficiency of rolling stock.

This document does not cover the comparison of energy consumption with other modes of transportation, or comparison between diesel and electric traction; only the energy consumption of rolling stock itself is covered.

This standard, as a whole or in part, applies to all railway vehicles except coal-powered vehicles, special purpose vehicles (e.g. shunting locomotives, vehicles for track construction and maintenance) and magnetically supported vehicles.

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 19659-3:2022, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 3: Energy efficiency*

ISO/DIS 10516:2024, *Railway applications – Vehicle reference masses*

IEC 60850, *Railway applications - Supply voltages of traction*

IEC 62888-2:2018, *Railway applications - Energy measurement on board trains - Part 2: Energy*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardisation at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

NOTE When possible, the following definitions have been taken from the relevant chapters of the International Electrotechnical Vocabulary (IEV), IEC 60050. In such cases, the appropriate IEV reference is given. Certain new definitions or modifications of IEV definitions have been added in this standard in order to facilitate understanding.

279 of the performance of electrical and electronic measuring equipment has been taken from
280 IEC 60359:2001.

281 3.1.1

282 auxiliary power supply line

283 electric cable running throughout a train and supplying the heating or other services on each
284 coach

285 [SOURCE: IEC 60050-811:2017/AMD1:2021, 811-23-11]

286 3.1.2

287 comfort systems

288 all equipment consuming energy for passenger and crew comfort belonging neither to the
289 traction equipment nor to traction auxiliaries, mainly for the provision of a comfortable
290 environment (for example lighting, heating, air conditioning, toilets, information and
291 entertainment systems, laptop supplies)

292 Note 1 to entry: Comfort systems are split in two groups for use in this standard: Heating, Ventilation and Air
293 Conditioning (HVAC) and Other comfort functions.

294 3.1.3

295 consist

296 single vehicle or a group of vehicles which are not separated during normal operation

297 [SOURCE: IEC 60050-811:2017/AMD1:2021, 811-37-20, modified – the Note 1 to entry has
298 been omitted.]

299 3.1.4

300 contact line

301 conductor system for supplying electric energy to vehicles through current-collecting equipment

302 [SOURCE: IEC 60050-811:2017/AMD1:2021, 811-33-01, modified – the Note 1 to entry has
303 been omitted.]

304 3.1.5

305 electric traction system

306 railway electric distribution network (infrastructure) used to provide energy for rolling stock

307 [SOURCE: IEC 60050-811:2017/AMD1:2021, 811-36-21, modified – “(infrastructure)” has been
308 added and the Note 1 to entry has been omitted.]

309 3.1.6

310 energy storage system

311 ESS

312 physical system which comprises energy storage technologies such as batteries, double-layer
313 capacitors, flywheel, etc. and other equipment to connect the storage technologies to traction
314 equipment, including control, cooling and monitoring systems

315 3.1.7

316 fuel

317 fuel refers to fossil fuels and alternative fuels

318 3.1.8

319 heating, ventilation and air conditioning

320 HVAC

321 system to provide heating, ventilation and air conditioning for comfort

322 Note 1 to entry: Without HVAC means, the HVAC system is switched off.

3.1.9**infrastructure**

fixed installations of the railway system (for example tracks, power supply, signalling, communication)

3.1.10**net energy**

difference between the energy taken (consumed) from the contact line, fuel tank by the traction unit, and the energy fed back (regenerated) into the contact line by the traction unit

3.1.11**primary power source**

subsystem with the primary purpose of which is to supply energy to other subsystems by either consuming the fuel stored on-board or taking in energy from external source

3.1.12**regenerative braking <of a vehicle>**

braking in which the energy produced by the motors is fed into the line or used by on-board devices

[SOURCE: IEC 60050-811:2017/AMD1:2021, 811-06-25, modified – “electro-dynamic” and “contact” have been removed, “into energy storage” has been replaced with “or used by”, and the Note 1 to entry has been omitted.]

3.1.13**rolling stock**

all vehicles with or without motors

Note 1 to entry: Examples of vehicles include a locomotive, a coach and a wagon.

[SOURCE: IEC 60050-811:2017/AMD1:2021, 811-02-01]

3.1.14**service profile**

outline of the expected range and variation in the mission with respect to parameters such as time, loading, speed, distance, stops, tunnels, etc., in the commercial exploitation of the train.

3.1.15**single train run**

run of one train over a part of the infrastructure, without inclusion of effects of other trains

3.1.16**standard service profile**

service profile which is characterised by definitions of standard values, see Annex B

3.1.17**state of energy****SoE**

remaining energy to be discharged, normally expressed as a percentage of full energy.

Reference is begin of life of the ESS and usable energy, i.e. energy available to be discharged depending upon applications.

[SOURCE: IEC 62864-1:2016, 3.1.14, modified – the end of the definition “as expressed in relevant standards” has been removed and the Note 1 to entry has been omitted.]

3.1.18**traction auxiliaries**

equipment needed to operate the traction equipment and the train in normal operation mode, but not producing tractive or dynamic braking efforts themselves (for example cooling fans, oil and water pumps, compressor, air supply for brakes, HVAC for the leading driver's cabin, train control and management system and signalling equipment)

Note 1 to entry: The definition of traction auxiliaries in this standard may differ from other standards.

3.1.19**traction chain**

the complete set of traction equipment on-board of the train

3.1.20**traction equipment**

equipment on-board of the train directly needed to produce tractive or dynamic braking effort (for example transformers, converters, motors, gearboxes, internal combustion engines, fuel cells, energy storage systems)

3.1.21**traction unit**

locomotive, motor coach or train-unit

[SOURCE: IEC 60050-811:2017/AMD1:2021, 811-02-04]

3.1.22**train**

combination of rolling stock coupled together

[SOURCE: IEC 60050-811:2017/AMD1:2021, 811-01-08, modified – the Note 1 to entry has been omitted.]

3.1.23**user-defined service profile**

service profile which is agreed by the involved parties for the comparison of the energy consumption of trains

Note 1 to entry: It is also intended for the comparison of simulations and real tests of the energy consumption of trains on an existing infrastructure.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

AC	Alternating Current
DC	Direct Current
ESS	Energy Storage System
HVAC	Heating, Ventilation and Air Conditioning System
LCC	Life Cycle Cost
SoE	State of Energy

4 General

4.1 Train modes

Train operations always takes place under the constraints of infrastructure and operational requirements. Normal operation is considered only. During normal operation, all systems function as intended. Degraded modes, which refer to situations where a system is not fully available, are not considered as part of normal operation.

The following train modes are used in this standard:

— **In-service with commercial operation mode:**

The operation of a train, including several passenger load cases or a locomotive hauling a consist of freight wagons. The train can be moving or stationary and the HVAC system is running in its normal operation mode.

— **In-service without commercial operation mode:**

A stationary train where the HVAC system is in operation as for commercial operation but no passengers are in the train. This situation can occur, for example, when the train is waiting between two commercial train runs or when a freight train is waiting for proceeding with driver on-board.

— **Parking mode:**

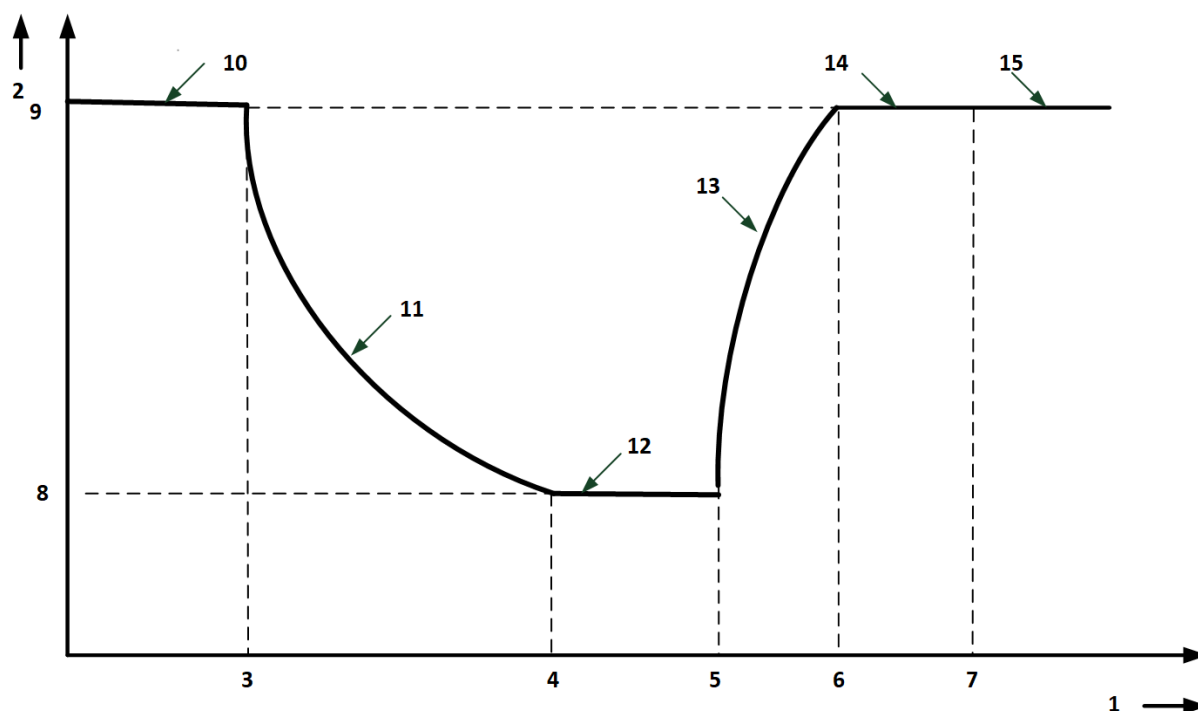
A stationary train in a depot, without staff or passengers on board. In this mode, systems that are not required can be switched off.

The HVAC system typically operates with different set points for temperature and airflow, or alternatively, is shut down to save energy. The purpose of parking mode usually includes frost protection and maintaining the interior temperature to a reasonable level.

Figure 1 is an example illustration of different phases in parking mode during winter.

NOTE: Not all phases must be implemented in the train design. Parking mode in the summer can follow the same phases with cooling instead of heating.

424



425

Key

- 1 Time [h]
- 2 Interior temperature [°C]
- 3 Start of parking mode
- 4 Start of heating to maintain temperature
- 5 Start of pre-heating
- 6 End of pre-heating, start of in-service without commercial operation mode for HVAC
- 7 Train ready for: in-service without commercial operation (can be at the same point of time than 6)
- 8 Interior temperature setting during parking mode
- 9 Interior temperature setting during in-service without commercial operation mode
- 10 Phase 1 : In-service without commercial operation mode
- 11 Phase 2 : Parking mode without heating
- 12 Phase 3 : Parking mode with heating (maintain interior temperature)
- 13 Phase 4 : Parking mode with pre conditioning (pre-heating)
- 14 Phase 5 : Parking mode to prepare for in-service without commercial operation mode (e.g. brake tests, etc.)
- 15 Phase 6 : In-service without commercial operation mode

426

Figure 1 — Winter parking and pre-heating mode

427 Parking mode in winter is composed of different phases (from key 11 to key 14 of Figure 1).

428 During phase 1, the system operates with a nominal interior temperature setting for in-service without
 429 commercial operation. After this phase 1 (key 3), the parking mode is starting.

430 During phase 2, the train heating does not operate because the mean interior temperature is higher than
 431 the temperature setting.

432 During phase 3, the train maintains a mean interior temperature to avoid a temperature that is too cool.

433 Generally, this temperature is set to around 3 or 5 degrees Celsius.

During phase 4, the train operates in heating (pre-heating).

At the end of phase 4 (key 6), the train reaches the interior temperature setting for in-service without commercial operation.

Phase 5 is the remaining time to finish parking mode. For example, if the duration of the parking mode is 8 hours and if the pre-heating mode finishes after 7 hours 30 minutes, the duration of phase 5 is 30 minutes. Similarly, if pre-conditioning is ongoing for other systems the train maintains the mean interior temperature according to the temperature setting in-service without commercial operation mode during this time.

The pre-conditioning of other systems need to be considered during parking as well.

Other train modes, for example empty carriage stock movements, are not considered in this standard. If the empty carriage stock has a significant impact to the annual energy consumption, it can be treated as part of in-service with commercial operation mode without load.

In this standard, cleaning is not considered separately. The corresponding hours should be counted in the in-service without commercial operation mode.

Note 1: Activation and deactivation of parking mode can be done in different ways, such as automatically after a given condition, e.g. when the train is in the previous state “In-service without commercial operation mode” after a time duration, or manually, by an action from the train crew (driver, maintenance worker, etc.) on a device located on-board (e.g. a switch in driving cab, HMI, etc.) and on-ground remotely.

Note 2: Where a train is switched off for maintenance periods, this can be considered either in a reduced annual sum of mileage and operating hours or by additional reserve trains outside the energy calculation.

4.2 Energy categories

To simplify the verification process and ensure reproducible results, the energy consumption of the entire train is subdivided into the following three distinct energy categories:

- 1) Traction and Auxiliaries (in-service with commercial operation mode, without HVAC);
- 2) Traction and Auxiliaries (in-service without commercial operation mode and parking mode, without HVAC);
- 3) HVAC.

Unless otherwise specified by the purchaser, the following applies for Energy categories “1) and 2) Traction and Auxiliaries”:

- Losses in the traction chain and auxiliary converters shall be included; and
- All traction auxiliaries as e.g. cooling fans, cooling pumps, air compressor, signalling systems shall be included.
- Subsystems, where the usage depends on staff or passengers, shall be switched off, if not defined otherwise by the purchaser (e.g. kitchen, toilet flush, reading lights).
- All additional subsystems excluding HVAC for passenger compartment shall be considered according to normal operation in the respective train mode (including, for example, lighting, passenger information systems).

4.3 Service profiles

This document combines infrastructure and operational conditions into “service profiles” for the train. The user-defined service profile for traction and auxiliaries is assessed via train runs along a line for in-service with commercial operation and stationary for in-service without commercial operation. HVAC is assessed via a set of operational points for different operational modes.

The methodology for the specification and verification of energy consumption is based on the evaluation of service profiles. The selected approach has two steps:

a) simulation of the energy consumption of the train for the three energy categories mentioned in 4.2; and

b) verification of the simulation by undertaking measurements.

User-defined service profiles for traction and auxiliaries are based on data from a real railway line, normally one or several lines of the railway network where the train will be operated. Definitions of relevant parameters for these user-defined service profiles are set out in Annex A and the values shall be given by the purchaser.

In the case that the energy consumption of trains is compared without the context of real operation, such as for research, the standard service profiles from Annex B could be used. The standard service profiles cannot replace user-defined service profiles for representative energy consumption calculation and verification, as pointed out in Table B.1.

For the assessment of HVAC energy consumption, standard weighting factors and operational points for Europe are set out in Annex C.

4.4 Verification acceptance criteria

The acceptable tolerances shall be agreed by the involved parties before the verification.

5 Traction and Auxiliaries (in-service with commercial operation, without HVAC)

5.1 General

This clause is focused on traction energy in-service with commercial operation mode on a single train run for a train travelling from origin to destination, including standstill times on the way using the representative driving cycles. It includes energy related to traction and auxiliaries as defined in 4.2.

For traction and auxiliary energy in service, the defined timetable for the operation over a specified line plays an important role. This document is therefore not a direct specification of detailed driving styles but instead provides a framework which allows freedom for the user to propose solutions for integrating a mix of energy efficient technologies and driving styles.

5.2 Operational requirements

5.2.1 General

The information in this subclause is applicable to both simulation and verification of energy consumption. The definitions of relevant parameters are given in Annex A. Each parameter is identified by a letter followed by two digits.

5.2.2 Train data

5.2.2.1 Train and traction equipment

The analysis of energy consumption shall include the train and its mechanical losses, the traction chain (e.g. electric, diesel-electric or diesel-mechanic) and all auxiliaries as defined in 4.2.

5.2.2.2 Load conditions

ISO/DIS 10516:2024(E) shall be read in conjunction with this subclause.

The gross mass, and therefore the load, of a train has an influence on its energy consumption. The mass of the train shall be specified as set out in this clause based on the following train categories:

a) Passenger trains:

The train mass (ID S05) is based upon the design mass in working order plus the mass of passengers:

Europe: 50 % of seated passengers set out in ISO/DIS 10516:2024(E) with 70 kg per passenger.

The load case of passengers for other regions is not pre-defined. The purchaser and manufacturer may use any number with their agreement.

The passenger load shall be evenly distributed over the train.

b) Locomotive without trailing consist in the scope of the manufacturer

The train mass consists of the locomotive mass which is based upon the design mass in working order plus a trailing consist, which shall be homogeneous, i.e. the trailing consist should not be a mix of different axle arrangements or aerodynamic designs. The following values shall be specified for the trailing consist as a load:

- 1) total mass of the trailing consist [t] (ID S06);
- 2) rotating masses in terms of equivalent mass [t] (ID S07);
- 3) length of the trailing consist [m] (ID S08);

- 4) running resistance [kN] of the trailing consist versus speed [km/h] over the whole speed range (ID S09).

The parameters used to characterise load conditions are set out in [Table A.4](#).

5.2.3 Infrastructure conditions

5.2.3.1 Longitudinal profile

The longitudinal profile shall be defined by the following parameters:

- 1) total distance of selected route or reference track from selected origin location to selected destination location [km] (ID I01);
- 2) height [m], as an absolute value (above sea level) (ID I02);
- 3) gradient [‰], as difference in height divided by difference of distance in longitudinal direction (ID I03).

ID I02 and ID I03 are correlated. It shall be checked and documented that the integral of gradients along the track results in the correct difference of height between origin and destination location.

The parameters used to characterise the longitudinal profile are set out in [Table A.2](#).

5.2.3.2 Maximum speed profile

The maximum speed profile [km/h] shall be defined by the following parameters:

Maximum speed profile at every location along the selected route or reference track (ID I04). The speed profile shall include the following criteria:

- 1) maximum speed for which the line, relevant to the profile, is planned;
- 2) permanent speed reductions due to curves, defined by the required capabilities of the specified train, for example, tilting trains may have a higher permitted speed in some sections along the route than other trains;
- 3) non-permanent speed reductions due to signalling, defined by conditions during verification runs or service operation of the train, for example, speed restrictions imposed by the changeover between two tracks shall already be included in the speed profile;
- 4) rules for safe operation, for example, if the operation rules require the target speed to be reached 100 m before a permanent speed restriction, this shall be included in the profile.

The parameters used to characterise speed profile are set out in [Table A.2](#).

5.2.3.3 Curves

The curves shall be defined by the following parameters:

Location and radius of each curve along the selected route or reference track [m] (ID I05). Transitions can be simplified as step-functions.

The parameters used to characterise curves are set out in [Table A.2](#).

5.2.3.4 Tunnels

The tunnels shall be defined by the following parameters:

- 1) location and length [m] of each tunnel along the selected route or reference track (ID I06);
- 2) location and cross-sectional area [m²] of each tunnel along the selected route or reference track (ID I07).