



**BSI Standards Publication**

# **Railway applications — Heating, ventilation and air conditioning systems for rolling stock**

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Part 3: Energy efficiency

## National foreword

This British Standard is the UK implementation of ISO 19659-3:2022.

The UK participation in its preparation was entrusted to Technical Committee RAE/4/-/3, Railway Applications - Air conditioning, Heating and Ventilation.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Railway applications — Heating,  
ventilation and air conditioning  
systems for rolling stock**

**Part 3:  
Energy efficiency**

*Applications ferroviaires — Systèmes de chauffage, ventilation et  
climatisation pour le matériel roulant —*

*Partie 3: Efficacité énergétique*





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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](http://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](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 269, *Railway applications, Subcommittee SC 2, Rolling Stock*.

A list of all parts in the ISO 19659 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](http://www.iso.org/members.html).

## Introduction

The world's energy resources are being consumed at a significant rate that will result in the depletion of non-renewable resources. It is imperative that energy be conserved. Conservation of energy in railway vehicles can result in a slowdown of non-renewable resource usage and consequently of the build-up of greenhouse gases.

The HVAC (heating, ventilation and air-conditioning) system is one of the main energy consumers on a train, and its energy efficiency is a key issue to reduce the environmental impact of public transport.

As most railway vehicles are designed to last for a long period (15 y to 40 y), lower energy consumption can also be considered a means of reducing the cost to railway operators and authorities.

The energy consumption of the HVAC systems is affected by multiple parameters therefore, a common guideline is essential for comparative assessment of energy efficiency between different systems.

This document offers methodologies to deliver comparable energy consumption values of the HVAC system without unnecessary lead times and costs by suggesting appropriate conditions for simulation or testing.

In general, this document describes the conditions that should be considered:

- train mode,
- principles such as measurements, climatic and operational boundary conditions,
- assessment methods such as simulation, calculation, verification and post-processing.

These can be used to assess the effectiveness of energy efficiency measures to evaluate different cars and/or HVAC concepts and to provide an indication of the annual HVAC energy consumption for the whole train (except driver's cab).

The specifications in this document are to be considered together with the national/regional standards, which take different preferences, local weather and operational conditions into account.



# Railway applications — Heating, ventilation and air conditioning systems for rolling stock —

## Part 3: Energy efficiency

### 1 Scope

This document is applicable to the calculation, measurement and/or verification of energy consumption of railway vehicle HVAC (heating, ventilation and air-conditioning) systems.

The HVAC system energy consumption is simulated, calculated, measured and validated in accordance with the requirements of thermal comfort defined in ISO 19659-2, considering the same category of passenger railway vehicles as detailed in ISO 19659-2, Clause 4:

- Category 1 (e.g. main line, intercity, long distance, high speed);
- Category 2 (e.g. suburban, commuter, regional);
- Category 3 (e.g. urban, LRV, tram, metro/subway).

This document only covers the passenger area HVAC systems. Driver's cab HVAC systems are excluded but could be treated in a similar way.

### 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 19659-1, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 1: Terms and definitions*

ISO 19659-2, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 2: Thermal comfort*

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19659-1 apply.

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

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

#### 3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

|      |                              |
|------|------------------------------|
| TISM | Train in-service mode        |
| TRSM | Train ready for service mode |
| PCM  | Pre-conditioning mode        |
| PM   | Parking mode                 |

## 4 Train mode

### 4.1 General

The following train modes, [4.2](#) to [4.5](#) are the different operating states of train and relate to the operating mode of the HVAC system.

### 4.2 Train in-service mode (TISM)

This mode covers the commercial operation of the train, including several passenger load cases. The train is moving or is stationary with the HVAC system running in its automatic mode.

### 4.3 Train ready for service mode (TRSM)

In this mode, the HVAC system is operational (same as for TISM) without passengers.

This situation occurs frequently, for example when the:

- train is waiting between two commercial runs;
- train is at a terminal station with the doors closed;
- train is in operation between a depot and a terminal station.

When the train is being cleaned at a terminal station, the time should be considered for this mode.

### 4.4 Pre-conditioning mode (PCM)

Pre-conditioning is the process which enables the interior temperature to be lowered or raised to a defined comfort level including pre-cooling and pre-heating. This mode will depend on the ambient temperature conditions at which the train is operating. During hot conditions pre-cooling is required and in cold conditions, pre-heating is required.

This mode of operation is without passengers on the train.

This mode is an option. If the customer requires this mode, the detailed requirements shall be specified in the technical specification.

### 4.5 Parking mode (PM)

Parking mode is used when the train is not in operation, and there are no staff or passengers on board. The HVAC system runs normally with different setpoints for temperature and airflow or alternatively, is shut down to conserve energy.

The purpose of parking mode includes frost protection and keeping the interior temperature at a reasonable level. Trains are normally shut down during the night to reduce noise and energy consumption.

This mode is an option. If the customer requires this mode, the detailed requirements shall be specified in the technical specification.

## 4.6 Operating timetable, hours for each mode and category

Operating timetables and the number of hours for each train mode and category shall be specified in the technical specification. If values are not available in the technical specification, the values can be selected from [Table 1](#).

**Table 1 — Train mode (timetable and operating hours)**

| Train mode      | Category 1                                                                                             |                                                                                                                            | Category 2 and Category 3                                                                              |                                                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
|                 | Timetable                                                                                              | Operating hours                                                                                                            | Timetable                                                                                              | Operating hours                                                                                                            |
| TISM            | 5:00 to 24:00                                                                                          | 12 h/day                                                                                                                   | 5:00 to 24:00                                                                                          | 14 h/day                                                                                                                   |
| TRSM            | 5:00 to 24:00<br>excluding peak<br>time<br>7:00 to 9:00<br>17:00 to 19:00                              | 4 h/day                                                                                                                    | 5:00 to 24:00<br>excluding peak<br>time<br>7:00 to 9:00<br>17:00 to 19:00                              | 2 h/day                                                                                                                    |
| [Option]<br>PCM | 5:00 to 24:00<br>excluding peak<br>time<br>7:00 to 9:00<br>17:00 to 19:00                              | 0,5 h/day                                                                                                                  | 5:00 to 24:00<br>excluding peak<br>time shown above<br>7:00 to 9:00<br>17:00 to 19:00                  | 0,5 h/day                                                                                                                  |
| [Option]<br>PM  | 1) 0:00 to 5:00<br>2) 5:00 to 24:00<br>rest of the time<br>excluding the<br>three modes<br>shown above | 1) 5 h/day<br>2) 2,5 h/day<br>addition of all<br>parking mode<br>periods 7,5 h/day<br>includes switch on<br>and switch off | 1) 0:00 to 5:00<br>2) 5:00 to 24:00<br>rest of the time<br>excluding the<br>three modes<br>shown above | 1) 5 h/day<br>2) 2,5 h/day<br>addition of all<br>parking mode<br>periods 7,5 h/day<br>includes switch on<br>and switch off |
| Total           |                                                                                                        | 24 h                                                                                                                       |                                                                                                        | 24 h                                                                                                                       |

## 5 Principles

### 5.1 General

The energy consumption of a HVAC system could be measured on an in-service train for a certain period. Cycles for the HVAC system energy consumption would have to include annual cycles, or at least daily cycles for several days during a year, covering seasonal influences. This method is very time consuming and expensive with poor repeatability regarding the results. Furthermore, simulation of energy consumption for transient conditions in the HVAC system is difficult and not state of the art in view of a precise prediction of energy consumption.

Therefore, a different method shall be applied for the energy consumption of the HVAC system.

A matrix of steady-state operational points is defined to represent the annual climatic and operational conditions. It might be necessary to define different operational points depending on the respective region where the train is operating.

Each operational point is defined by the exterior temperature, corresponding relative humidity, passenger load and equivalent solar load. All operational points are defined at zero train speed.